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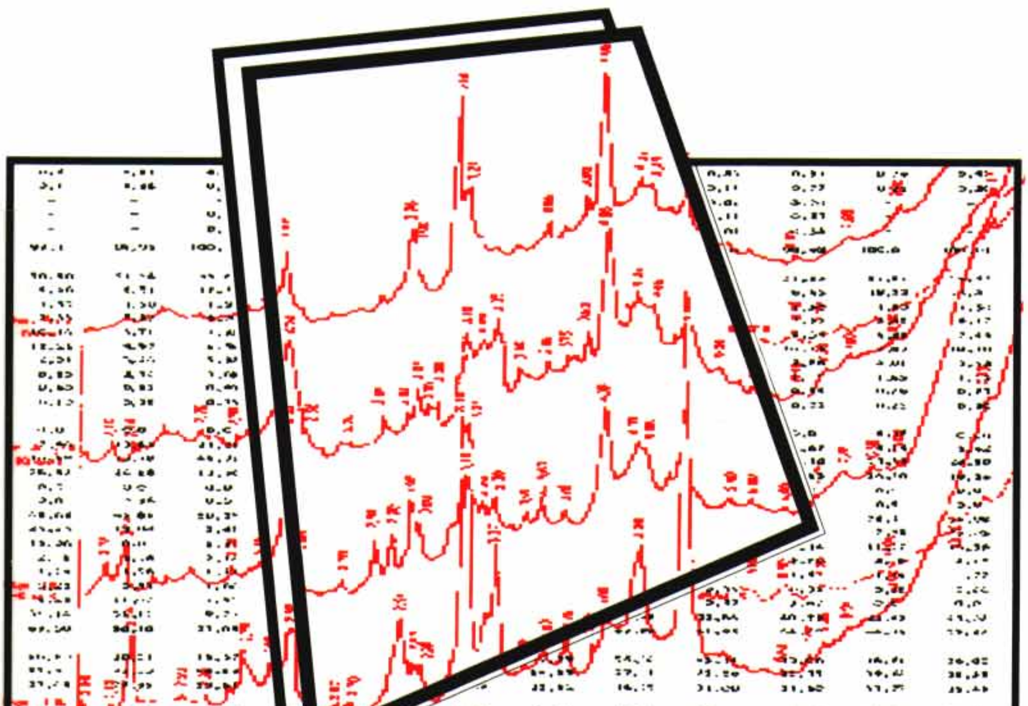
LES INDICATEURS DE SCIENCE POUR LES PAYS EN DÉVELOPPEMENT

SCIENCE INDICATORS FOR DEVELOPING COUNTRIES

Textes réunis, édités et présentés par
RIGAS ARVANITIS et JACQUES GAILLARD



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À la mémoire de
Mike Moravcsik

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VERS UN RENOUVEAU DES INDICATEURS DE SCIENCE POUR LES PAYS EN DEVELOPPEMENT

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Les textes ici réunis forment la quasi totalité des communications présentées lors de la Conférence Internationale sur les Indicateurs de Sciences pour les Pays en Développement organisée à l'UNESCO en octobre 1990. Cette conférence fait suite à un Atelier de travail international organisé en 1985 à l'Institute for Scientific Information (ISI) à Philadelphie[1]..

Présentant un ensemble de 45 textes d'auteurs de 24 pays, ces Actes présentent l'état de l'art sur les travaux quantitatifs portant sur la science et la technologie dans les pays en développement. Plusieurs travaux sont empiriques, originaux et porteurs de renseignements inusités. Ils reflètent avant tout la diversité des approches. Pour un très grand nombre de participants cette diversité fut une découverte. Ces Actes prolongent également l'esprit de la Conférence qui a consisté à briser l'isolement des spécialistes en la matière. Pour la première fois des chercheurs venus de continents différents se rencontraient; pour la première fois nombre d'entre nous se rendirent compte qu'il y avait une véritable communauté de chercheurs travaillant à partir de données quantitatives sur les sciences et les techniques dans les pays en développement. Ce volume tente donc de rassembler l'ensemble des enseignements en la matière, signaler les sources d'information et les types d'indicateurs, souligner les difficultés et les obstacles tant méthodologiques que théoriques et favoriser l'échange entre les diverses expériences à travers les continents.

Mais surtout, cette Conférence a voulu marquer la spécificité de la "scientométrie" -ou "épistèmométrie"[2]- des pays en développement. Bien que dans un très grand nombre de cas, les problèmes ne soient pas de nature différente que dans les pays développés, les différences de proportions sont telles qu'il est le plus souvent difficile d'utiliser les mêmes outils dans les deux cas. La diversité des situations institutionnelles et scientifiques est plus grande parmi les

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[1] La question de savoir si la science produite dans les pays en développement (PED) est représentée de façon adéquate dans les bases de données internationales, et notamment celle de l'ISI, était au centre des débats de l'Atelier de Philadelphie. Le titre du rapport final préparé à l'issue de la conférence: "Strengthening the Coverage of Third World Science" indique clairement qu'elle ne l'est pas. Ainsi, les experts présents à cet Atelier ont estimé que "seulement la moitié de la production scientifique des PED qui répond aux standards internationaux d'excellence est incluse dans l'ISI".

[2] Terme suggéré par Manuel Krauskopf.

pays en développement que parmi les pays occidentaux. Les traditions culturelles sont souvent différentes, les écarts de potentiel scientifique sont nombreux, même parmi des pays de dimensions comparables et les développements scientifiques affectent de manière très différenciée les continents, les pays, les institutions et les hommes.

Pour faire apparaître cette diversité, nous nous sommes efforcé de présenter les textes dans un ordre qui respecte leur contenu, différent parfois de celui de la Conférence. Nous avons également repris les principales conclusions des quatre tables rondes qui furent riches en discussions et commentaires. Les quelques pages qui suivent veulent donc rappeler les débats qui ont été lancés au cours des journées d'octobre 1990 tout en résumant l'essentiel des communications.

Un grand nombre de participants ont exprimé une prise de conscience nouvelle de l'importance du thème des indicateurs de science. A la faveur de cette prise de conscience un renouveau de la réflexion est nécessaire qui doit porter sur les concepts les plus couramment usités: science visible, science utile au développement, communauté scientifique, sont certains de ces concepts incontournables. Ce thème est développé dans la première section de ce texte introductif. Cette réflexion d'ensemble sur les enjeux de la science -et donc des indicateurs de science-, doit en entraîner une autre, plus technique mais tout aussi cruciale, sur les types d'indicateurs et les méthodes de construction, traitement et interprétation des données; ce n'est qu'au prix de cette réflexion que nous obtiendrons les indicateurs les plus adéquats pour la situation particulière des pays en développement (deuxième section). Parallèlement, et de manière complémentaire, il est important de diversifier les sources d'informations (base de données, enquêtes, statistiques), d'améliorer l'accès à l'information. Tâche ardue pour laquelle il faut associer des compétences diverses (documentalistes, spécialistes de l'information, scientifiques, experts). Rien ne se fera si on continue à considérer l'information comme un produit en bout de chaîne de la production intellectuelle, si on continue à ne prendre en compte l'information que sous sa forme de "service de documentation". Le domaine des indicateurs de science suppose un usage non conventionnel de l'information contenue dans les bases de données documentaires; il implique donc un renouveau dans la conception de ces bases et banques de données et la création de bases de données locales (troisième section). Enfin, il est évident que des travaux de comparaison sont nécessaires, entre les différents pays, les disciplines, les institutions. Travaux difficiles mais nécessaires: un des principaux résultats de cette Conférence n'a-t-il pas été de montrer l'extrême diversité des situations derrière une apparente uniformité due au décalage qui existe entre les pays "du centre" et ceux de la "périphérie" ? (quatrième section). Les voies ainsi ouvertes devraient être encouragées par l'existence d'une Association internationale dont l'objectif sera de promouvoir la réflexion dans ce domaine encore trop peu développé (cinquième section).

Les Actes ont été organisés en six parties dont les titres et le contenu sont présentés ci-dessous.

Plan général des Actes

I. De la construction des indicateurs de science
Réflexions d'ensemble sur les hypothèses permettant de construire les indicateurs de science (aspects institutionnels, présupposés idéologiques, considérations pratiques).

II. Structuration des champs scientifiques, évaluation et conditions du développement scientifique
Aspects sociaux de l'organisation de la science dans les PED, structuration des milieux scientifiques, évaluation des disciplines ou des institutions en utilisant des indicateurs scientifiques, circulation des concepts, enquêtes auprès des chercheurs.

III. Collaborations scientifiques et géostratégie
Contexte politique et influence sur les publications, description des collaborations internationales, rapports Nord-Sud, coopération scientifique.

IV. Visibilité et stratégies de publication
Couverture de la recherche du Tiers Monde par les bases de données internationales, comparaison de la part de la science des PED dans diverses bases de données, rapport entre les publications mainstream et publications locales, stratégies de publication et stratégies de communication, effets "d'in-breeding".

V. Le rôle des revues scientifiques
Importances et caractéristiques des revues scientifiques des PED, politiques de soutien des revues locales, création de nouveaux moyens de communication scientifique, évaluation de l'impact des revues des PED.

VI. Les systèmes nationaux de recherche
Mesure des moyens disponibles pour la recherche, description des systèmes ou sous-systèmes nationaux de recherche, relation input-output, bases de données pour les décideurs ("policy makers").

Rechercher les déterminants structurels de la faible visibilité internationale de l'activité scientifique des PED

Les participants de la Conférence ont signalé à maintes reprises que, puisque la faible visibilité de la science dans les PED ne semble pas s'améliorer rapidement, les causes de cette faible visibilité doivent être recherchée au-delà du simple problème technique de la représentation de la science des PED dans les bases de données. Ainsi, Arunachalam suggère que les problèmes sont complexes, et par conséquent, les solutions qu'il faudra trouver sont également complexes. Elles doivent porter sur plusieurs aspects: circulation et diffusion de l'information scientifique des PED vers le "mainstream", fonctionnement de l'évaluation scientifique, participation des chercheurs dans les débats internationaux. L'ensemble de ces questions renvoient au rôle et fonctions de la science dans le contexte des PED. De nombreux participants ont tenu à souligner l'importance des mécanismes institutionnels, le rôle particulier que joue l'activité scientifique dans les PED, la question du fonctionnement social de la science (Voir encadré Table ronde 1).

PREMIERE TABLE RONDE
La visibilité de la science des pays en développement
présidée par Hebe Vessuri

- La visibilité de la science est-elle une fonction de la gestion de l'information scientifique ou des stratégies de la recherche scientifique ?
- Science nationale ou science international : l'universalité du savoir est-il un argument suffisant en faveur de la science internationale ?
- Le complexe "périphérique" des chercheurs de la périphérie est-il responsable de la mauvaise gestion de l'information scientifique ?
- Comment les relations géo-stratégiques affectent-elles les frontières disciplinaires ? Existe-il des disciplines plus internationales que d'autres et donc plus visibles ?
- Quels sont les effets des collaborations scientifiques internationales ?
- Que signifie publier dans les PED ? Les scientifiques publient-ils pour diffuser le savoir ou pour des raisons liées à l'évaluation ? Pourquoi existe-il une quantité tellement importante de littérature grise ? Pour quelles raisons devrait-on ou non publier dans des revues institutionnelles (revues "maison") ?
- Quel est le rôle et la vie des revues scientifiques locales ?
- Quels sont les effets des stratégies éditoriales des revues scientifiques locales, notamment sur la quantité d'articles produits ?

Science nationale ou science internationale ?

La réflexion a tout d'abord porté sur la notion de science au service du développement. En effet, comme le soulignait Hebe Vessuri lors de la Conférence, de manière assez caricaturale, il est facile d'opposer la science pour le développement et le développement de la science. Vaut-il mieux, au nom de l'universalité du savoir, développer les activités scientifiques quelle qu'elles soient, ou vaut-il mieux opérer des choix thématiques en fonction de l'utilité des savoirs dans le développement économique et social du pays ? La réponse à cette question implique des indicateurs différents. Question qui est donc loin d'être anodine, qui forme même le coeur des débats de politiques scientifiques dans les PED.

Focaliser l'attention de manière trop exclusive sur l'internationalisme ou le nationalisme revient tout simplement a oublier des facettes méconnues de la configuration sociale de la recherche, de son histoire, de ses particularités nationales. Car en effet, comme le souligne Saldaña, à force de crier haut et fort que la science est universelle on en vient à oublier que ses conditions d'application et de développement sont locales. On en vient aussi, et ceci est peut-être plus grave encore, à cultiver une sorte de schizophrénie: d'une part le chercheur est sommé de faire de la science universelle, de l'autre il est appelé à répondre aux mandats du développement national.[3]

La Conférence a montré que stratégies nationales et stratégies internationalistes ne s'opposent pas nécessairement. Tout est fonction, non pas d'un choix vers une direction nationale ou internationale, mais plutôt en fonction de l'utilitarisme plus ou moins déclaré des activités scientifiques. C'est dans les critères même de l'évaluation de la recherche que ceci devient apparent.

En effet, comme le soulignent Larissa Lomnitz et Susana García Salord au sujet du Mexique, la définition de ce que doivent évaluer les organismes de promotion de la recherche devient un enjeu de débat politique. Face aux restrictions budgétaires, les institutions de recherche de caractère institutionnel différent se trouvent de plus en plus en concurrence pour des ressources de plus en plus rares. Il y a donc nécessairement concurrence, notamment entre recherche académiques et recherche finalisée ou -plus rarement- industrielle. Ce qui fait problème c'est que tout le monde reconnaît que les critères d'évaluation doivent être différents dans les deux cas. Il y a donc discussion non pas sur la validité des jugements issus de la règle du jeu actuel, mais plutôt remise en cause de cette règle du jeu. On se rend donc bien compte que la légitimité des financements est soumise à une forte pression et que les agences financières risquent de se trouver au centre de débats inextricables. C'est là l'intérêt des indicateurs: mettre à plat les données, connaître les enjeux avec précision (nombre de contractants potentiels, taille de la communauté scientifique, effet et impact des financements en cours, distribution sectorielle et disciplinaire).

Une autre origine du débat national/international réside dans les "styles" de science, comme les appellent Waast et Gaillard, à savoir "un idéal et des normes professionnelles...". Il existe des disciplines et des configurations institutionnelles particulières qui favorisent plutôt la production d'articles; d'autres au contraire dont la production d'articles scientifiques dans les revues mondiales est moins important. Dans le premier cas se trouvent généralement les sciences

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[3] C'est cette contradiction qu'a étudié au Venezuela Arvanitis (1990), De la recherche au développement. Les politiques et pratiques professionnelles de la recherche appliquée au Vénézuéla, Thèse de Doctorat, Paris VII.

biomédicales; dans le second cas on retrouve plus volontiers les sciences agricoles.

Le style de science est souvent lié à une opposition des modèles institutionnels. Ceci est particulièrement frappant dans le cas des pays africains, comme le signale par exemple Adamson au sujet du Nigeria.[4] En effet, les anciennes colonies britanniques ont développé sous la colonie un style institutionnel, où les débouchés de la recherche sont la métropole, et, par voie de conséquence, les revues anglaises. Avec l'arrivée de la deuxième et troisième génération de scientifiques nigérians, on voit se développer un autre standard de recherche, plus orienté vers les nécessités du pays, cherchant des débouchés locaux.

Malheureusement, concomitant à ce développement, on assiste dans un grand nombre de pays à une érosion bureaucratique de l'infrastructure scientifique, une augmentation massive des besoins en enseignement due à une croissance souvent spectaculaire des effectifs d'étudiants, qui rendent la tâche de la recherche au sein des universités très difficile. Ces phénomènes ne sont pas spécifiques au Nigéria. Loin de là. Les mêmes constatation ont lieu au Zimbabwe, au Venezuela, en Argentine, au Chili, pour ne citer que quelques pays sur lesquels nous disposons de données et d'études précises.[5]

Cette très importante détérioration des conditions de recherche dans les universités des PED est endémique.[6] Les chiffres de production scientifique s'en sont ressenti. Or, en dehors de la crise qui frappe les universités, la dynamique de la recherche permet tant bien que la de faire face. Ce sont plus les initiatives personnelles des chercheurs, leur intense activité pour construire des collaborations scientifiques aussi bien au niveau international[7] que national[8] qui permettent à la science non seulement de subsister mais aussi de se développer. Cette intense activité de construction des réseaux, souvent informels, devrait être prise en compte au moment de la construction et de l'interprétation des indicateurs

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[4] Une étude récente des sciences agricoles au Zimbabwe menée par Eva Rathgeber de l'IDRC confirme cette situation. Rathgeber, 1991, comm. pers.

[5] Cf. par exemple, Eva Rathgeber sur le Zimbabwe, Polanco et Yero ainsi que Pirela, Rengifo et Ynaty (Estudio sobre la participación de investigadores del Estado venezolano en el desarrollo del país, CENDES, Caracas, 1990) sur le Venezuela, Krauskopf sur le Chili.

[6] Cf. le recueil d'articles sur le sujet dans Carlos Augusto Di Prisco et Erika Wagner (eds, 1990) Investigación y docencia en la Universidades, INTERCIENCIA /Fondo Editorial Acta Cientifica Venezolana, Caracas; H.Vessuri, (1986) The Universities, Scientific Research and the National Interest in Latin America, Minerva 24(1), pp. 1-38; on mentionnera aussi l'intéressant recueil d'articles sur les universités en Amérique latine paru dans la Revue Nueva Sociedad, no.107, Mayo-Junio 1990.

[7] Cf. Voir section III des Actes les articles de Narvaez-Berthelemot et alii. et Fernández et alii sur l'Amérique du Sud; El Alami et alii. sur les pays Arabes.

[8] Cf. Arvanitis et Bardini. Mais aussi les réponses formulées par les chercheurs aux questionnaires de Szarina Abdullah (Malaisie) et M.A. Cagnin (Brésil).

de science. L'appareil de la recherche dans la plupart des PED est moins structuré que dans les pays du Nord. Cette informalité est constitutive de la science dans les PED.[9]

Cette informalité des structures est saisissante pour tout observateur attentif. On observe plutôt une collection de petits groupes de chercheurs dans la plupart des PED, un monde assez peu structuré. Ainsi, en Inde, assiste-t-on à des véritables groupes d'adeptes autour d'un maître incontesté.[10] Rendre compte de ces "effets d'école" devrait être un intéressant objectif des travaux de bibliométrie. Viswanathan suggère que l'on effectue de véritables arbres généalogiques de la science pour repérer ces écoles. Dans le même sens, Delgado et Russell suggèrent que compter le nombre d'articles par chercheurs n'a pas de sens dans les PED; c'est plutôt en termes de production de groupes de chercheurs qu'il faut raisonner.

Les facteurs géo-politiques

Un autre phénomène trop rarement pris en compte et qui joue un rôle déterminant dans la constitution de l'activité scientifique dans les PED est la toile de fonds géopolitique. La position géographique et politique des pays en développement influence très certainement les contenus des sciences, les types de travaux, les types de collaborations envisagées. Un exemple de l'influence des facteurs géopolitiques nous est fourni par le travail de Lancaster et Abdullah qui étudient l'influence des pays de l'Est en Egypte et à Cuba à travers les citations. Curieusement, l'orientation politique vers le bloc socialiste a eu moins d'effets sur les références citées par les chercheurs cubains que sur celles des chercheurs égyptiens. A ce sujet, Lancaster et Abdullah ne fournissent pas d'explication. Peut-être réside-t-elle dans le fait que le style de science développé par les Cubains, les disciplines qui y sont prioritaires, ne sont pas des disciplines très prisées par les chercheurs soviétiques ou ceux des autres pays dits socialistes. Ou faut-il s'interroger sur le fait que nombre de pays Arabes ont été beaucoup plus proche de l'Union soviétique politiquement et culturellement que ne l'a été Cuba, qui n'a jamais interrompu ses relations avec les autres pays latino-américains. Ou encore, faut-il voir là le fait que la science à Cuba a connu une croissance proportionnellement plus importante dans la société que ce ne fut le cas en Egypte.

Les relations privilégiées qu'entretiennent les PED avec telle ou telle puissance ont certainement des effets sur le choix des sujets de recherche et l'orientation des travaux. On peut à ce sujet mentionner les suggestions de Chatelin sur les

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[9] Comme le souligne Argenti.

[10] comme le suggère Viswanathan. Le phénomène de création des écoles de pensée dans les PED a été très peu examiné.

"dominations scientifiques"[11] qui s'expriment au sein des disciplines scientifiques, mais qui ont des effets très profonds quant aux orientations de la recherche dans les PED. Un exemple peut être fourni par la pédologie, très différente selon qu'elle est executée "à la française" ou "à l'américaine. Mais ce sujet mérite une attention minutieuse, car les apparences peuvent être singulièrement trompeuses. C'est le cas par exemple des travaux sur les "farming systems" que l'on a prétendu longtemps très différents parmi les anglophones par opposition aux francophones. Cela pourtant ne semble pas être le cas.[12] Ce clivage semble assez peu fondé. Par contre, il existe des véritables différences de méthodes, de cadres de références, d'objets de recherche selon que les recherche sont effectuées par des institutions de type internationales ou par des institutions plutôt nationales.

Cette toile de fond géopolitique a été peu explorée, et notre conférence montre qu'elle nous fait cruellement défaut. Trois pistes de recherche sont suggérées pour lesquelles nous ne disposons que de fort peu de travaux: les migrations scientifiques[13], les effets des formations des chercheurs des PED dans les pays du Nord, les impacts des financements internationaux de la recherche et de l'aide à la recherche et la coopération scientifique internationale.[14]

Seul ce dernier aspect a reçu une attention particulière lors de la Conférence.[15] Il semble en effet que les collaborations scientifiques internationales sont très largement sous-estimées par l'analyse bibliométrique et que les choix de collaborations ont des effets durables sur la production et les choix de sujets aussi bien dans les pays du Nord que les pays du Sud. A ce sujet on pourrait rappeler que rares sont les collaborations Sud-Sud, et ceci renvoie à ce que Roche avait appelé le complexe périphérique: les chercheurs des pays du Sud préfèrent collaborer avec les pays du Nord et font plus confiance à leurs pairs du Nord[16]. Les causes de cette préférence restent à examiner, car pour le moment nous n'en sommes qu'au stade des conjectures.

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[11] Selon l'expression de Yvon Chatelin (1985) Quelques effets de blocage dans la recherche des milieux naturels tropicaux, "Pratiques et politiques scientifiques" Bulletin de liaison no.1 du département H (ORSTOM), pp.16-21.

[12] Pillot,Didier (1987) Francophone and Aglophone Farming Systems Research: Similarities and Differences, GRET: Paris/Hat Yai: Thailande, April 1987.

[13] Mais voir par exemple Hebe Vessuri (1983) Scientific Immigrants in Venezuela: National Identity and International Science, Marks,A.; Vessuri,H. (eds) White Collar Immigrants in The Americas and The Carribean, pp.171-198, Leiden:Dpt Carribean Studies, Royal Institute of Linguistics and Anthropology.

[14] Voir les travaux du LEPI (ici articles de Narvaez-Berthelemot et alii. et El Alami et alii.).

[15] Section III des Actes.

[16] Voir à ce sujet la thèse de Lea Velho, 1985, Science on the Periphery: a Study of the Agricultural Scientific Community in Brazilian Universities, SPRU, Iniv. of Sussex. Voir également Jacques Gaillard, 1991, Scientists in the Third World, The University Press of Kentucky, Lexington, 190 pages.

Il est clair que là se trouve des orientations de la recherche scientométrique qui devraient se renforcer. Car, en s'attachant à une bibliométrie trop descriptive on manque l'essentiel. D'ailleurs on ne semble pas avoir considérablement avancé depuis les fameux travaux de Frame, Narin et Carpenter (1977) sur la distribution de la science mondiale[17].

La multiplicité des modèles de développement

Pour comprendre ces dynamiques assez complexes, il faut se rendre à l'évidence: il existe une véritable stratification scientifique, par disciplines, par institutions, par pays ou zones géographiques. On voit que nous sommes loin de l'image simpliste d'une science internationale qui s'opposerait à une science localiste.

En réalité la division national/international relève de l'opposition de deux modèles institutionnels, de deux styles de science que l'on suppose opposés. D'un côté il y aurait un premier modèle où l'Etat joue un rôle fondamental, avec une action locale et en référence à un débat politique national (fonction publique). Son exact opposé serait un modèle académique "pur" régulé par les scientifiques eux-même par le biais d'associations savantes. Dans ce cas l'AAAS et la BAAS ont été le modèle de référence notamment au sein de l'Unesco et parmi de nombreux scientifiques qui ont été des constructeurs d'institutions scientifiques (voir les cas de l'ASOVAC au Venezuela ou de la SBPC au Brésil).[18]

Mais le paysage institutionnel s'est beaucoup enrichi. Ainsi rencontre-t-on le modèle de la fondation agissant au niveau international soit avec des moyens de recherche propres (type Institut de recherche agronomique)[19] ou au contraire fonctionnant sur le principe des bourses de recherche individuelle (Fondation Internationale pour la Science) ou institutionnelles (fonds de financements internationaux type programme Science Technologie Développement de la CEE).

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[17] Frame, J.D.; Narin, F. & Carpenter M.P. (1977) The distribution of World science, Social Studies of Science, Vol. 7, pp.501-516.

[18] Cf. pour le Venezuela, par exemple, Díaz, Elena (1983) Aspectos socio-políticos de la formación de la élite científica en Venezuela, in Díaz, Texera,Vessuri (ed), La ciencia periferica Monte Avila, Caracas.; pour la Sociedade Brasileira de Progreso da Ciência (SBPC) voir Botelho, Antonio J.J. (1989) Struggling to Survive: The Brazilian Society for the Progress of Science (SBPC) and the Authoritarian Regime (1964-1980), Historia Scientiarum, No. 38,pp. 45-63 et Botelho, Antonio J.J. (1983) Les scientifiques et le pouvoir le cas de la Société Brésilienne pour le Progrès de la Science, Mémoire de DEA, Centre Science-Technologie-Société, CNAM, Paris.

[19] Sur la diffusion du modèle agronomique nord-américain voir Rogers, Everett M. (1989) Evolution and transfer of the US extension Model, in The Transformation of International Agricultural Research & Development, J.Lin Compton (ed), Lynne Rienner Publishers, Boulder, Colorado, pp.137-152, et Flora,C.B. et Flora, J.L. (1989) "An Historical Perspective on Institutional Transfer", in idem, pp.7-32.

Enfin, les nouvelles technologies, qui sont des domaines à haute technicité et fort input de science (biotechnologie, nouveaux matériaux, électronique, chimie fine, nouvelles énergies) contribuent à la mise en place d'un nouveau modèle qui associe très étroitement des recherches publiques et universitaires avec des laboratoires de recherche industriels.[20]

Ces différentes configurations mériteraient d'être mieux étudiées car la production scientifique, n'est pas le produit d'un monde homogène qui serait une "communauté scientifique internationale", pas plus qu'il n'existe cette fiction d'une "communauté scientifique nationale".[21] A ce sujet, le cas de Singapour est un exemple original de développement scientifique sans le développement d'une véritable communauté scientifique.[22]

Ces différences institutionnelles recouvrent partiellement des choix disciplinaires différents et, partant, des différences de visibilité internationale. Ainsi, les travaux sur la production animale semblent produire des publications et des produits de recherche orientés vers le national, alors que les travaux sur les substances pharmaceutiques naturelles sont plus orientées vers l'international.[23] Il est clair que le choix disciplinaire va donc obligatoirement imposer un choix de débouché pour la production. Travailler sur les conditions agronomiques d'une culture sera plus localiste que travailler sur la biochimie d'une toxine d'une plante issue de cette même culture.[24] Certaines disciplines connaissent un équilibre entre ces deux débouchés: c'est le cas de l'aquaculture, à la fois forte productrice de savoir faire techniques locaux et de publications internationales. Cela est dû à la nature même des travaux à la fois de biologie assez fondamentale et de technique, mais aussi à l'histoire propre des recherches en aquaculture, domaine très largement issu d'un mouvement extrêmement volontariste de développement technique et scientifique.[25] Ainsi, les orientations de recherche n'impliquent pas nécessairement des productions d'articles dans les revues internationales du fait de la nature même du sujet. Un bon exemple est fourni par la sociologie au Chili

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[20] Voir par exemple Botelho sur la diffusion du modèle MIT, Conférence sur l'Emergence des communuatés scientifiques dans les PED, Annaba (Algérie), ISG/ORSTOM, Réseau ALFONSO

[21] Le terme même de communauté scientifique, dont l'origine remonte à Michael Polanyi renvoie à un modèle d'organisation particulier de la science, Voir J.Gaillard (forthcoming) Scientists and Scientific Communities in Developing Countries, in J.J. Salomon et F.Sagasti (eds) Science, Technology and development: A source book.

[22] Cf. Goudineau, Yves (1990) Etre excellent sans être pur. potentiel technologique et pouvoir technocratique à Singapour, Cahiers des Sciences Humaines (ORSTOM), Vol.26,no.3.

[23] J. Gaillard (1991), op. cit.

[24] Arvanitis et Bardini.

[25] Sur la constitution du champs de l'aquaculture par exemple en France voir Serge Bauin (1986) Aquaculture: A Field by Bureaucratic Fiat, in Callon, Law et Rip (eds) Mapping the dynamics of science and technology, Macmillan, London.

qui fut assez conservatrice dans ces thématiques, toujours d'intérêt local, mais avec un grand nombre de contacts étrangers sur des sujets d'intérêt locaux.[26] Certains sujets sont toujours à cheval entre le planétaire (universel) et le local, entre le fondamental et le technologique. Ainsi en est-il par exemples des questions environnementales (l'effet de serre, le rôle de ressources forestières dans la désertification, le réchauffement de la planète, les effets des changements climatiques, la pollution). De manière générale, l'opposition entre le local et l'universel est une caricature. Peut-être le débat s'est-il focalisé sur cette opposition car n'ont pas été suffisamment pris en compte des thèmes qui débordent très largement la bibliométrie. Ainsi par exemple en est-il du développement technologique (l'apprentissage industriel et technologique, la maîtrise technique des équipements, le rôle des équipements scientifiques et appareils de mesure), du rôle des disciplines les plus appliquées (production animale tropicale, épidémiologie, sciences d'ingénierie, chimie, etc...).

Ce recouvrement partiel entre les modèles institutionnels de développement scientifique et les choix disciplinaires est probablement le phénomène le plus important qui doit servir de référence aux travaux sur les publications scientifiques.

Les stratégies individuelles de publication

Si l'on examine avec plus d'attention la production scientifique des PED, on se rend compte qu'il existe non pas deux types de production, une qui serait locale et une autre qui serait internationale, mais au moins trois types de productions. Une production orientée vers des revues internationales, publiée en anglais. C'est ce que nous avons accepté d'appeler communément le "mainstream".[27] Mais au sein même de la production dite locale semble coexister deux courants: l'un s'apparente au mainstream, l'autre semble nettement plus localiste. Le cas de Taiwan, Singapour, la Malaisie et la Corée du Sud, étudié par Eisemon et Davis[28] est explicite à ce sujet: "... non mainstream science appears to be composed of two literatures. Local language and English, which share a common English language information base but wich differ in their use of local language literature" (Eisemon et Davis, 1990: 345). Dans des pays comme le Brésil, qui dans l'ensemble, ont une très nette préférence pour des stratégies de

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[26] Barrios, A. & Brunner, J.J. (1988) La sociologia en Chile, Instituciones y practicantes, FLACSO: Santiago de Chile.

[27] Bien que ce soit une généralisation parfois excessive: quel rapport y a t'il entre une revue comme Nature ou Science et une petite revue de nématologie ou de physiologie végétale?

[28] Thomas O. Eisemon et Charles H. Davis (1990) Publication Strategies of Scientists in Four Peripheral Asian Scientific Communities: some issues in the measurement and interpretation of non-mainstream science, in Philip G. Altbach (ed) Scientific Development and Higher Education, Praeger, New York.

recherche "localistes"[29], cette double littérature est plus difficile à repérer, car il n'y a pas deux différentes langues employées dans les articles qui sont publiés localement. C'est de là que provient le débat sur le "localisme", l'in-breeding.[30] En effet, il existe dans la plupart des pays en développement des revues produites par les universités, par les institutions de recherche elles-même et qui attirent de manière préférentielle la production des chercheurs de l'institution. Du coup, la production des chercheurs de cette institution diffuse assez peu hors de ses murs. Le débat est ouvert, car pour le moment les résultats des recherches montrent qu'effectivement il y a in-breeding, mais que ce phénomène est encore mal quantifié notamment à cause d'une certaine confusion qui règne quant aux termes employés (mainstream, local, cosmopolite, national, international).

La première confusion porte sur les auteurs. On tend à considérer que les auteurs publient toujours d'une seule et même façon, soit internationalement, soit nationalement, soit uniquement dans des revues institutionnelles. Ceci est faux par exemple dans le cas des pays étudiés par Eisemon et Davis: 61% des chercheurs qui publient dans les revues locales apparaissent dans le Current Biographic Index, alors que seuls 1% des papiers non mainstream apparaissent dans le SCI. Ces auteurs sont cosmopolites et publient à la fois localement et internationalement. Les travaux de Gaillard aboutissent également à la même conclusion. Ces chercheurs des PED qui vivent à cheval entre le mainstream et le local jouent un rôle très important car il permettent de rendre la science locale visible internationalement. Ainsi, par exemple, les écologistes argentins qui publient dans les revues mondiales, publient aussi dans des revues locales, et c'est leurs références aux travaux publiés localement qui permettent de diffuser la science locale au niveau international.[31] Mais leur rôle ne se borne pas à cela: ce sont aussi des médiateurs qui permettent d'intéresser des chercheurs étrangers, quelque soit leur origine aux travaux menés dans leur pays. Un exemple est fourni par Arvanitis et Bardini qui mentionnent le cas de ce chercheur vénézuélien qui fait connaissance en Afrique avec un chercheur français, à la suite de quoi a pu se mettre en place tout un programme de recherche international autour d'un sujet de recherche intéressant le développement de l'agriculture tropicale.

Par ailleurs, Eisemon et Davis montrent que les chercheurs nationaux qui reçoivent le plus de citations non seulement publient dans les revues mondiales mais aussi sont ceux qui publient le plus dans les revues locales. On rejoint ici la

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29 R. Arvanitis et Y. Chatelin (1988) National Scientific Strategies in Tropical Soil Sciences, Social Studies of Science, 18(1), pp.113-146, qui comparent les stratégies de publication au niveau national; sur le Brésil voir Cagnin, Maria Aparecida (1985) Patterns of Research in Chemistry in Brazil, Interciencia, Vol 10, pp.64-77.

30 Velho, Lea; Krige,John (1984) Publication and citation practices of brazilian agricultural scientists, Social Studies of Science, 14, pp. 45-62.

31 Voir Section IV des Actes, en particulier Rabinovitch sur la visibilité de l'écologie en Argentine.

quasi totalité des problèmes posés par les travaux de bibliométrie. Pour y voir plus clair dans le futur il est nécessaire d'examiner ces stratégies individuelles des chercheurs nationaux, sans même parler des stratégies de recherche qui sont orientées avant tout vers des résultats pratiques destinés non pas aux autres scientifiques mais aux utilisateurs de la science (agriculteurs, producteurs, industries, administrations publiques).[32]

Une deuxième confusion porte sur la notion de qualité. On assimile, un peu vite, qualité scientifique et publication mainstream internationale. En publiant au niveau international, les chercheurs valideraient la qualité de leurs travaux. Sous jacente est cette idée que la communauté scientifique internationale est la seule capable de juger de la qualité de la recherche. De nombreuses institutions de financement de la recherche exigent même de leurs chercheurs des publications mainstream. Tout concourt donc pour confondre qualité et publication dans des revues mainstream: le désir des chercheurs d'être reconnus internationalement, la pression des organismes de recherche nationaux et des financeurs internationaux, le manque de scientifiques locaux de haut niveau pour juger de la qualité des travaux.[33] Il y aurait donc, par la voie de la publication internationale, un passage de l'obscurantisme à la lumière, de la médiocrité à l'excellence. Pourtant, divers éléments devraient nuancer cette vision. Nous assistons à un long processus de croissance de l'activité scientifique qui prend des formes qui ne répondent pas à un simple schéma d'adoption des modèles scientifiques "centraux".[34] Le fait de voir la production internationale d'un institut scientifique croître considérablement ne signifie pas nécessairement que cet institut fait tout d'un coup de la bonne science. Ce serait plutôt qu'il a changé de stratégie de légitimation de son activité.[35] Car certaines légitimités s'acquièrent par la publication dans des revues mondiales; d'autres passent par d'autres cheminements, par exemple par la participation dans les organismes locaux de développement économique, agricole, social, ou encore par le renforcement des statuts -non nécessairement

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32 Un essai d'analyse de ce type a été fourni par Chatelin et Arvanitis sur le cas des pédologues tropicaux français, Y. Chatelin, & R. Arvanitis (1989) Between Centers and Peripheries: the rise of a new scientific community, Scientometrics, Vol.17 (5-6), pp. 437-452.

33 En ce sens voir F.Spagnolo (1990) Brazilian scientists' publications and mainstream science: some policy implications, Scientometrics, Vol.18 (3-4), pp.205-218. Voir le débat entre Velho et Moravscik dans Scientometrics, Vol.11 (1987).

34 Voir le cas de la réinterprétation de la science occidentale par les physiciens indiens décrite par Kapil Raj (1987) Hermeneutics and cross-cultural communication in science: the reception of Western scientific ideas in 19-th century India, Revue de Synthèse, IV, No.1-2, pp.107-120.

35 Un bon exemple allant dans ce sens est l'analyse de la production d'un institut de biochimie au Mexique, Lomnitz, L.A.; Rees, M.W. & Cameo, L. (1987) Publication and referencing patterns in a Mexican institute, Social Studies of Science, Vol.17, pp. 115-133.

scientifiques- des chercheurs[36]. Ces autres voies sont moins connues et le demeureront tant qu'on associera systématiquement excellence et production mainstream internationale.

Une troisième confusion porte sur la notion même de communauté scientifique. La vision de la communauté scientifique sous-jacente au débat sur la visibilité internationale est celui d'une communauté internationale qui fonctionnerait de manière homogène. Or nous savons tous que les communautés scientifiques des pays centraux sont loin d'être homogènes. Tous les travaux de sociologie des science des dix dernières années le prouvent. Quelle raison y a-t-il alors pour considérer que la communauté "internationale" est homogène dès que l'on envisage la question de la production scientifique des PED ? Les stratifications disciplinaires et institutionnelles dont nous faisions état sont également valables pour l'ensemble du globe. Il faut donc examiner les questions autour de la visibilité avec les mêmes outils et les mêmes interrogations dans les pays du Sud comme dans les pays du Nord. Parmi les déterminants de la production des PED nous venons de mentionner les stratégies de légitimation qui sont particulièrement importantes dans des pays où il n'existe pas de tradition scientifique ancienne, mais dont les mécanismes de fonctionnement ne sont pas fondamentalement différents au Sud ou au Nord. Mais il y a un autre aspect, que l'on peut qualifier de socialisation. Par là nous voulons signaler le fait que les chercheurs des PED doivent construire de toutes pièces leur environnement social de recherche. Ils doivent en effet mettre en place leurs propres réseaux de collaborations, ils doivent créer leur environnement de recherche, ils doivent se donner de toutes pièces les conditions d'une recherche efficace. C'est pour cette raison que les chercheurs évoquent lors des enquêtes sur les conditions de travail l'importance de la communication entre chercheurs, la nécessité d'entretenir le débat scientifique, le besoin de participer à des conférences internationales et nationales. C'est ce qui ressort particulièrement de l'enquête auprès des chimistes menée au Brésil par Cagnin. Il faut souligner tout particulièrement la participation à des colloques et conférences, car plusieurs participants y ont fait référence et de nombreux travaux confirment le rôle essentiel que jouent les colloques et réunions.[37] Le cas de figure d'une communauté très orientée vers des sujets locaux, adoptant une stratégie localiste de publication tout en déployant une intense activité de participation à des colloques est beaucoup plus fréquent que ne le suppose le modèle "internationaliste".

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[36] C'est le cas généralement des ingénieurs agronomes. Pour les ingénieurs au Moyen Orient, cf. E. Longuenesse (ed., 1990) Bâtisseurs et bureaucrates. Ingénieurs et société au Maghreb et au Moyen Orient, Maison de l'Orient, Lyon (France). Sur les ingénieurs agronomes au Venezuela, voir Arvanitis et Bardini (1990) Le rôle de l'ingénieur agronome au Venezuela, Cahier des Sciences Humaines, Vol. 26, no.3.

[37] Cf. Arunachalam entre autres.

Ces quelques observations indiquent la multiplicité des motivations des chercheurs quant à la diffusion de leurs travaux. La grande majorité des chercheurs des PED semblent être à la fois localistes et cosmopolites. Leur stratégies de publication ne répondent pas donc à une motivation unique (le prestige ou l'utilité), mais à un "mix" de motivations quant à leur carrière (évaluation, prestige, légitimité), le choix de leurs stratégies de recherche (population privilégiée à laquelle ils cherchent à s'adresser), le choix de leurs thèmes de recherche (dynamique scientifique, pression des demandes externes à la recherche). Publier dans le mainstream est donc le résultat de ces choix préalables.[38] Enfin, tout semble indiquer que le niveau d'analyse doit être avant tout le groupe de recherche, voire l'institution, plus que le chercheur individuel.[39]

La question des revues scientifiques

Nous ne pouvons examiner les stratégies de publication sans examiner les véhicules de publication. En effet, la production dépend non seulement des choix individuels et institutionnels, mais aussi de la possibilité qu'ont les chercheurs de trouver le support adéquat pour diffuser leurs connaissances. Or dans les PED, c'est là l'un des problèmes majeurs, qui en grande partie détermine la nature des stratégies de diffusion des savoirs.

La première question qui se pose est celle du coût de la publication. En effet, trop souvent on fait l'impasse sur ce thème, en considérant que le moyen de diffusion est neutre.[40] En cette époque de l'information et de la communication, après les travaux pionniers de MacLuhan, une telle supposition a de quoi étonner. A juste titre Cano rappelle que les entreprises d'éditions doivent satisfaire à des impératifs économiques. Pour une revue d'ampleur internationale, les investissements commencent à être rentabilisés aux alentours de cinq ans.[41] Il est clair, de plus, que les subventions aux publications locales jouent un rôle important.[42] On ne peut donc pas faire abstraction de cette économie des publications. Peu de travaux permettent de faire le point à ce sujet, d'autant plus que le coût d'accès à une publication internationale en langue anglaise pour un non anglophone provenant d'un PED est nettement plus élevé que pour un

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38 Si on s'en réfère par exemple au cas des chercheurs en agriculture en Malaisie, la publication mainstream est loin d'être leur principale préoccupation, Voir Szarina Abdullah.

39 On peut mentionner à ce sujet que l'attention exclusive portée au chercheur individuel est probablement un biais introduit par cette vision idéalisée de la communauté scientifique internationale dont les origines remontent probablement à la conception "universaliste" signalée par Polanyi et par la sociologie de Merton.

40 Mais voir ici même les contributions de Moriconi et Cano.

41 Jarvis, cité par Cano.

42 Moriconi.

anglophone provenant d'un pays du centre. C'est pour cette raison que nombre de chercheurs interrogés ont indiqué que l'une des raisons pour lesquelles ils publient dans des revues locales est le coût relativement plus faible et la facilité d'accès à ces revues comparativement aux revues internationales. Il est urgent de remédier à cette situation, en commençant des évaluations précises et quantifiées des coût de publication aussi bien du côté des éditeurs que du côté des auteurs.

Un des principaux facteurs déterminant la visibilité est non seulement le fait de publier en anglais, mais de le faire dans des revues publiées régulièrement. La disponibilité de l'information est probablement un des éléments les plus importants pour un chercheur.[43] Cette régularité est aussi fonction de la structure scientifique, dont nous parlions précédemment (déterminants individuels et institutionnels). Les entreprises commerciales d'édition utilisent elles-même des indicateurs parfois peu précis mais très parlants: existence de conférences sur un sujet donné, viabilité et existence de sociétés académiques sur un sujet, nombre de diplômés de quatrième niveau par disciplines. Enfin, pour être lancé un journal nécessite de disposer du matériel suffisant pour une année entière. Il est rare que les revues institutionnelles des PED et les petits bulletins qui bourgeonnent çà et là répondent à des critères aussi stricts et des stratégies commerciales aussi bien définies, ce qui explique aussi leur mortalité élevée.[44] De nombreuses revues actuellement dans les PED ont été créées autour d'une école de pensée ou de groupes de recherche qui ne sont pas éternels.[45]

Les chiffres de Cano sont éloquents: les publications d'Amérique latine sont orientées essentiellement vers des publics locaux. Seules 45% des revues ont un ISSN, seules 11% des revues sont indexées, seules 20% des revues ont un éditeur nommé dans la revue, seules 22% ont un domaine bien défini et mentionné en clair dans les pages de la revue. Parmi les types d'éditeurs, le secteur académique et le secteur commercial sont responsables pour un tiers des revues, le gouvernement pour un quart. Seules 20% des revues sont multilingues ou ont des résumés multilingues. Enfin 74% des revues ne connaissant pas leurs chiffres de circulation ou ne les mentionnent pas. La plupart des fois, ce sont les publications officielles, publiées par des organismes publiques, qui présentent ces aspects. Les revues publiées par des universités ou des sociétés savantes,

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43 Disponibilité et régularité de la publication vont de pair comme le souligne Cano. Voir aussi Chatelin et Arvanitis qui utilisent cet indicateur et Szarina Abdullah qui souligne l'importance de la disponibilité de l'information pour les chercheurs.

44 Arends, T. (1976) Las Revistas Latinoamericanas. Diagnóstico de la situación y proposiciones para mejorarlas, Investigación Clínica (Caracas), 17, pp. 1-17.

45 Voir le cas de Kalikasan étudié par MacLean et Vega ou de la revue de physique "Contribución al estudio de la ciencias físicas" qui a disparu avec l'extinction du groupe de recherche qui animait la revue (1914-1931), in Galles. Voir le cas d'une revue en "bonne santé", celui de la revue Acta Científica Venezolana étudié par H.Vessuri (1986) La revista científica periférica. El caso de Acta Científica Venezolana , Interciencia, 12(3), pp.124-34.

ainsi que les revues commerciales sont légèrement plus internationales (c'est-à-dire publient en anglais ou publient des résumés en anglais).

Ces caractéristiques des revues en Amérique latine devraient faire l'objet de comparaisons avec d'autres continents. Toujours est-il que l'on peut affirmer qu'il existe bien des publications locales "à deux vitesses", avec deux stratégies, nationale ou internationale. Il ne faut probablement pas confondre la stratégie nationale avec une mauvaise stratégie; pour cela nous ne disposons pour le moment que d'anecdotes. Par contre nous pouvons bien confirmer que l'univers des revues scientifiques est constitué de trois sous ensemble pour les chercheurs des PED: les revues mainstream, publiées à l'étranger dans une langue étrangère ou en anglais, les revues nationales à orientation internationale et les revues nationales à orientation locale.

Il est clair que le soutien et les subventions qui cherchent à promouvoir la publication nationale de revues à orientation internationale prendrons de l'ampleur dans les années à venir. Le paysage donc va être profondément modifié. L'ensemble de ces évolutions va donc poser de nouvelles questions auxquelles une attention renouvelée doit être portée. Ainsi, par exemple, certains auteurs évoquent la possibilité d'effets pervers: en cherchant à améliorer le standard de publication des revues nationales, on assistera à une augmentation des coûts d'entrée et donc peut-être un ralentissement de la production nationale totale.

Quelles que soient ces évolutions futures, il est clair que la bibliométrie ne peut plus considérer les revues comme un support intellectuel neutre. Le marché des revues est loin d'être pur et parfait. Cela suppose de réviser certains présupposés, notamment celui qui associe systématiquement le prestige au coût d'accès. Pour certaines revues de grand prestige le coût d'accès est élevé. De là on généralise à l'ensemble des revues. Cela pose quelques problèmes: il peut exister des revues à des coûts d'accès prohibitifs pour des raisons techniques, sans relation avec le prestige. Ou encore, une publication dans une revue de prestige élevé ne suppose pas forcément un article de prestige.

Cette dernière réflexion nous incite a beaucoup de précaution dans l'utilisation des "facteurs d'impact" des revues pour évaluer la recherche des laboratoires. Non seulement pour des raisons de mauvaise couverture des revues locales par la base de l'ISI (seule base contenant les références, que l'on nomme citations selon l'anglicisme consacré). Mais surtout parce que les facteurs d'impact semblent sous-estimer la véritable valeur de la production locale.[46] De plus le facteur d'impact ne peut être calculé que pour les revues répertoriées par la base ISI. C'est pour cette raison que le groupe de bibliomètres indiens de INSDOC a mis au point une méthode pour calculer les facteurs d'impact pour des revues non

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[46] Certains auteurs considèrent que les facteurs d'impact mesurent de manière assez simple la qualité des recherches, Cf. les travaux de B.K. Sen et Arunachalam, Delgado et Russel , Galles entre autres.

incluses dans le Science Citation Index.[47] Il est clair que les résultats de ces travaux intéressent au plus au point l'ensemble des PED. Certains auteurs pensent que le facteur d'impact devrait être calculé à partir des laboratoires, non pas des revues. Car en effet, les laboratoires sont la véritable unité d'analyse de la bibliométrie.[48] Par ailleurs, certains travaux semblent montrer des différences fondamentales entre les disciplines. Ainsi la biochimie au Brésil est-elle une discipline très nettement orientée vers la publication internationale et qui en même temps, pour ce qui concerne sa production nationale dénote des facteurs d'impacts très élevés.[49] Comme on peut le constater le débat reste ouvert sur l'utilisation des facteurs d'impact. L'accumulation de recherches autour de ce thème devrait permettre de résoudre l'ensemble de ces questions. Enfin, l'histoire et le fonctionnement des revues devrait faire l'objet d'une attention plus grande. La création des revues, leur vie sont étroitement liés à l'histoire des disciplines. C'est là un thème de recherche qui devrait être encouragé.

Ces quelques observations attirent des remarques de prudence. Se référer au caractère simplement "internationaliste" ou "localiste" d'une revue peut nous aveugler plutôt que nous guider. L'exemple de la revue philippinaise Kalikasan qui a du arrêter sa publication en 1983 alors même qu'il s'agissait d'une revue satisfaisant tous les critères d'internationalité est à cet égard très éloquent. MacLean et Vega signalent à ce sujet que le mode d'utilisation de la littérature, tel qu'il apparaît à travers une analyse des références contenues dans les articles de la revue, est plus important que les références reçues par la revue. Ce qui renvoie, évidemment, au mode de fonctionnement des disciplines et à la structuration du monde scientifique.

Toujours est-il que le vocabulaire d'origine d'anthropologie des castes ("parochialism", "in-breeding", d'endogamie ou exogamie) utilisé dans la bibliométrie des revues est particulièrement dangereux, car il suppose, entre autres, que les frontières naturelles sont plus fortes que la dynamique scientifique.

Un renouveau des concepts et méthodes

Argenti signale que le débat actuel sur les indicateurs de science dans les PED est par bien des aspects similaire à celui qui avait porté en son temps sur les

47 Cf. Sen, Karanjai et Munshi cité par B.K.Sen. Une évaluation de cette méthode dans d'autres pays serait souhaitable. L'Association internationale sur les indicateurs de science devrait permettre de faire circuler les méthodologies mises au point en Inde.

48 Viswanathan suggère que l'analyse au niveau des laboratoires de recherche permet d'obtenir des résultats plus favorables pour les PED, car le facteur d'impact calculé sur les institutions est nettement plus élevé que s'il est calculé à partir des revues. Ce sont en effet les revues locales qui posent problème, non pas les laboratoires.

49 Meneghini.

indicateurs sociaux.[50] Il faut alors mener à la fois une réflexion sur le fonds (quoi mesurer) et sur la forme (comment mesurer). Ce constat n'est pas nouveau et c'est lui qui a donné naissance au Manuel de Frascati (OCDE) et au Manuel de statistiques en science et technologie de l'Unesco.[51] Pour beaucoup de chercheurs il y a un refus souvent très explicite et violent, comme le rappelle Ishola Adamson, des indicateurs de science. C'est là ne voir que l'aspect outil de contrôle, outil de gestion, des indicateurs. Il est donc fondamental d'agir directement sur les utilisations des indicateurs, de faire en sorte que l'utilisation ne soit pas restreinte, mais au contraire la plus large possible. Il existe un autre soupçon: celui qui porte sur les scientométriciens eux-mêmes. Certains sont accusés d'être de mauvais chercheurs qui se reconvertissent à la scientométrie pour critiquer leurs collègues. Cette accusation, nombre des contributions ici le prouvent, est infondée. Mais au-delà du soupçon, se pose la question de la formation des scientométriciens. Nous y reviendrons en conclusion.

L'utilisation des indicateurs de science

L'utilisation des indicateurs de science intéresse non seulement les PED mais aussi les organismes de recherche des pays dit "centraux" qui jouent un rôle actif dans les PED (nous pouvons à ce titre mentionner les organismes spécialisés dans la recherche tropicale en France, Grande Bretagne, Hollande, etc...) ou des agences de financement et d'appui de la recherche des PED (tels l'Unesco, la FIS, l'IDRC et les divers fonds de financements de la recherche des PED comme l'USAID, la Communauté Européenne, le ministère de la Coopération en France, pour n'en retenir que quelques uns).[52]

Les indicateurs de science intéressent donc une multiplicité d'acteurs différents dont les objectifs sont foncièrement distincts. Ceci implique des demandes distinctes, des interrogations parfois divergentes selon que l'on est un administrateur de la recherche, un financeur national, un financeur privé, une organisation internationale ou un chercheur. S'interroger sur les utilisations des indicateurs fut l'objet de la deuxième table ronde (Voir encadré 2).

Il est important de souligner que les indicateurs ne sont pas innocents. Un indicateur n'a de sens que par rapport à l'usage qu'on en fait. Il sera donc très différent selon que l'on désire effectuer une analyse de "recherche sur la recherche" une évaluation institutionnelle ou une évaluation d'impact d'un programme de recherche. Même si les indicateurs sont similaires, même si la base d'informations est similaire, les motivations des études sont trop différentes. Bien que peu de participants l'ait signalé, il existe une tension très forte entre cette

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[50] Rappelons que le livre "Toward a metric of science" a également rassemblé des réflexions très similaires au moment de l'émergence des indicateurs de science aux Etats-Unis.

[51] Voir la contribution de Y.de Hemptinnes et J.Mba-Nzé.

[52] Gaillard (1990) Les politiques d'aide à la recherche, Cahiers sciences humaines, Vol.26,3.

utilisation d'évaluation et le développement d'outils statistiques à des fins de recherche. Il est clair que la réflexion à laquelle nous faisons allusion ne pourra avoir lieu que si les chercheurs se donnent le temps de la réflexion quant au contenu et la nature des indicateurs. Il est illusoire de croire que les indicateurs sauront dépasser leurs défauts de jeunesse en se bornant à les utiliser à des fins d'évaluation. La multiplication des travaux spécifiques sur une discipline ou une institution est bénéfique car elle permet d'élargir la base empirique de nos observations. Nombre des communications ici rassemblées sont de ce point de vue extrêmement riches même si les méthodes à proprement parler ne sont pas toujours originales.

DEUXIEME TABLE RONDE
L'utilisation des indicateurs de science
présidée par Subbiah Arunachalam

- Les indicateurs scientifiques sont-ils appropriés pour évaluer la qualité de la recherche ou pas ?
- Quels biais sont introduits par la mesure des activités de recherche et quels sont leurs effets sur la recherche ?
- Evolution de la signification des indicateurs de science et sa relation avec les structures institutionnelles.
- Les indicateurs de science sont-ils utiles pour planifier ou ne sont-ils que des outils de l'analyse de la recherche, de "la recherche sur la recherche" ?
- Utilisation des indicateurs dans la gestion de la main d'oeuvre scientifique: mobilité géographique, inter-institutionnelle, disciplinaire, formation.
- Les indicateurs peuvent-ils mesurer l'utilisation des résultats de la recherche ?

Les questions en suspens auxquelles les chercheurs de notre discipline auront à répondre sont nombreuses. Prenons le débat central au sujet de la science dans les PED, le lancinant débat de la qualité de la science dans les PED. Affirmer la spécificité, voire l'originalité des chercheurs des PED, n'est pas rejeter leur possibilité de faire de la science "mainstream". Mais de même qu'il ne faille pas opposer science de bonne qualité à science du Tiers Monde, il faut se garder d'affirmer que la science dans les pays du Tiers Monde est obligatoirement différente de celle des pays du centre. Elle peut l'être, elle l'est probablement, dans des degrés et à des niveaux forts divers. C'est là dessus que nous devons statuer, en tant que "scientomètres", non pas sur la qualité jugée bonne ou mauvaise.

A cet égard, nous devons aussi souligner qu'il ne faut en aucun cas que les travaux de scientométrie remplacent le travail des "pairs" scientifiques. Ceci serait encore plus dangereux dans des pays qui n'ont qu'une vision parcellaire de leur propre production scientifique. Nos travaux doivent fournir des renseignements utiles aux évaluateurs, mais non remplacer ces évaluateurs. Ils doivent être discutés -et donc également rectifiés- au même titre que toute connaissance qui passe par la nécessaire mise à l'épreuve des arguments scientifiques. Il faut arriver à un point, et nous espérons que l'Association que nous nous proposons de créer saura le faire, où rien ne se dit sur les communautés scientifiques des PED qui ne soit vérifiable. C'est donc bien, avant tout, une quête de vérité à laquelle nous convions les futurs travaux de scientométrie, bien plus qu'au travail de décision politique.

Par ailleurs, l'évaluation par les pairs est avant tout un mécanisme de sanction, une évaluation a posteriori. La grande richesse des indicateurs nous semble se trouver non pas à cette étape, mais nettement plus en amont, comme le souligne W. Turner. Ce qui manque le plus aux décideurs ce ne sont pas tant les mécanismes d'évaluation-sanction, mais plutôt les mécanismes d'évaluation stratégique, a priori, qui permettent d'effectuer des repérages des disciplines, des thématiques de recherche, des domaines scientifiques et techniques émergents, mouvants, nouveaux. Sur ce terrain, les travaux que nous rassemblons ici sont pratiquement muets. Or dans les années à venir cette "infométrie", cette utilisation de l'information pour piloter et orienter les choix politiques prendra une ampleur considérable.[53] Il s'agit d'avancer dans la connaissance de ces outils nouveaux, et le faire avec une certaine précaution. A ce sujet le travail de Sandra Thomas est particulièrement intéressant. Elle s'est rendu compte que dans le cas d'un domaine de recherche très appliquée, il était impossible d'obtenir une information adaptée ni par l'évaluation par les pairs ni par des indicateurs quantitatifs. Elle prône donc l'utilisation "d'experts voyageurs" ("peripatetic experts"), un peu à l'image des agronomes voyageurs du 18-ème siècle qui comparaient les différents systèmes agricoles à travers le monde.

Enfin, il serait utile aux hommes politiques, aux décideurs, aux responsables de programmes de développement de la science dans les PED d'aboutir à une cartographie cohérente des types de développements scientifiques. Mais pour cela encore faudrait-il disposer de critères pertinents de classification. Se baser sur la seule quantité d'articles ou sur la seule analyse de citations est manifestement insuffisant. Contribuer à introduire plus d'éléments dans la prise de décision que les seuls chiffres d'ensemble sur les moyens de recherche ou sur les seules mesures de base de la production totale devrait être notre objectif en tant que "scientométriciens".

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[53] On peut s'en rendre compte en examinant les différentes méthodes de prospective technologique et scientifique dans les pays du Centre. Voir B.R. Martin et J. Irvine (1989) Research Foresight: Priority-setting in Science, London, Pinter Publishers.

Portée et limites des indicateurs

La question du renouveau de la réflexion sur le indicateurs que nous avons longuement développé dans la première section de cette introduction doit concerner les concepts. Il faut réfléchir sur les notions de production et productivité scientifique qui sont, nous l'avons dit, des notions dépendantes du cadre institutionnel, des mécanismes d'évaluation de la recherche, des relations que tissent les chercheurs, des stratégies individuelles et institutionnelles de publication. Ces divers éléments doivent être pris en compte par l'analyse des indicateurs.

TROISIEME TABLE RONDE
Portée et limites des indicateurs de science dans les PED
Présidée par Virginia CANO

-Peut-on et doit-on mesurer différemment les différents types d'activités de recherche: recherche fondamentale, activités de développement ? Comment mesurer les autres activités des chercheurs ?
-Existe-t-il une mesure adéquate de la "littérature grise" ?
-Les différents indicateurs de science donnent-ils une image similaire des disciplines ou de l'activité scientifique d'un pays ? Comparaison des indicateurs de main d'oeuvre, de financement, de production ?
-Relations entre les statistiques de science et les indicateurs de science: main d'oeuvre, financement, publications, brevets, statistiques sociales et économiques.
-Définition des limites de la communauté scientifique

Il se pose aussi des problèmes d'échelle (petits ou grands pays, taille et type d'institutions), de niveaux d'observation (discipline, unité de recherche, institution, chercheur individuel) qui ne peuvent se résoudre simplement. Dans la majorité des études, les auteurs donnent une définition précise de leur unité d'observation et des sources d'information. Un débat devrait être entrepris pour essayer de standardiser au maximum les niveaux d'observation.

Enfin, le type de données qu'il faut utiliser et étudier est lui aussi sujet à de nombreuses discussions. Trop souvent on s'attache à l'analyse des publications, car cela et plus facile de compter des publications dans une seule base de donnée que d'effectuer des enquêtes par questionnaires ou encore des analyses des financements. Curieusement, on arrive à un paradoxe: la science la plus fondamentale, la plus internationaliste est la plus facile à mesurer (par les publications) alors que les sciences les plus appliquées -et donc les plus locales- sont nettement plus difficiles à évaluer. De la même manière, les institutions de recherche qui ont une stratégie d'incitation des chercheurs à intégrer le "mainstream" semblent plus faciles à évaluer par la bibliométrie que celles qui adoptent des stratégies localistes.

Ces observations suggèrent donc à la fois une diversification des sources d'information et des objets que l'on cherche à dénombrer et introduire dans les indicateurs de science. Quelques objets nouveaux ou peu utilisés peuvent être par exemple les formations doctorales, les diplômes de troisième degré universitaire ou de quatrième degré (post-docs).[54]

Il faut aussi encourager les enquêtes par questionnaire, ce qui est loin d'être une nouveauté. Peut-être serait-il judicieux de proposer à ceux qui détiennent des données de base de chercher à effectuer des comparaisons entre enquêtes différentes, reprendre les analyses secondaires des données de base recueillies au cours de ces enquêtes. De ce point de vue, quelques participants ont insisté pour relier les indicateurs "perceptuels" ou d'opinion avec les indicateurs quantitatifs (que l'on nomme à tort d'objectifs). Ceci devrait à terme suggérer des thèmes de recherche nouveaux.[55]

Les méthodes de construction des indicateurs

Malgré l'appel de Argenti au nécessaire renouveau des méthodes, nous ne pouvons que faire le constat du peu d'indicateurs nouveaux. Est-ce parce que les indicateurs usuels sont suffisants, ou bien s'agit-il d'une paresse intellectuelle comme le prétend Argenti ? Cependant, on a vu certaines méthodes nouvelles de représentation des données (analyse factorielle,[56] graphes polaires,[57] graphes d'association,[58] graphes de réseaux,[59] figures de Chernoff[60]). Améliorer la forme des représentations des données est d'ailleurs en soi une nécessité, dans notre domaine comme dans toute analyse utilisant des données quantitatives.

Le mieux semble, dans un premier temps, d'accepter que les indicateurs que nous relevons sont tous des indicateurs partiels.[61] Selon donc le niveau auquel on se situe (chercheurs, institutions, pays), ce qui compte plus qu'un indicateur particulier c'est la conjonction des indicateurs, qui permettent de dégager des tendances fortes. Ainsi par exemple, la présentation simultanée de plusieurs

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[54] Comme le font par exemple Polanco et Yero.

[55] On peut mentionner: les causes de la fuite des cerveaux au niveau international (brain-drain), les fuites des chercheurs de la recherche vers l'industrie, les jugements de valeur sur le rôle des institutions "payeuses" (organismes de politique scientifique, entreprises, fonds de financement), les "styles de recherche", etc...

[56] Narvaez-Berthelemot, Frigoletto, Miquel ; El Alami , Doré, Miquel; Waast et Gaillard.

[57] Chatelin et Arvanitis.

[58] Macias Chapula.

[59] Arvanitis et Bardini; Schubert.

[60] Schubert.

[61] Voir S. Thomas qui reprend l'expression devenue célèbre de Irvine et Martin.

indicateurs dans un graphe polaire par disciplines permet de dégager un type d'activité scientifique.[62] Au niveau de la production scientifique par pays on pourra dégager clairement des stratégies d'ensemble. L'Inde et le Brésil par exemple semblent adopter dans l'ensemble des stratégies opposées: publications en anglais, thèmes généraux, importance de travaux théoriques en Inde par opposition à des publications en portugais sur des thèmes plus locaux au Brésil. De même, au niveau des institutions on peut dégager des oppositions entre laboratoires à forte propension à la publication "internationale" contre les laboratoires à faible publication.

Afin de dépasser le débat sur la visibilité internationale il serait grand temps d'associer des indicateurs bibliométriques aux indicateurs d'inputs. Ceci a rarement été effectué. Généralement cela se fait pour mesurer l'efficacité d'une institution.[63] Pour pouvoir apporter des conclusions sur l'impact des financements de la recherche il faut relier les indicateurs d'input et d'output. On ne peut pas traiter de la même manière une petite "communauté" scientifique de 200 chercheurs et une communauté de 2.000 chercheurs. De même 2.000 chercheurs dispersés dans 30 unités de recherche n'agissent pas de la même façon que cette même quantité de chercheurs dans une dizaine d'unités. Enfin, quand on assiste à des croissances de la production totale de 600% en moins de dix ans, il est clair que la nature même de l'activité scientifique change. Nous convions donc les chercheurs à porter leur attention sur les effets qualitatifs des dimensions quantitatives.

De même, il nous faudrait étendre le champs d'analyse pour inclure la technologie à proprement parler. Un curieux ostracisme règne sur cette question parmi les scientométriciens. Pourtant, il existe des méthodes plus ou moins développées pour mesurer le développement technologique que nous n'avons même pas effleuré lors de la Conférence (mesures de brevets, technométrie, questionnaires technologiques, par exemple). Nous espérons que d'ici à la prochaine Conférence il y ait des travaux en matière de croissance technologique et ses rapports avec la science.[64]

Pour une diversification des sources d'information

Dans les dernières années nous avons assisté à un véritable renouveau dans les sources d'information, très apparent dans les communications de la Conférence. Les analyses, notamment bibliométriques -les plus nombreuses- sont beaucoup

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62 Chatelin et Arvanitis.

63 Voir par exemple Krauskopf.

64 Une première tentative spécifique aux PED sont les travaux de l'équipe CENDES-ORSTOM. Par exemple Arvanitis,R.; Pirela,A.; Rengifo,R.; Mercado,A. (1988) Empresarios y Académicos: ¿Un matrimonio imposible?, chapitre 3 de Conducta empresarial y Cultura tecnológica, CENDES, Caracas.

plus audacieuses. Elle ne se bornent pas à une ou deux bases de données, mais au contraire examinent toutes les bases disponibles. Quant au statut très particulier de la base de l'ISI, dû au fait que c'est la seule base qui contienne les références (les citations, selon l'anglicisme consacré), il est maintenant mieux maîtrisé. Les auteurs cherchent à effectuer des sondages dans le SCI mais ne mesurent pas la production nationale ou régionale des PED à partir du SCI. La comparaison est donc à l'ordre du jour et c'est tant mieux. Pour un grand nombre de "scientométriciens" la découverte de la multiplicité de bases nouvelles est un événement majeur. Elle implique un bouleversement dans l'image même que l'on se fait de l'information. Les "Fact Sheets on Databases" que nous avons rassemblé au moment de la Conférence ont été fort utiles pour un grand nombre de chercheurs.[65]

QUATRIEME TABLE RONDE
La disponibilité d'informations pertinentes
présidée par Michel J. Menou

A l'occasion de cette dernière table ronde ont été reprises l'ensemble des questions précédentes sous l'angle de la disponibilité, l'accessibilité et de la fiabilités des données. Comme pour l'ensemble des tables rondes précédentes on ne s'est pas limité à constater les problèmes mais on s'est efforcé de proposer des solutions pratiques. C'est dans cet esprit que nous avons préparé pour les participants de la conférence un document intitulé "Collection of Fact Sheets on Data Bases" qui présente une collection de base de données, non exhaustif, mais dont l'objectif est de diffuser le plus largement possible une information sur des bases peu ou pas connus. Nous relevons parmi les conclusions "pratiques":
- la dispersion croissante des sources d'information oblige à effectuer du "repackaging" de l'information pertinente pour les PED;
- la constitution de Bases de données nationales devrait être une priorité; on doit aussi assurer le suivi bibliographique des littératures grises; nécessité de développer des standards pour la constitution des BDD.
- les bases de données devraient contenir les éléments nécessaires pour l'analyse bibliométrique, dès leur conception;
- développer les supports nouveaux: E-mail,, revues électroniques, disques optiques et magnétiques; développer des software "dédiés" et adaptés.
- faciliter les flux d'information Nord-Sud (une donation gratuite des revues mainstream auprès d'une grande bibliothèque de prêt dans chaque PED, généralisation du système de donation de l'AAAS au-delà de l'Afrique Subsaharienne, disponibilité sur supports magnétiques/optiques -ex. ADONIS, PGI)

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65 Les Fact Sheets ont été créé sur une idée de Michel Menou. Une copie peut être obtenue auprès du programme STD de l'ORSTOM.

- étudier faisabilité de systèmes de distribution des données centralisés ou régionaux pour les PED (évaluer mécanisme des coupons de l'UNESCO);
- intervenir au moment des financements des projets de recherche pour y inclure: budgets spécifiques pour l'acquisition de données, acquisitions de coupons ou autres moyens de financement d'informations internationales, inclure systématiquement des frais de documentation/recherche on-line, donner autant d'importance à l'information qu'aux autres moyens de recherche.

La nécessité du travail comparatif

Si nous sommes -en tant qu'organisateurs de la Conférence- en accord avec le ferme appel à la reconnaissance de la situation particulière des PED en matière de science, nous ne pouvons que difficilement souscrire à cette autre affirmation selon laquelle les indicateurs de sciences ne peuvent être comparables que sur un plan très général à ceux des pays de niveau de développement différent. Le pari que nous faisons est que la prise en compte de la spécificité par exemple "tropicale" dans les sciences de la nature, ou encore sociale dans la configuration des communautés scientifiques des PED, n'est pas incompatible avec le souci de la comparabilité. Mais il faut savoir définir ce qui est comparable. Manifestement, comparer les USA avec par exemple Singapour, ou l'Uruguay, ou comparer l'Inde et le Botswana, est tout simplement comparer l'incomparable. Par contre, comparer les mécanismes de reconnaissance sociale tels qu'ils apparaissent par l'analyse des citations aux USA et en Argentine ou encore les thématiques développées par les chercheurs d'une même discipline dans des pays de développement scientifique très divers est tout à fait possible et même souhaitable. C'est à cet exercice que nous aimerions convier les futurs travaux de bibliométrie et de scientométrie.

De même comme nous l'avons dit auparavant il est important d'effectuer des comparaisons entre diverses bases de données. C'est ce qu'ont proposé divers participants à la Conférence. En effet, non seulement le poids d'un pays est différent selon les différentes bases de données, mais l'évolution de cette position dans le temps varie parfois dans des proportions considérables et souvent à l'insu des producteurs eux-mêmes.[66]

En dehors de la bibliométrie et dans le cadre des organismes internationaux comme des organismes nationaux chargés des statistiques, une volonté nouvelle se fait jour: celle de comprendre le fonctionnement de la science dans les PED, celle de comprendre les phénomènes de structuration, d'organisation, d'institutionnalisation des communautés scientifiques. Peu de travaux ont présenté des élaborations sur les données d'input, or ce serait là un important enjeu pour les organismes nationaux chargés de la politique scientifique.

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[66] Cf. Gretchen Whitney.

Finalement, de nombreux auteurs ont fait état d'un effort de systématisation des données et d'élaboration de banques et bases de données nationales.[67] On peut ici faire état de la banque du GRADE,[68] de la base de données BIBLAT au Mexique, de la base du MARDI en Malaisie[69],de INSDOC en Inde[70], ainsi que les banques de données spécifiques élaborées dans le cadre de certaines recherches (banque de données sur les formations en Santé au Venezuela, Brésil, Cuba et Mexique,[71] banques de données nationales sur les chercheurs et les projets de recherche un peu partout).

Créer un lieu de permanent de rencontre

L'ensemble des contributions montrent qu'il y a matière abondante pour continuer à effectuer des recherches fructueuses. Même parmi nous de nombreuses questions restent en suspens. Il serait bon d'encourager les efforts parfois dispersés des chercheurs des PED. C'est dans cet esprit que la Conférence a décidé la création d'une **Association internationale sur les indicateurs de science dans les pays en développement.**[72]

Pour développer ce champs de réflexion, il est nécessaire non seulement de mobiliser l'opinion internationale sur l'importance du thème, mais aussi de former des chercheurs dans ces domaines. La viabilité de cette réflexion en dépend. Il faudra stimuler les travaux de recherche, dans un état d'esprit d'indépendance et de discussion ouverte. La qualité des conseils que nous pourrons fournir aux décideurs dépend très largement de notre capacité à réaliser des travaux en profondeur sur les différents aspects qui concernent les indicateurs de science et de technologie. Il est donc recommandable de réaliser des travaux à la fois pertinents, rigoureux et méthodiques et ouverts à la discussion avec les politiques.

Cette Association devrait faciliter une coordination des travaux menés dans les différents pays du monde en effectuant des conférences régionales et internationales, en participant aux différentes instances internationales qui apportent leur soutien au développement de la science dans les pays en développement, en émettant des recommandations adressées aux responsables de la politique scientifique et technologique, en organisant des ateliers de formation

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67 Rappelons que les "bases de données" contiennent les références bibliographiques, alors que les banques de données réunissent les données elles-mêmes.

68 Cf. la présentation effectuée par Patricia Arregui.

69 Cf. présentation de Szarina Abdullah.

70 Cf. présentation de B.K. Sen.

71 Cf. présentations de Licea de Arenas et de Polanco et Yero.

72. Pour tous contacts s'adresser à Rigas Arvanitis, ORSTOM-STD, 72 route d'Aulnay, 93143 Bondy Cedex, France, ou Juan José Saldaña, Instituto Iberoamericano de Estudios sobre la Ciencia y la Tecnología, Apartado postal 21-023, 04000-Mexico, DF, Mexique.

sur des aspects particuliers de scientométrie, bibliométrie, technométrie, qui doivent tenir compte des particularités de la science et la technologie dans les PED.

D'autres aspects concrets concernent la circulation de l'information. L'Association publiera une "Newsletter" pour informer les membres des travaux qui se réalisent ici et là. Elle cherchera à promouvoir l'échange d'informations statistiques et de méthodes de construction des indicateurs (échanges d'articles et "working papers", échanges de programmes statistiques, échanges de données). Par ailleurs des travaux spécifiques devront être réalisés pour améliorer la connaissance et l'accès aux bases de données internationales.[73] La possibilité de créer un journal électronique, à l'image de celui réalisé par Preston et Speedy dans le domaine de la production animale, sera envisagée. Enfin, l'Association publiera régulièrement un annuaire des chercheurs des PED travaillant sur ces domaines.[74]

L'Association devra examiner les collaborations qui peuvent donner lieu à des échanges fructueux avec d'autres organisations professionnelles et scientifiques, comme la Society for the Social Study of Science (4S) ou son homologue européen la EASST, l'ADEST en France ou la Société Française de Bibliométrie Appliquée, le réseau ALFONSO (réseau de chercheurs travaillant sur l'émergence des communautés scientifiques dans les PED dans quatre pays), la Société latino-américaine d'histoire des sciences et des techniques, l'INIDET (réseau de chercheurs travaillant sur les technologies dans les pays en développement), le réseau de chercheurs latino-américains sur l'apprentissage technologique industriel, pour n'en mentionner que quelques unes. Par ailleurs, des liens institutionnels seront mis en place avec les Associations pour l'Avancement de la Science dans différents pays du monde et les différents lieux de réflexion des sciences dites "dures" (Institut de Physique théorique de Trieste, Académie du Tiers Monde). Ces relations professionnelles sont de grande importance dans la mesure où les chercheurs des sciences "dures" sont généralement engagés activement dans la construction des institutions scientifiques et la réalisation de la politique de recherche. Nos travaux peuvent faciliter leur effort de réflexion et leurs moyens d'action.

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73 La Conférence a publié un premier recueil de fiches concernant un très grand nombre de bases de données tant nationales qu'internationales, aussi bien factuelles que bibliographiques. On peut se procurer ce document auprès de l'ORSTOM, 70/74 Route d'Aulnay, 93143 Bondy Cedex.

74 Une évaluation des logiciels permettant la gestion de cette base d'information est en cours.

ALLOCUTION D'OUVERTURE

Marc CHAPDELAINE
Directeur, Division des politiques scientifiques et technologiques
Unesco

Monsieur le Président du Comité d'Organisation,
Mesdames et Messieurs les membres du Comité,
Mesdames et Messieurs les participants,
Chers collègues,

Il me fait grand plaisir, au nom du Directeur général de l'Unesco, de vous souhaiter la bienvenue en notre Maison où vous vous réunissez pour y discuter dans les jours qui viennent, sur le thème des "indicateurs de science pour les pays en développement".

Je voudrais tout d'abord féliciter les organisateurs de la conférence, Monsieur Gaillard et son équipe de l'ORSTOM et du CNRS, d'avoir pris cette initiative, et marquer dès maintenant notre appréciation pour le succès qu'ils ont manifestement rencontré dans la mobilisation de la communauté internationale des spécialistes et des chercheurs intéressés par le thème en discussion. L'Unesco, par sa vocation dans le domaine de la coopération scientifique internationale, ne peut qu'encourager de telles initiatives, et nous nous sommes fait un devoir d'apporter à cette conférence, avec d'autres partenaires, notre concours et notre soutien.

Je voudrais ensuite rappeler, à l'orée de vos travaux, quelques réalités élémentaires qu'il est utile de ne pas perdre de vue quand on plonge dans des débats plus specialisés et plus savants. Tout d'abord que les avancées de la connaissance scientifique se font à l'heure actuelle dans un relativement petit nombre de pays, et ceci pose la question de l'universalité de la science, du moins dans ses origines. Ensuite que ces avancées se diffusent dans un grand nombre de pays, à des rythmes qui sont allés en s'accélérant dans les temps récents, et selon des modes parfois ouverts, et parfois également, hélas, plus ou moins fermes. Et ceci pose la question de l'accélération de la communication, avec ses supports et ses procédures, en même temps que la question de l'accès à l'information. Il ne faut pas oublier non plus qu'un bon tiers des Etats membres de l'Unesco, soit une cinquantaine de pays, manquent des infrastructures essentielles à une participation active à la recherche mondiale. Je veux parler ici de ces pays qui, typiquement pour une population de un million d'habitants, possèdent un stock de scientifiques et d'ingénieurs d'au plus 20 000, dont moins d'une centaine engagés dans la recherche, avec 2000 étudiants dans l'enseignement supérieur, et une dépense de recherche de l'ordre de quelques dixièmes d'unités de pourcentage du PNB. Enfin, je rappellerai que les enjeux de la connaissance scientifique de nos jours se traduisent presque toujours, et rapidement, sur le plan technologique et, in fine, sur le plan économique.

Dans ce cadre, le thème de vos travaux pose l'importante question du développement scientifique. Entendons par là, non pas le développement de la science, ou de la connaissance, tous apports confondus, mais le développement chez tout un chacun: pays, nations, sociétés, groupes sociaux, de la capacité à s'approprier les connaissances scientifiques pour en tirer le meilleur parti dans les quêtes spécifiques qui leur sont propres, qu'elles soient politiques, économiques, sociales ou culturelles.

La question du développement scientifique est posée indirectement par le biais d'interrogations sur ses manifestations, et sur les moyens que nous avons de les observer. La théorie générale du développement scientifique reste à faire - à supposer que la chose soit faisable -, mais il est assurément intéressant en attendant de se poser des questions sur ce qui fait marcher le chercheur, sur la nature du produit de son activité, et sur l'impact de celle-ci sur la société.

Dans les pays en développement,le développement scientifique est une condition *sine qua non* de leur développement général, même s'il peut être une visée à long terme, car il leur ouvre la porte aux entreprises technologiques nouvelles qui sont en train de déterminer en grande partie, et à une échelle sans précédent, les conditions de notre sort de demain, asservissement ou affranchissement. Il est essentiel que les responsables des pays en développement et leurs communautés scientifiques, possèdent des instruments d'observation de leur propre activité, de ses orientations et de ses applications.

Pendant longtemps, l'on s'est limité à prendre la mesure des ressources cumulées du potentiel national de recherche et des moyens consentis à son expansion. Puis, les spécialistes se sont attaqués à la question de l'observation du produit de l'activité, ce qui permettait par comparaison avec les moyens de se faire une idée de l'adéquation des moyens aux résultats et de l'efficience de leur utilisation.

Les techniques d'analyse bibliométrique développées dans les années 70 sont arrivées effectivement à rendre substantiellement compte de l'avancement des connaissances, toutes contributions confondues. Mais les chercheurs ont justement diagnostiqué que justice n'était pas entièrement rendue à l'apport des chercheurs du Sud à ce corps commun des savoirs .

Il est revenu à Michael Moravcsik, notre regretté collègue et ami, à qui je voudrais ici rendre hommage, d'inspirer et de conduire une opération pionnière pour corriger cette lacune. La réunion de Philadelphie en 1985 a utilement mis en évidence les faiblesses du système international d'information sur la production scientifique, et surtout sur son inadéquation quant à la production issue des pays du Sud.

Il faut féliciter les initiateurs de votre conférence d'avoir suivi les traces de Michael Moravcsik, et d'avoir poussé leur propos plus loin. En effet, supposons un instant que nous puissions arriver, techniquement parlant, à refléter fidèlement l'apport des pays du Sud au stock mondial des connaissances scientifiques, à l'avancement de la science, et que nous disposions des supports nécessaires (bibliographies, répertoires, etc..) et que nous nous soyons assurés de leur disponibilité d'accès par tout un chacun. Ce qui est déjà tout un programme. Même en supposant cette conjoncture idéale, il restera toujours à répondre à un certain nombre de questions connexes, mais non secondaires.

En disposant de toute cette information, il resterait à se poser la question: les chercheurs du Sud n'aspirent-ils qu'à contribuer au stock mondial des connaissances, et n'auraient-ils pas d'autres projets, comme par exemple d'appliquer leur curiosité et leur inventivité à comprendre et à résoudre des problèmes très locaux, ce qui assurément participerait d'une oeuvre de développement scientifique endogène, mais pas forcément en laissant une trace dans les voies internationalement reconnues actuelle-ment ? Il y a là une interrogation fondamentale, à laquelle les organisateurs de cette conférence ne se sont pas soustraits.

Le programme qui vous est proposé est extrêmement riche par les diverses perspectives qu'il ouvre aux débats dans la problématique du développement scientifique. Il est à souhaiter que malgré cette diversité, une ligne directrice soit trouvée dans le propos, afin de bénéficier pleinement de la synergie des différentes approches. C'est, j'imagine, dans ce genre de rencontres que naissent des convergences d'idées et il serait dans ce cas intéressant de songer à vous constituer en réseau plus formel de relations, afin de donner corps aux intentions que vous formulerez dans vos conclusions. Soyez assurés que l'Unesco sera prête à vous appuyer dans cette tâche.

Je vous souhaite plein succès dans vos travaux et vous remercie, Monsieur le Président.

ALLOCUTION D'OUVERTURE

Jacques GAILLARD
Président du Comité d'organisation
Responsable du Programme Science, Technologie et Développement (STD)
ORSTOM

Monsieur le Directeur de la Division des politiques scientifiques et technologiques de l'Unesco,
Mesdames et Messieurs les participants,
Chers collègues,

C'est pour moi un honneur et une grande satisfaction de pouvoir vous accueillir aujourd'hui, au nom de l'ensemble des membres du Comité d'Organisation et du Comité Scientifique, pour l'ouverture de cette Conférence Internationale sur les Indicateurs de Science dans les Pays en Développement.

Je souhaite tout particulièrement la bienvenue à nos amis et collègues étrangers venus de 22 pays d'Amérique Latine, d'Afrique, d'Europe et d'Asie réunis pour réfléchir sur l'élaboration, l'utilisation, la pertinence et les limites des Indicateurs de Science dans les Pays en Développement.

LE PARI

Cette conférence fait suite à un Atelier de travail international organisé en 1985 à l'Institute for Scientific Information (ISI) à Philadelphie. La question de savoir si la science produite dans les pays en développement (PED) est représentée de façon adéquate dans les bases de données internationales, et notamment celle de l'ISI, était au centre des débats de l'Atelier de Philadelphie. Le titre du rapport final préparé à l'issue de la conférence: "Strengthening the Coverage of Third World Science" indique clairement qu'elle ne l'est pas. Ainsi, les experts présents à cet Atelier ont estimé que "seulement la moitié de la production scientifique des PED qui répond aux standards internationaux d'excellence est incluse dans l'ISI". Le critère de citation qui est à la base du système joue en défaveur des communautés scientifiques de la périphérie dans la mesure où une grande partie de leurs travaux est publiée dans des revues locales dont la diffusion souvent ne dépasse pas les frontières nationales. Des études, de plus en plus nombreuses, effectuées depuis lors ont clairement montré que les modes de citation étaient influencés de façon significative par des facteurs externes à la science.

L'ensemble des études réalisées à partir des bases de données internationales nous apporte des renseignements intéressants sur la position relative de différents pays dans la science mainstream, leur impact sur la science mondiale et les niveaux et modes de collaboration ou de coopération scientifique entre pays (plusieurs communications qui seront présentées au cours de la semaine l'illustre clairement). Ces études révèlent cependant une image incomplète et parfois même inexacte sur la façon dont la science se construit dans ces pays, ainsi que sur les stratégies scientifiques de leurs chercheurs et leur participation relative à la science locale et internationale. C'est dans le but de faire le point sur cette question ainsi que sur une série d'autres questions liées à la production, à la diffusion, à l'accessibilité et à la visibilité des informations scientifiques et techniques que le Professeur Michael J. MORAVCSICK (de l'Université d'Oregon), assisté de Virginia CANO (travaillant alors au Conseil National de la Recherche en Espagne) avait programmé une seconde rencontre qui devait se tenir à Madrid en Espagne au mois de mars dernier. La mort subite du Professeur MORAVCSIK en avril 1989 et le départ de Virginia CANO de Madrid pour Amsterdam ont remis en cause l'organisation de cette conférence et sa tenue à Madrid.

Conscients de l'importance pratique, stratégique et théorique de ce thème et forts de la mobilisation active d'un noyau de chercheurs dans le monde sur cette problématique nous avons fait le pari (par nous j'entend le programme Science Technologie et Développement de l'ORSTOM), nous avons donc fait le pari à l'occasion d'un de nos séminaires mensuels il y a environ 10 mois de reprendre le dossier de cette conférence pour l'organiser à Paris dans un délai le plus court possible. Participait ce jour là à notre séminaire Nora NARVAEZ du Laboratoire d'Evaluation et de Prospectives Internationales (LEPI) du CNRS, dirigé par Jean-François MIQUEL, à qui nous avons proposé de s'associer pour organiser cette conférence à Paris. Il s'agissait véritablement d'un pari dans la mesure où nous nous trouvions en fin d'année budgétaire et que la plupart des budgets pour l'année 1991 étaient déjà engagés. Une promesse de parrainage et de soutien financier a pu cependant être rapidement obtenu de l'ORSTOM et du CNRS ce qui nous a permis d'approcher les autres donateurs avec plus de confiance et de détermination. j'y reviendrais.

Avant d'aller plus loin je voudrais revenir un peu en arrière et saluer le rôle d'impulsion décisif qu'a eu notre regretté collègue et ami Mike Moravcik dans cette entreprise. Sans lui et son intérêt constant au cours des trentes dernières années pour le développement de la science dans le Tiers Monde cette conférence n'aurait probablement jamais vu le jour. Nous avons tenu à lui rendre hommage en dédiant à sa mémoire la première conférence qui sera donnée ce matin par le Professeur Schubert. Je voudrais également remercier chaleureusement Virginia Cano pour les efforts qu'elle a déployés depuis la Hollande pour tenter de sauvegarder, désormais seule, l'entreprise dans laquelle elle avait été associée avec Mike. C'est notamment grâce à son carnet d'adresse que nous avons pu contacter la plupart d'entre vous. Venons en maintenant au thème de la conférence.

POURQUOI UNE CONFERENCE SUR LES INDICATEURS DE SCIENCE DANS LES PAYS EN DEVELOPPEMENT ?

Je n'ai ni l'intention ni la prétention de vous faire un cours exhaustif sur l'histoire et le rôle des indicateurs de science. D'autres ici pourraient le faire beaucoup mieux que moi. Permettez moi seulement un bref retour en arrière avant d'introduire le sujet et les objectifs de notre conférence.

L'augmentation des budgets consacrés à la Science et à la Technologie qui s'inscrit dans un contexte de compétition Internationale accrue a débouché sur une volonté de programmation et de gestion, aussi bien de la part des Etats que des Institutions de Recherche et des entreprises privées. Cette évolution se traduit également par une exigence d'évaluation qui va en s'amplifiant.

Il est donc apparu nécessaire de mettre au point des outils présentant des informations systématiques, fiables, accessibles et aisément manipulables pour rendre les choix concernant les activités Scientifiques et Techniques plus transparents et accroître leur légitimité. Pour passer, selon la formule de notre collègue Michel Callon, de l'arbitraire à l'arbitrage. Ainsi sont donc nés des outils appelés indicateurs, destinés non seulement à éclairer les décisions au moment où elles sont prises, à apprécier les effets des choix antérieurs mais également à appréhender les dynamiques et les stratégies scientifiques.

Si la notion d'indicateurs est loin d'être une nouveauté, les Indicateurs Scientifiques et Techniques ont une histoire récente. Des auteurs comme Bernal et Kuhn puis plus récemment Dereck de Solla Price ont largement contribué à leur naissance et à leur développement. C'est principalement à partir des années 60 avec le développement de la Sociologie des Sciences (dominée alors par l'école de Merton) et le développement d'ordinateurs plus performants que se sont développés et multipliés les travaux qu'il est maintenant convenu d'appeler scientométriques.

Des bases de données importantes ont ainsi été établies au cours des années 70 dans les Pays Industrialisés et des efforts importants ont été consentis par des organisations comme l'OCDE, l'UNESCO, la National Science Foundation (NSF) aux Etats Unis pour collecter et analyser les statistiques sur la Science et la Technologie. Parmi les plus connus citons les Science Indicators de la NSF aux USA. Rappelons également qu'un journal spécialisé dans la mesure des activités scientifiques 'Scientometrics', journal dans lequel beaucoup d'entre nous publient, a été créé il y a à peine un peu plus de 10 ans en 1978.

La plupart des premiers travaux sur les indicateurs Scientifiques et Techniques ont été consacrés à la mesure des inputs et notamment des ressources financières à partir de statistiques incomplètes utilisant une variété de définitions non standardisées qui se sont peu à peu affinées. L'UNESCO et l'OCDE ont largement contribué à ce problème de la standardisation internationale des statistiques sur la Science et la Technologie. Partant du constat que les systèmes de collecte et d'analyse des statistiques des Etats membres n'étaient pas tous au même niveau de développement, c'est également l'UNESCO qui a mis au point différents niveaux de complexité de collecte de données. Monsieur de Hemptinne nous en parlera plus longuement demain après midi. Très rapidement sont donc apparus des limites quand on a essayé d'appliquer les indicateurs de science à la réalité des pays de la périphérie.

LIMITES DES INDICATEURS SCIENTIFIQUES ET TECHNIQUES POUR LA SCIENCE DU TIERS MONDE

De fait, les indicateurs Scientifiques et Technologiques ont été développés pour mesurer les performances scientifiques de pays disposant de ressources et d'infrastructures Scientifiques et Techniques importantes et bien établies. La limite la plus importante des indicateurs scientifiques et techniques est sans doute leur manque de "validité contextuelle" dans un grand nombre de pays en développement, dans la mesure où les informations nécessaires à leur élaboration ne sont pas disponibles ou peu fiables et dans la mesure également où l'importance et la diversité de leurs activités scientifiques est souvent insignifiant comparé aux activités des pays industrialisés ce qui rend les comparaisons peu pertinentes.

Les données sur les ressources humaines sont souvent fondées sur une interprétation large des définitions des scientifiques, d'ingénieurs et de techniciens sans prendre véritablement en compte la nature et la qualité de leur travail ni qualifier l'environnement dans lequel ils évoluent. La nature de ce travail et son environnement varient de façon considérable selon les pays.

L'évaluation des ressources financières consacrées à la recherche dans les PED pose également des problèmes de définition et dans beaucoup de pays ces dépenses ne sont pas identifiées de façon distincte. Les dépenses en R&D calculées en pourcentage du PNB aboutit également à des approximations souvent fallacieuses. Il faut de fait se garder d'appliquer une règle de proportionnalité simple pour la comparaison des dépenses consenties par les divers pays car il y a assurément un phénomène d'échelle qui joue au détriment des petits pays par rapport aux efforts que peuvent fournir les grandes puissances scientifiques.

Enfin, un des inconvénients majeurs des indicateurs de production scientifique et notamment de publication réside dans le fait qu'ils définissent les activités scientifiques de façon trop étroite et qu'ils ignorent les efforts de recherche des personnels Scientifiques et Techniques (y compris de chercheurs) qui ne publient pas ou dont les écrits ne sont pas ou peu diffusés.

L'argumentaire principal, à la base de l'organisation de cette Conférence Internationale sur les Indicateurs de Science dans les PED, part donc du constat que les Indicateurs Scientifiques dont nous disposons, construits pour mesurer la science occidentale, ne sont plus toujours pertinents quand il s'agit d'appréhender la science des pays de la périphérie, et notamment les pays en développement. Cette inadéquation est, nous l'avons vu plus haut , en partie dûe à la mise à l'écart de la science du Tiers Monde des bases de données internationales, à la difficulté de collecter des informations fiables et pertinentes dans la durée dans beaucoup de PED mais également à de nombreux autres facteurs extérieurs à la science, plus de nature sociale que cognitive.

C'est à l'ensemble de ces problèmes que nous allons consacrer nos débats au cours de cette semaine. Notre principale ambition est de faire en sorte que cette conférence soit autre chose qu'une rencontre académique ou plutôt quelque chose de plus qu'une rencontre académique.

C'est pourquoi, en plus de la présentation des communications scientifiques, une place importance sera consacrée aux échanges et discussions. Nous avons en particulier prévu quatre tables rondes qui, nous l'espérons vivement, seront les temps forts de cette conférence. Nous comptons donc sur la participation de tous à ces tables rondes. Quatre thèmes ont été retenus et vous trouverez dans vos dossiers une présentation succinte de chaque table ronde avec une série de questions pour ouvrir les débats.

La première concerne la visibilité de la science des Pays en Développement elle sera présidée par Hebe Vessuri, Université de Campinas, Brésil. Nous avons désormais accumulé suffisamment d'évidences pour montrer que si la science des Pays en Développement est moins visible que celle des pays du centre ce n'est pas seulement pour des raisons scientifiques. Est-ce que le mainstream, la science internationale est la seule voie possible pour accéder à la visibilité comme nous le suggère Subbiah Arunachalam dans la communication qu'il présentera cet après midi ? Est ce que l'universalité de la connaissance est un argument suffisant pour plaider en faveur de la science internationale ? N'existe t'il pas d'autres stratégies possibles qui passent notamment par une meilleure connaissance et plus grande utilisation des bases locales et régionales et une revalorisation des journaux scientifiques locaux ? Ces questions et d'autres encore seront débattues à l'occasion de cette première Table Ronde

La deuxième porte sur l'utilisation des indicateurs de science dans les PED. Elle sera présidée par Subbiah Arunachalam, Responsable de la publication, Indian Journal of Technology. Cette table ronde devrait principalement débattre des problèmes qui sont à l'interface entre les producteurs et les utilisateurs des Indicateurs de Science. Pour qui produit-on des Indicateurs de Science ? Les thèmes abordées seront tout naturellement très liés à ceux de la Table Ronde N°3 qui traitera du champ et des limites des Indicateurs de Science et sera présidée par Virginia CANO, Consultante à l'EBSCO, Pays Bas.

La troisième se penchera sur le champ et les limites des indicateurs de science. Elle sera présidée par Virginia Cano, Consultante à l'EBSCO aux Pays Bas. La question centrale de cette troisième table ronde sera donc "pourquoi des indicateurs de science ? Elle traitera également de la pertinence et des limites de ces indicateurs dans le contexte des pays en développement ? Peut-on mesurer y compris la qualité scientifique des travaux de recherche ? Si oui, quels sont les biais introduits dont-il faudra tenir compte? Les indicateurs dont nous disposons nous permettent-ils de mesurer l'utilisation des résultats de recherche dans le contexte des pays en développement ?

La quatrième traitera de la collecte d'informations pertinentes. Elle sera présidée par Michel J. Menou, consultant en systèmes d'information. A l'occasion de cette dernière table ronde seront reprises l'ensemble des questions précédentes sous l'angle de la disponibilité, l'accessibilité et de la fiabilités des données. Comme pour l'ensemble des tables rondes précédentes on ne se contera pas de constater les problèmes mais on fera en sorte de proposer des solutions pratiques. C'est dans cet esprit que nous avons préparé un document que vous trouverez dans vos dossiers qui présente une collection de base de données qui ne prétend pas à l'exhaustivité mais dont l'objectif est de diffuser le plus largement possible une information sur des bases peu ou pas connus.

D'une façon plus générale, nous essayerons de garder à l'esprit lors de ces tables rondes les objectifs suivants:

-Quels sont les recommandations et messages pratiques que nous pouvons utilement faire passer aux administrateurs de la recherche, aux responsables des activités d'information scientifique et technique (IST), aux responsables des politiques de science dans les Pays en Développement pour améliorer la situation?

-Quelles sont les priorités de recherche que nous devons privilégier pour les années 90 ?

-Et enfin, sous quelles formes pouvont nous institutionnaliser nos efforts pour permettre une meilleure coordination et une plus grande structuration du champ de recherche qui nous réunit aujourd'hui ?

Les conclusions et recommandations de ces tables rondes seront présentées au cours de la session finale. La session finale visera également à l'adoption par l'ensemble des participants d'un document proposant des actions concrètes destiné aux chercheurs scientométriciens qui travaillent dans ou sur les PED, aux responsables et aux opérateurs des bases de données nationales et internationales ainsi qu'aux responsables des agences de financement de la recherche dans les PED et des politiques de recherche dans les PED.

REMERCIEMENTS

L'organisation de la conférence n'aurait pas été possible sans le soutien financier de plusieurs institutions françaises et internationales. Toutes les contributions attendues et annoncées sur la brochure de la conférence ont été confirmées à la différence près que la contribution de l'Académie des Sciences du Tiers Monde a été remplacée par une contribution du même montant provenant du Centre International de Physique Théorique dont le Professeur Abdus Salaam est le Président. Le Professeur Abdus Salaam regrette de ne pouvoir être parmi nous et nous a transmis ses voeux de plein succès pour la conférence. Parmi les autres soutiens, j'ai déjà mentionné le parrainage de l'ORSTOM et du CNRS qui a été déterminant pour approcher les autres donateurs. A l'ORSTOM nous voudrions

en particulier remercier Monsieur Perrois, le directeur de la Division de l'Information Scientifique et Technique, et Monsieur Bonnemaison le Chef de notre département qui ont contribué sur leurs budgets respectifs. Au CNRS nos remerciements vont à M. Stuick-Tallandier, le directeur des relations internationales qui nous a soutenu dans nos efforts dès les premiers jours. Nous remercions aussi chaleureusement Monsieur Sant'Ana Calazans de la Direction Générale Science, Recherche et Développement de la Commission des Communautés Européennes qui a soutenu avec beaucoup de conviction notre dossier à la CEE et qui sera parmi nous au cours des derniers jours de cette conférence. Nous tenons également à remercier l'Unesco et tout particulièrement M. Marc Chapdelaine, le Centre de Recherche pour le Développement International (le CRDI) et tout spécialement M. Sitoo Mukerji, sous-directeur de la division des communications ainsi que le Ministère de la Coopération Français pour leurs contributions respectives.

Nous comptons également sur un soutien du Ministère de la Recherche et de la Technologie Français pour le financements des Actes qui seront publiés à la suite de la conférence.

L'organisation pratique de la conférence a reposé sur quelques personnes et n'a bénéficié que de peu de moyens notamment en secrétariat. Nous avons fait notre possible pour que votre séjour et la conférence se déroulent dans les meilleures conditions possibles. Ceci étant dit nous ne sommes pas des organisateurs professionnels de conférences internationales et nous vous demandons d'être indulgents en cas de problème. Venez nous en parler et nous essayerons de trouver une solution ensemble.

Je tiens à remercier tout particulièrement Michel J. Menou qui bien que n'appartenant ni à l'ORSTOM ni au CNRS n'a pas ménagé son temps malgré ses activités professionnelles, Nora Narvaez qui a tenu à revenir du Mexique plusieurs semaines avant le début de la conférence pour nous aider dans les derniers préparatifs, Rigas Arvanitis qui a réussi à mettre un point final à sa thèse dans le tumulte des préparatifs de la conférence et Anne Marie Gaillard dont la contribution à l'organisation pratique de la conférence et de votre séjour à Paris a été déterminante.

J'exprime le voeu que nos échanges et nos débats permettent de faire avancer de manière utile et significative les réflexions et les projets des uns et des autres, et je veux croire que cette conférence aura un retentissement appréciable non seulement auprès de l'ensemble des institutions au sein desquelles nous travaillons mais quelle aboutira également sur une (re)définition d'un agenda de recherche pour les années 90, une plus grande structuration du champ qui nous concerne et une institutionnalisation de nos efforts sous une forme qui reste à trouver. C'est sur ces voeux que je déclare ouverte notre conférence.

THREE SCIENTOMETRIC ETUDES ON DEVELOPING COUNTRIES AS A TRIBUTE TO MICHAEL MORAVCSIK

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INTRODUCTION

All of us, who knew Mike Moravcsik either personally or through the literature, can remember both his strong belief in the power of quantitative and analytical thinking and his deep commitment to help improving the science in the developing countries (1). "Assessing science and technology (S&T) is an absolutely crucial and yet a difficult task" ÷ stands in one of his unpublished manuscripts (2). "In countries of the Third World such assessment is practically never practiced." -he continues. "It is ironic that exactly those countries in which resources are most scarce but in which the establishment of S&T is at a most crucial and sensitive stage, the assessment of such activities is absent."

In the following three small studies our modest tribute is paid to Moravcsik's memory by using scientometric assessment techniques to reveal some features of the scientific research in the developing countries.

All results reported here are based on ISSRU's Scientometric Datafiles 1981-1985, (3) built by processing the magnetic tapes of the Science Citation Index (SCI) database of the Institute for Scientific Information (ISI, Philadelphia, PA, USA). The deficiencies of the SCI database, particularly as the coverage of the science of the developing countries is concerned, are well known. An attempt is, nevertheless, made here to show that with appropriate methods non-trivial and valid results can be derived even from SCI's often criticized data.

PUBLICATION POTENTIAL OF DEVELOPING COUNTRIES

Scientific manpower seems to be a natural measure of the scientific strength of countries. In fact, manpower is among the first indicators reported in statistical compilations of data on science by UNESCO (4) OECD (5) or NSF (6). However, the UNESCO survey, in its diplomatic style, also warns that "national statistical practices and concepts are not necessarily designed for the specific requirements of international comparisons" (4). What is worse, even for the same country, different sources may contain different data. Let us take for example the number of researchers in Japan in 1979. The values reported by UNESC0 (4), OECD (5), and NSF (6) are 418 000, 363 500, and 281 900, respectively. For smaller or less developed countries even order of magnitude differences are not uncommon.

For the above reasons, the use of an independent, common database for estimating scientific manpower seems to be rather advisable. Author counts based on SCI data, as used, e. g., by PRICE (7) is a very rough proxy due to the biasses in the SCI coverage. Authors represent only a fraction of the total scientific manpower, the tip of the iceberg, as it were. Unlike for real icebergs, however, this fraction may vary from country to country. The total size of "potential author" population has successfully been estimated by combining author counts with publication frequency counts (8-10). The basic idea of this estimation is as follows. Instead of a single number representing the number of authors a series of numbers is used representing the number of authors publishing 1,2,3,... etc papers in the given period. By extrapolating this series to 0, the number of "authors publishing zero papers" and thereby the complete set of "potential authors", i.e., the publication potential of the given country can be assessed. Such an extrapolation must be based on an adequate theoretical model of the frequency distribution of scientific publication productivity. The Waring distribution proved to be a suitable model for this purpose (8-13). The formula for calculating the publication potential is fairly simple:

$$T = N\,(1 - f_1)\,/\,(1 - 2f_1 + f_1/x), \qquad \text{Eq. (1)}$$

where T is the publication potential;
N is the number of authors;
f_1 is the fraction of authors with exactly one publication;
x is the average number of papers per author.

For the derivation see the cited literature.

In Table 1, scientific manpower estimates are presented for 51 developing countries with at least 50 scientists publishing as first authors in SCI covered journals in the 1981-1985 period. The number of first authors, N, has been counted by assigning them to the country of the first institutional address recorded in the Corporate Index files of the SCI database. No correction for misspelled names or homonymes has been made. In our experience, for most countries the two kinds of errors are compensating each other. (The only notable exception is Japan, which is outside the scope of the present study.) The publication potential was calculated by Eq. (1). Missing data indicate the fatal non-fit of the Waring distribution and thereby the impossibility of giving any sensible estimate. Wherever data were available, UNESCO (4) estimates are also given (n.a. stands for data not available).

Table 1. Estimates of scientific manpower

Code	Country	Number of 1st authors	Publication potential	UNESCO estimate
DZA	Algeria	213	1012.7	n.a.
ARG	Argentina	2934	10926.6	9500
BGD	Bangladesh	209	1345.6	n.a.
BRA	Brazil	4252	31692.0	24015
CHL	Chile	1473	6150.8	n.a.
COL	Colombia	186	1025.5	1449
CRI	Costa Rica	127	818.1	320
EGY	Egypt	2151	6575.3	n.a.
ETH	Ethiopia	108	685.1	n.a.
GHA	Ghana	125	434.2	4084
HKG	Hong Kong	676	2476.2	n.a.
IND	India	17585	41890.6	28233
IDN	Indonesia	157	÷	7645
IRN	Iran	309	÷	n.a.
IRQ	Iraq	454	6444.0	n.a.
CIV	Ivory Coast	145	908.4	502
JAM	Jamaica	183	1004.5	n.a.
JOR	Jordan	162	1390.2	452
KEN	Kenya	584	2205.0	361
KWT	Kuwait	319	1137.1	606
LBN	Lebanon	223	2119.2	180
LBY	Libya	127	1309.1	n.a.
MWI	Malawi	60	742.5	189
MYS	Malaysia	442	2307.4	n.a.
MEX	Mexico	1841	10685.5	n.a.
MAR	Morocco	198	1186.8	n.a.
NGA	Nigeria	1823	5310.8	2200
PAK	Pakistan	310	3948.8	n.a.
PAN	Panama	53	322.9	204
PNG	Papua N. Guinea	153	÷	n.a.
PER	Peru	109	2852.3	3932
PHL	Philippines	312	÷	3647
PRC	PR China	5706	24047.2	n.a.
SAU	Saudi Arabia	773	2972.9	n.a.
SGA	Senegambia	143	830.2	522
SGP	Singapore	457	1151.8	461
KOR	South Korea	708	3263.4	18434

Table 1. Estimates of scientific manpower (Continued)

Code	Country	Number of first authors	Publication potential	UNESCO estimate
LKA	Sri Lanka	192	1962.5	606
SDN	Sudan	260	774.4	3266
TWN	Taiwan	1115	3805.3	n.a.
TZA	Tanzania	192	3520.6	n.a.
THA	Thailand	543	5149.3	n.a.
TTO	Trinidad&Tobago	116	413.6	n.a.
TUN	Tunisia	215	1830.1	n.a.
UGA	Uganda	61	212.0	n.a.
ARE	United Arab Emir	51	246.3	n.a.
URY	Uruguay	95	÷	n.a.
VEN	Venezuela	796	7253.7	1627
ZAR	Zaire	76	÷	n.a.
ZMB	Zambia	105	452.0	250
ZWE	Zimbabwe	194	1283.7	n.a.

Figure 1. displays N/T, i.e., the percentage share of publishing authors (the "visible tip" of the iceberg) in the total scientific manpower estimated by the publication potential. Countries are denoted by their triliteral codes (see Table 1) and ranked in decreasing order of N/T.

Table 1 and Figure 1 speak for themselves without any detailed commentary. Some hints may, nevertheless, help to orient the reader to the most conspicuous features of the data.

The scantiness of UNESCO data is most striking in cases when author counts are higher than total UNESCO estimates (Kenya, Lebanon) or the two values are almost the same (Nigeria, Singapore). Only partial explanation of the deviance is given by the vast number of footnotes in the original UNESCO report (4).(Usually, the statistical data concern only to the personnel of some selected universities or institutes.) On the other hand, for some countries there are order of magnitude differences between UNESCO and publication potential estimates ÷ in favour of the former (Ghana, South Korea). In these cases one may suspect that the statistical standards of the given countries do not suitably conform to the general norms. Leaving UNESCO estimates aside, Figure 1 let us judge the width of the window opened by the SCI database to the universe of scientific publications. The percentage share of the "visible tip" ranges from 5% to nearly 50%. It is worth noting that the publication potential estimation apparently works well at both end of the scale: for the two extremes, Peru and India, the publication potential and the UNESCO estimates happen to be in fairly good agreement. For developed countries N/T is usually in the range 30-40%. Only a few of the developing countries reach this level. By lowering the limit to 25%, it appears that scientists of 14 developing countries represent themselves in the SCI database at a level comparable to that of the most developed countries. It is interesting to observe that these countries are either those of strong British traditions (India, Nigeria and Egypt all over 30%) or the newly riches (Singapore, Taiwan and Hong Kong of the "tigers", Kuwait and Saudi Arabia of the "oil powers"). The underrepresentation of most of the Francophonic and Latin American countries can partly be explained by the language barrier (but why not Argentina?), countries at the low end of Figure 1 are, nevertheless, worth reconsidering their publication strategy.

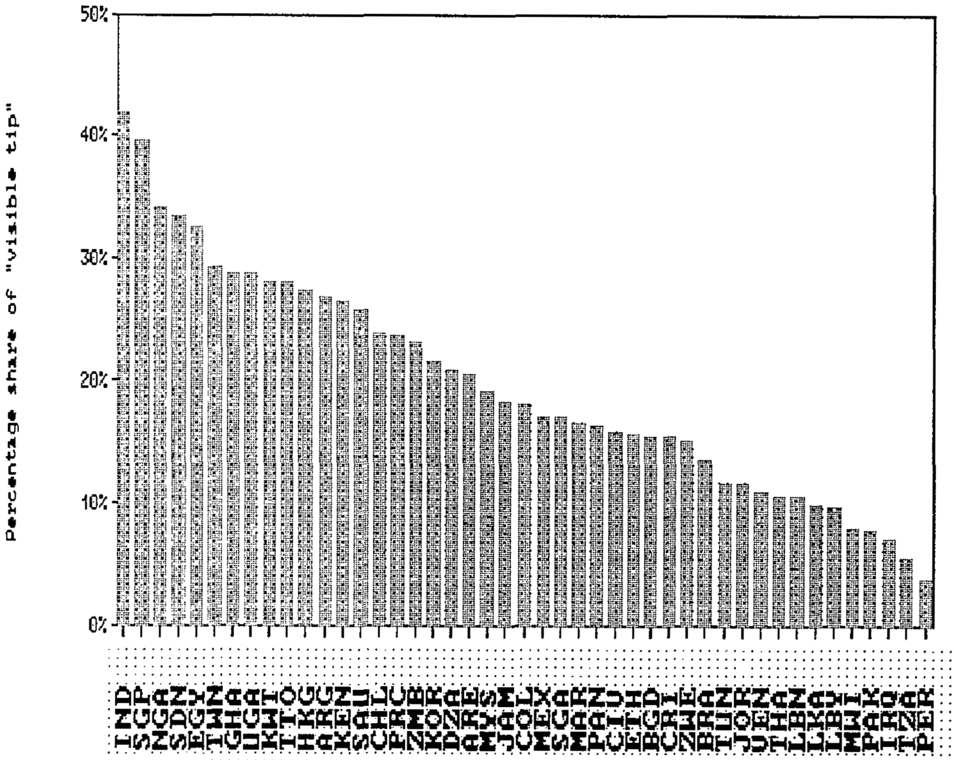

Figure 1. Percentage share of the "visible tip" of publication potential

CO-AUTHORSHIP PATTERNS OF DEVELOPING COUNTRIES

In a recent study on international collaboration in the sciences, co-authorship data of papers published in SCI covered journals in the period 1981-1985 were analyzed (14). Although summary statistics on 167 countries were reported, detailed analysis of co-authorship patterns was restricted to the most productive 36 countries. Developing countries were represented in this selection by Argentina, Brazil, Chile, China, Egypt, and India. It was found that with the single exception of a China ÷ USA link, none of the developing countries had co-authorship links with any other developed or developing country strong enough to be indicated on the co-authorship world map (Fig. 3 of Ref. 14).

One can, of course, get a finer resolution map by lowering the limits of representability, this method, however, easily results in a totally incomprehensible, obscure figure. In the present study, an attempt was made to "zoom" on the co-authorship patterns of developing countries both with the developed countries and among each others.

Basic methodology was the same as in our earlier study (14) Country assignment of papers was based on the corporate address of the authors as given in the Corporate Index files of the SCI database. International co-authorship was recorded whenever addresses from more than one country were indicated in the by-line of a paper. The absolute strength of the co-authorship link between two countries, i and k, is defined as the number of their co-authored papers, n_{ik}; the relative strength, r_{ik}, is given by Salton's measure:

$$r_{ik} = n_{ik} / (n_i n_k)^{1/2} ,$$

where n_i and n_k are the total numbers of papers published by countries i and k, respectively.

A minimum number of 50 publications in the period 1981-1985 was required for a country to be included in the study (72 developing countries) The 72 countries were grouped into four geographical regions: Latin America (18 countries), Africa (27 countries), Near East (10 countries), and Far East (17 countries). Both intraregional and interregional links were treated similarly: a minimum absolute strength of 5 joint papers and a minimum relative strength of 0.2% were the threshold values for a link between two developing countries to appear on the map of Figure 2.

Connections to developed countries are indicated in Figure 2 by assigning each developing country to its strongest (in the sense of relative strength) cooperating partner from among the six major "cooperating center": Australia, France, Japan, South Africa, UK and USA. The assignments convincingly reflect the historical-political-geographical connections. Only a few of the 74 developing countries under study had a strongest developed cooperating partner other than one of the above six countries: some notable exceptions are Chile (Spain), Zaire (Belgium) and Liberia (FR Germany).

The most conspicuous feature of Figure 2 is the fact that "local interactions" are overwhelming among developing countries. Countries of Latin America and the Far East are particularly closely intertwined by cooperation links. By combining North Africa (particularly Lybia and Egypt), India and its neighbourhood (Nepal, Pakistan, Sri Lanka) with the Near East region, interregional co-authorship would be reduced to a minimum. Francophonic countries appear to be rather isolated, the Ivory Coast ÷ Senegambia ÷ Upper Volta triangle forms the only positive exception. Brazil, Egypt and India seem to act as local centers in their respective regions.

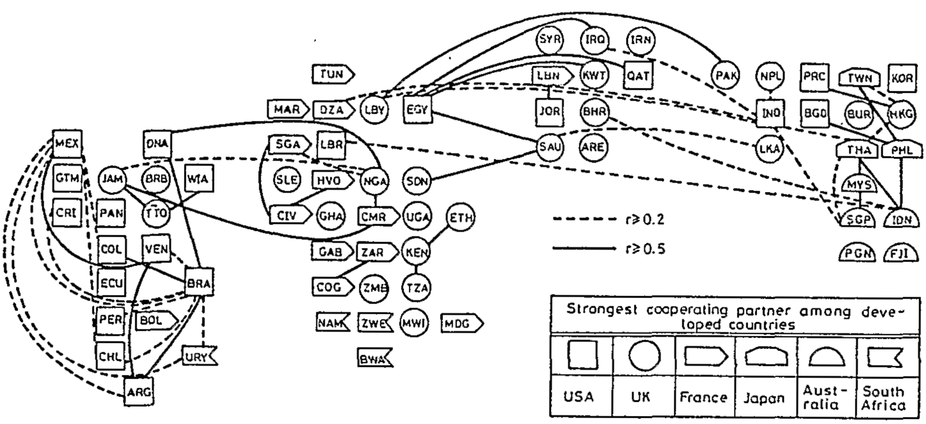

Figure 2. Co-authorship map of developing countries

SOCIO-ECONOMIC VERSUS SCIENTOMETRIC INDICATORS OF DEVELOPING COUNTRIES: FACE TO FACE

Multidimensionality was one of MORAVCSIK's guiding principles worthy of being followed (1,15). Let our personal attempts be mentioned here to change the form of presentation of scientometric indicators from linear rankings (16) to two-dimensional "charts" (17) and three-dimensional "landscapes"(18). It is not easy to proceed further, since representation of data in four or more dimensions apparently meets considerable difficulties. CHERNOFF (19) proposed a rather original method of representing multivariate data. "Each point in k-dimensional space, k<=18, is represented by a cartoon of a face whose features, such as length of nose and curvature of mouth correspond components of the point. Thus every multivariate observation is visualized as a computer-drawn face. This presentation makes it easy for the human mind to grasp many of the essential regularities and irregularities present in the data."
The present attempt is the first to apply CHERNOFF's quasi-4D representation of scientometric data. For each country, two faces were designed, one characterizing its socio-economic features, the other its scientometric measures. For simplicity, not more than four indicators are represented by a single face. The following indicators were chosen:

Socio-economic indicator	Scientometric indicator	Represented by
Illiteracy	Uncitedness	Shape of face
Life expectancy	Citation rate per cited paper	size of eyes
Telephones per capita	Mean expected citation rate	Length of nose
GNP per capita	Relative citation rate	Curvature and length of mouth

Socio-economic indicators were taken from THE WORLD BANK's survey (20). Scientometric indicators are from our Datafiles (3). Methodological details can be found in the cited references, let us only recall here some basic scientometric definitions and terminology.

Both publications and citations were counted in the five-year period 1981-1985. In publications counts only four publication types: articles, reviews, notes and letters were considered. Citations were counted irrespective of the type of the citing publication. Expected citation rates are calculated by counting the average citation rate of the publishing journals. This indicator can be interpreted as the expectation for the citation rate per paper as if all papers would be an average paper in the corresponding journal. The mean expected citation rate of a country indicates the visibility of the publication channels used and informs about the publication strategy of scientists of the country in question. Moreover, the expected citation rate may serve as a reference standard for the actual citation rate. Relative citation rate is the ratio of actual to expected citation rate.

Figure 3 demonstrates the correspondence between indicator values and facial features. Each pair of faces illustrates the minimum and maximum values of one of the four measures, the other three set to an average value.

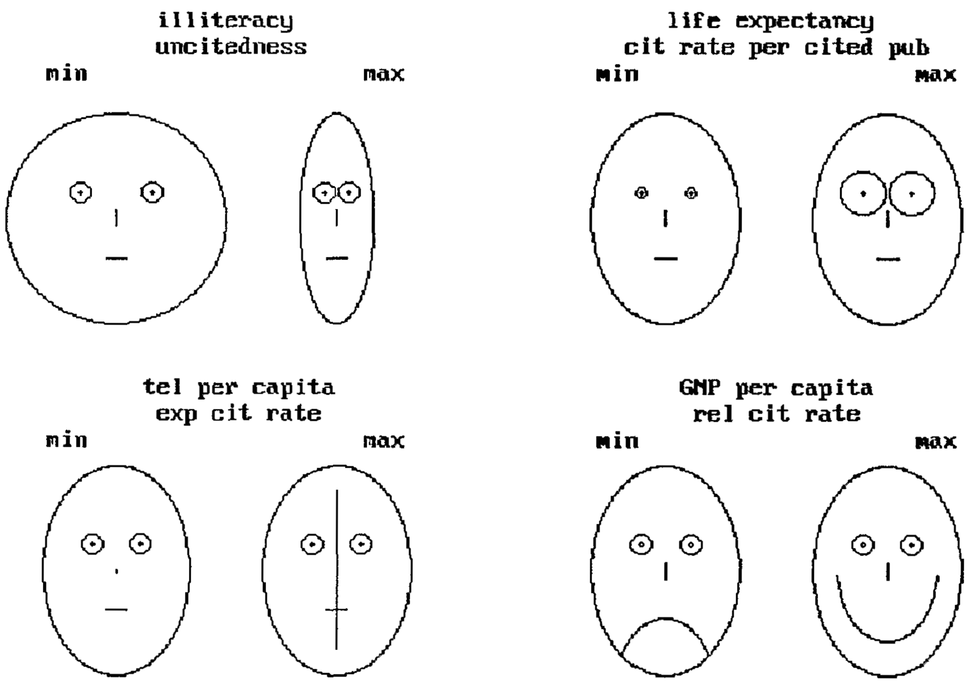

Figure 3. Representation of indicators by facial features

The minimum, average and maximum values of the indicators are tabulated in Table 2. Indicator values within the min-max range are represented by a proportionally sized facial feature; values outside this range were set to the corresponding extremal value.

38 pairs of faces are presented in the Appendix. All developing countries are included for which all the eight indicator values were available. The left hand side faces represent the socio-economic indicators, the right hand side faces the scientometric ones. Just to be sure, round face, big eyes, long nose and wide smile are the "positive" features. No specific commentary is added to this gallery of portraits. Enjoy them.

Table 2. Minimum, average and maximum values of socio-economic and scientometric indicators

Indicateur	Minimum	Average	Maximum
Illiteracy	0.0%	33.3%	66.6%
Life expectancy	25	50	100
Telephones per capita	10	100	1000
GNP per capita (USD)	0	1000	2500
Uncitedness	22.2%	44.4%	66.6%
Citation rate per cited paper	1.0	2.0	4.0
Mean expected citation rate	0.1	1.0	10.0
Relative citation rate	0.17	0.67	1.67

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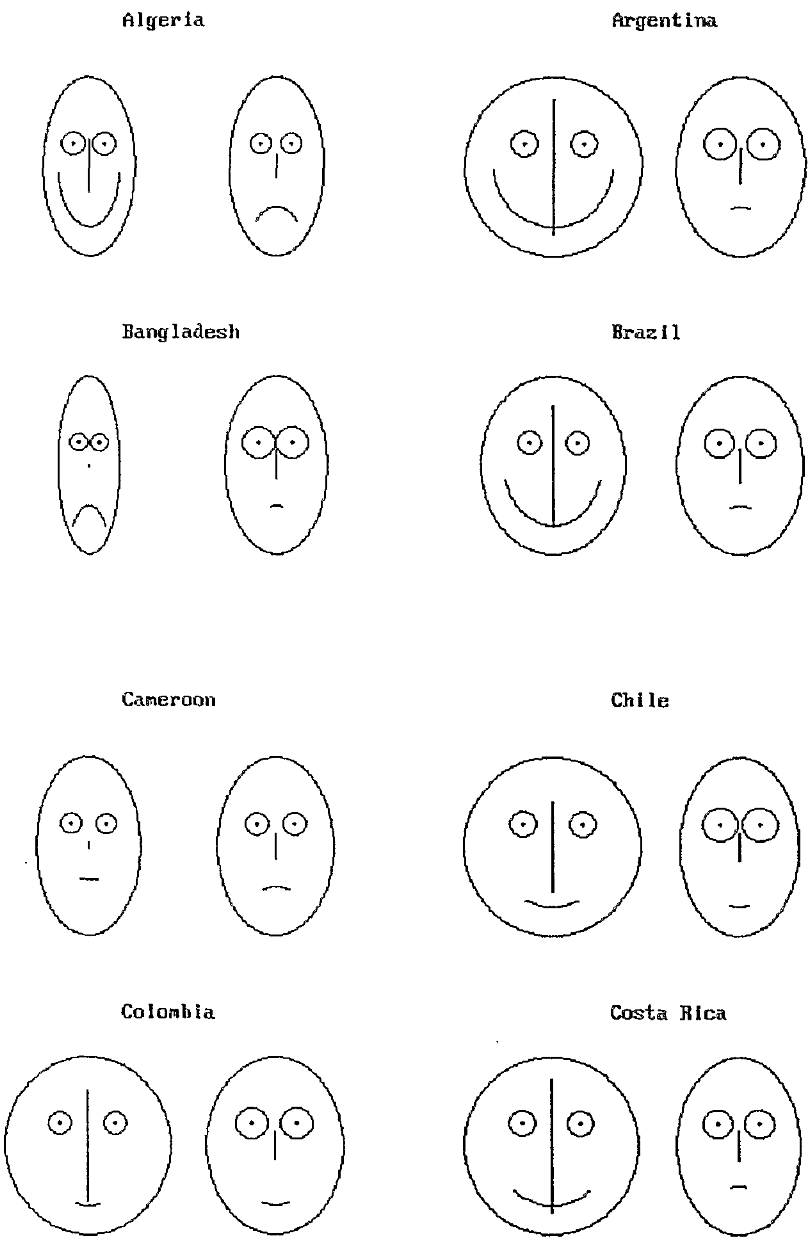
APPENDIX

Chernoff faces representing socio-economic and scientometric indicators of developing countries



Appendix
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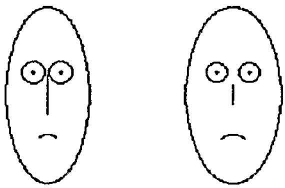

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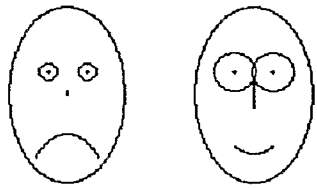

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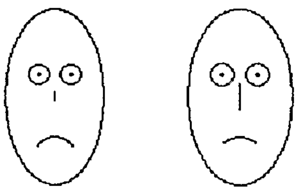

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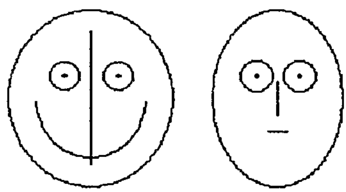

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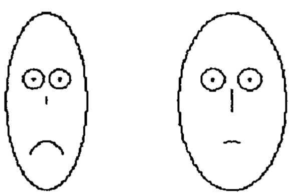

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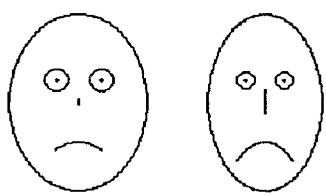

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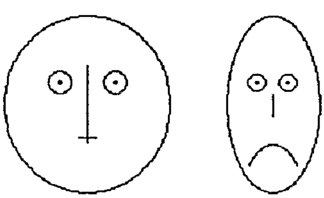

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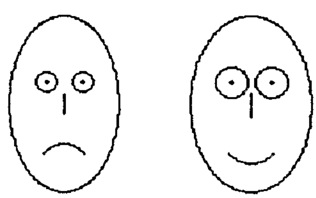

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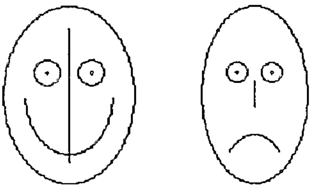
Kuwait



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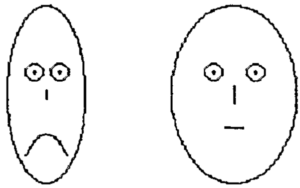

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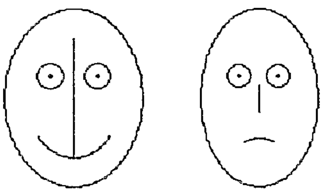

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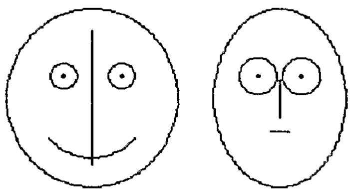

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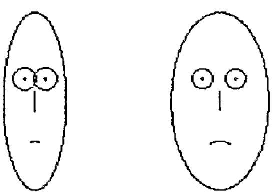

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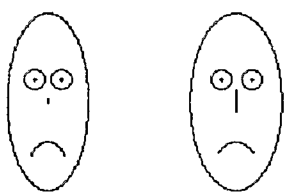

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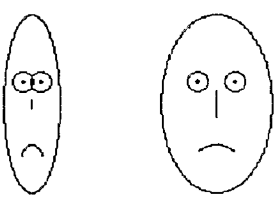

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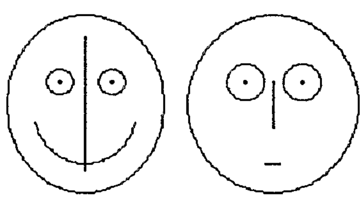

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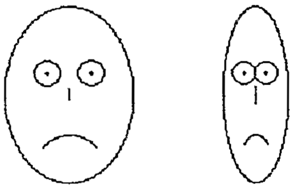

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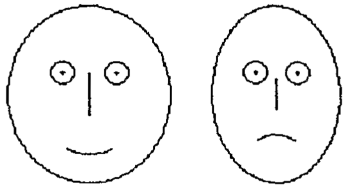

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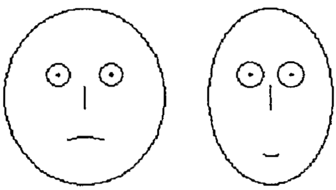

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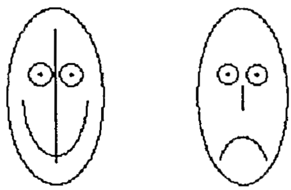

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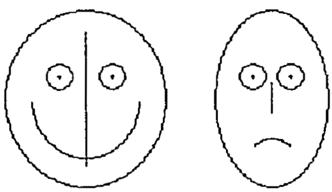

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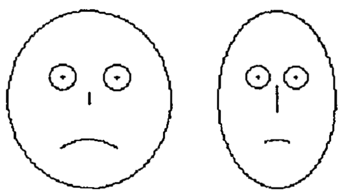

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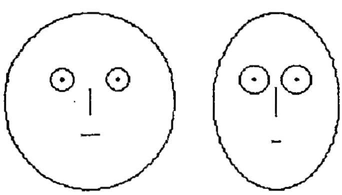
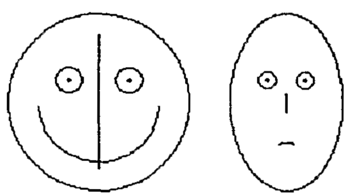


Trinidad&Tobago



Appendix
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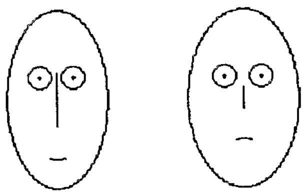
Tunisia



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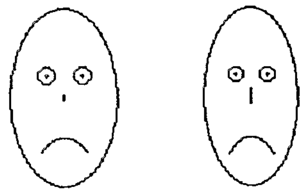

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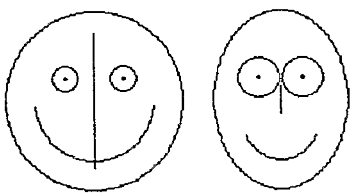

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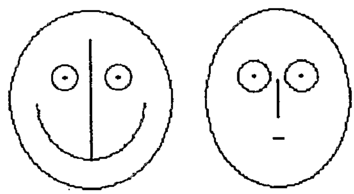

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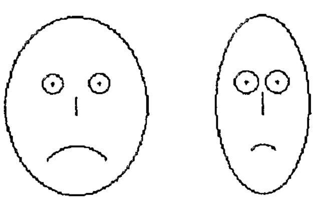

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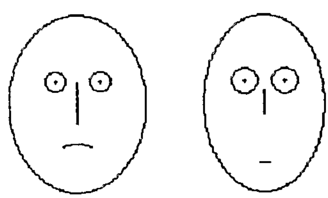

PREMIERE PARTIE

DE LA CONSTRUCTION DES INDICATEURS DE SCIENCE

PERIPHERALITY IN SCIENCE : WHAT SHOULD BE DONE TO HELP PERIPHERAL SCIENCE GET ASSIMILATED INTO MAINSTREAM SCIENCE

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ABSTRACT

Science on the periphery is characterised by (i) absence of a viable scientific community, (ii) an insularity (resulting from inadequate access to relevant information and inadequate communication within the local scientific community and with the international invisible colleges), (iii) an unduly long phase lag before participants in these peripheral societies can take part in hot/emerging research fronts, (iv) weak institutional infrastructures (such as academies, research laboratories, and more importantly peer review systems), and (v) an excessive dependence on science done elsewhere. However, there are levels of peripherality and within a country there can be vast differences among different fields, for instance. And some researchers may be much better off than their colleagues in the same field. As the problems are so complex and multi-faceted, there can be no simple solution. Attempts to solve one problem or the other in isolation may not lead to an optimal solution. In my view, the key to science development in peripheral countries lies in improving access to information, better dissemination of whatever little is done in these countries, and facilitating the establishment of better peer evaluation procedures within the country and increased participation in international science. Problems and prospects in realising each of these steps are discussed.

RESUME

La science de la périphérie se caractérise par (i) l'absence d'une communauté scientifique viable, (ii) une insularité qui résulte d'un accès inadéquat à l' information pertinente et d'une mauvaise communication à l'intérieur de la communauté scientifique locale et avec les collèges invisibles internationaux, (iii) une mise à l'écart des fronts de la recherche, (iv) des infrastructures institutionnelles déficientes (telles qu'Académies, laboratoires de recherche, et plus important encore, les systèmes d'évaluation par les pairs), et (v) une dépendance excessive de la science produite ailleurs. Toutefois, il y a des niveaux de périphéricité et à l'intérieur d'un même pays on peut rencontrer des différences importantes entre différents domaines, par exemple. Ainsi, certains chercheurs peuvent être mieux lotis que leurs collègues dans le même domaine. La complexité des

problèmes appelle des solutions multiples: toute tentative pour résoudre un problème de façon isolée peut ne pas conduire à la solution idéale. A mon sens, la clef du développement de la science dans les pays de la périphérie réside dans une amélioration de l'accès à l'information, une meilleure dissémination des travaux locaux, la mise en place dans les pays mêmes de procédures d'évaluation par les pairs de meilleure qualité et une participation accrue à la science internationale.

INTRODUCTION

Mike Moravcsik was indeed a tall man. In a world where most scientists are happy to do their "normal" work of teaching, research and publishing papers, Mike decided to devote a considerable amount of his time and energy to promote science development in the Third World. He made a mark as a theoretical physicist, but his long and sustained work in the area of science development did not end with theorizing. He was always looking for practical solutions whose impact would be felt and could be tested quickly in the field. He had a great concern and genuine sympathy for the poorer countries of the world and he strongly believed that the introduction and development of science - as it is practiced in the advanced countries of the West today - in developing countries would not only change their status but it is a good thing per se for the world as a whole. He also believed that often voluntary efforts and individual initiatives could achieve a great deal more than government initiated programmes.

His books "Science Development" (Bloomington, Indiana, 1975) and "On the road to worldwide science" (World Scientific, Singapore, 1989), the large number of conferences he attended and spoke at, and the very large number of friends he made in the Third World are eloquent testimony to his keen interest in nurturing science in the developing countries. There is hardly any question or issue pertaining to Third World science on which Mike has not expressed his balanced views, often with supporting quantitative evidence. It should not, therefore, be surprising if what I say sounds familiar to those who have known Mike and who have read his copious writings! In fact, Mike played an important role in my own development as a keen student of scientometrics and science in the Third World. He was among the first to "spot" me working in virtual isolation in India and was responsible for my participation in more than one international conference. I feel greatly privileged to be one of those who will carry on with Mike's unfinished tasks.

I - PERIPHERAL SCIENCE.

Like everything else, science is not distributed uniformly among regions of the world or among different countries. In fact, the distribution of science - by which-ever means it is measured - is even more skewed than the distribution of wealth among nations. Just about a dozen countries account for close to four-fifths of the world's published journal literature! The differences are not restricted to the output of scientific research such as papers published, patens taken, processes developed, etc. But also cover a range of input indicators such as money invested in R&D, number ans size of laboratories, number of researchers and technicians, availability of equipment and instruments, etc. The recognition received by science done in different countries in terms of awards, medals, ans prizes won, the number of times work reported from a country's laboratories are cited in the literature, the number of people invited to speak at international conferences or to be on the editorial boards of journals, etc. Also vary widely.

Science is universal only to the extent that a large part of the cognitive content of science is context free. In the real world we live in, deviations to the "universalism" of science abound and affect both the practice of science and the dissemination of scientific knowledge.

Several hundred years after the emergence of modern Western science and the near-total eclipse of pre-Western scientific traditions and knowledge systems, today we live in a world where only a small minority is involved in both the generation of new scientific knowledge and its exploitation. Vast sections of humanity, living in the Third World, are mere bystanders, often not even able to realize the great consequences - not all of them benefitcal and some of them certainly detrimental to their interests - of such developments. Besides the loss of the vast human resources that remain untapped in scientific research, the benefits of research are largely confined to those countries that pursue science. Men like Moravcsik, Marcel Roche, Glen Seaborg and others like us who assemble in conferences such as this one believe that greater participation in science is inherently a good thing : good for science as it will enable science to draw upon talent from a larger pool and from a much more varied cultural milieu; and good for the people themselves as science could be a great liberating force.

I will not go inter a discussion of "alternative sciences". For the present, I will assume that science as it is known and practised today in the developed countries of the world, with its paradigmatic growth cycles and undisputed links to technology, has come to stay and that, despite reservations in some quarters, European science based on rational materialism, as pointed out by Ziman and Moravcsik in their classic paper in *Foreign Affairs*, "should become a dominant cultural force throughout the world", and proceed to look into the problems faced by science done in the peripheral countries in getting assimilated into mainstream science.

II - CHARACTERISTICS OF SCIENCE ON THE PERIPHERY.

What distinguishes a scientifically peripheral country from the mainstream countries ? The most obvious thing is the scale of operation, as pointed out in the previous section. But size per se need not prove to be an insurmountable obstacle : Israel is a case in point.

Absence of a "scientific community" - Science is not best done by individuals working in isolation. Although cognitive factors and an individual's "qualities of the mind" play a very important role, science is essentially a social activity. The creation of new knowledge, which in my opinion is the primary activity in science, does not take place in vacuum. A community of informed individuals and groups inter-acting with and augmenting one another's performance is a must. Such a scientific community either does not exist in most peripheral countries, or if one exists it is not mature. Even in a very large country like India which has a large number of publishing scientists, both sociologists of science and scientists - who unlike sociologists do not carry out scientific studies on India's scientific estate but have the benefit of insider's insight - believe that there is no viable scientific community in India. Both sociologists ans scientists of standing have categorically made this point - the sociologists have in fact published their findings, with ample evidence and sound logic, in refereed international journals. And no one, as far as I know, has refuted their assertion.

The problem of a weak (or non-existent) scientific community is often compounded further by a haste to raise the pace of scientific activity in peripheral countries. Many institutions - universities, higher institutes of science and technology, national laboratories, etc. - are created without much forethought. Often there may not be enough qualified people to man the various positions and therefore men who do not really deserve get appointed. Yet another factor could be adopting criteria which have nothing to do with a person's ability to perform scientific work competently in selecting candidates to man scientific positions.

As pointed out by sociologists Ramasubban and Singh, the organization of scientific research along bureaucratic lines stifles and distorts scientific activity in peripheral countries, leads to widespread frustration and dissatisfaction among researchers and gives scientists-administrators a higher status than that of working scientists.

One possible scenario is the division of the country's scientists into a small minority of better performers who have many of the attributes that go to make a good scientist and a vast majority of scientists who are in the profession but barely making their presence felt. A part of the scientifically more competent minority migrates to the West - the so-called brain drain. Those who stay back keep in touch with invisible colleges in the advanced countries, manage to attend international conferences, and contribute to better-run and better-cited journals published from the advanced countries. The other class of scientists usually make routine investigations of not much value, publish mostly in local journals of low impact, and do not normally belong to any invisible college or network. Often, despite the fact that scientists from one category know scientists from the other and they may even socialize, they may not influence one another's scientific work !

Weak institutional infrastructure - Often a peripheral country mimics the form without much care for the substance. National academies (sometimes more than one), professional societies/associations, etc. are established in much the same manner as in a developing country, but sooner than later these are allowed to deteriorate. The same goes for specialised institutes of higher education in science, engineering, medicine and agriculture. Then there are the ever proliferating number of scientific awards which distorts scientific perspectives altogether.

Here we would consider two institutions, viz. the peer review system is the linchpin of the scientific enterprise. Be it evaluating research proposals for funding or examining a research paper to see if it is worth publishing or choosing Fellows of an academy, one needs a very well working peer review system. In most Third World countries peer review system is not operating as well as it ought to. Let me give only one example from India. The late Professor Sambhu Nath De of Calcutta (1915-1985) made seminal contributions to our knowledge of cholera and related diarrhoeal diseases and indeed set the stage for the modern view of diseases caused by bacterial toxins. De's work constitutes a cornerstone of the edifice of cholera research and opened up the field of protein toxins. His work was not only highly relevant to India (after all Bengal was known as the home of cholera) but also set the highest standards of excellence in experimental design and execution. Undoubtedly it marked a high point of basic medical research in India. The full significance of De's work was brought out vividly in the 1983 book by van Heyningen and Seal Cholera : The American Scientific Experience (1947-1980). Prof. Joshua Lederberg, the American Nobel Laureate, nominated De for the Nobel Prize more than once. Gene Garfield paid rich tributes to Dr De in an essay he wrote in 1986 in his honour. And yet De died unhonoured and unsung in India. "That De received no major award in India during his lifetime and that our Academies did not see it fit to elect him to their. Fellowship must rank as one of the most glaring omissions of our time", said Prof. P. Balaram of the Indian Institute of Science in a special issue of *Current Science* (dated 25 july 1990) brought out to honour Dr De. A clear case of collective myopia, which fails to distinguish men of straw from scientists of substance. In contrast many of India's leading scientist (some of whom have turned administrators) are today more highly decorated than most generals of a victorious army after a successful war.

Although the neglect of Dr De by the Indian scientific community was brought home by Gene Garfield as early as 1986 (The 1983 book by van Heyningen and Seal is even now not easily available in India, and Garfield's tribute appeared in the much-circulated *Current Contents*), no regret was expressed in any quarters !

Well-run indigenous journals are essential components of a viable scientific community. True, many scientific journals are published from developing countries. But only about 40 of them are covered in *Science Citation Index*, the tool often used in studies on science indicators, evaluation of research performance, etc. Most developing country journals are of poor quality and the elite among the local scientists rarely publish their work in these journals. Because these journals publish a very large number of poor quality papers, they will find it difficult to attract good quality papers from both within the country and from abroad.

About three years ago, two professors from Madras - Prof. C N Krishnan of the Madras Institute of Technology and Prof. B Viswanathan of the Indian Institute of Technology - wrote a paper in a not-so-well-circulated journal called the *PPST Bulletin* and pleaded with Indian scientists to be more nationalistic in the matter of journals for publishing their research results. They thought that Indian should build journals of class as the Americans did in the early part of this century. And they found that it was the leaders of Indian science - fellows of the Academies and members of the editorial boards of journals who published most of their work in foreign journals. Although the Krishnan-Viswanathan paper was not the first to draw pointed attention to the quality of Indian journals, it had an unprecedented impact on India's scientific establishment. Prof. C N R Rao, one of India's most well known and highly regarded scientists, wrote to all Fellows of the Indian Academy of Sciences in December 1987 requesting them to consider publishing their better papers in the Academy journals. Prof. E S Raja Gopal, then editor of *Pramana,* India's best known physics journal, wrote on the declining support being received from leading Indian physicists and felt that it would indeed be sad if we had to close down our journals for want of adequate support from our scientists. *Physics News,* an organ of the Indian Physics Association, carried an editorial in early 1988 emphasising this point. Dr A P Mitra, Director General of India's Council of Scientific and Industrial Research, wrote to directors of all CSIR laboratories and members of the editorial boards of all CSIR journals seeking their suggestions on ways to make CSIR journals more attractive to Indian scientists.

However, the best that has happened since Krishnan and Viswanathan wrote their provocative paper was the appointment of Prof. S Ramaseshan, the man who founded *Pramana,* as the editor of *Current Science,* a fortnightly journal of more than 50 years standing. Within a year of his taking over the journal has shown remarkable improvement.

Insularity - Science in the Third World often suffers from insularity - lack of inadequate contact with international science. What is done in Third World laboratories and published in Third World journals is hardly ever noticed by scientists elsewhere. Many researchers, in particular Tibor Braun and colleagues at the Hungarian Academy of Sciences, have shown from publication and citation data the meagre - very nearly non-existent - impact Third World science has on world's mainstream science. Not only does most of peripheral science appear in low-impact and often non-SCI journals but il also has very low observed and relative citation rates. Added to this is the fact that most of the references quoted in peripheral science publications is pretty old and the work itself is of very low current relevance. In fact, rarely do Third World scientists have opportunities to work in newly emerging research fronts. There is a considerable time lag before research on an area initiated in Western laboratories reaches developing country laboratories. There is another kind of insularity as well, viz. disciplinary insularity. Rarely do we see work done in a Third World laboratory that can be called interdisciplinary. A large part of the citations to peripheral country journals and to articles published by peripheral country scientists in foreign journals will be from scientists from the same country and researchers from the same field.

Among the several factors responsible for this state of affairs two appear to be of crucial importance. These concern inadequate access to relevant information and poor communication facilities. After all, the creation of new knowledge, the most essential activity in the enterprise of science as in other areas of scholarship, takes place in "information space" ; when one finds something new one has raised our understanding from the existing level of information to a new level. No wonder then researchers ought to be well informed. In this respect most Third World scientists are neither well up nor well served.

That improved access to worldwide information leads to better performance in science has been demonstrated time and again. For instance, India fares well in areas where access to information and the viability of the scientific community are better than in other areas : astronomy, high energy physics and biochemistry. I have talked about this extensively elsewhere.

Most developing countries have poor library facilities. And many Third World scientists are not in preprints/reprints circuit. Almost all the important current awareness services, abstracting and indexing services and leading journals are all produced either in North America or in Western Europe and they are frightfully highly priced. Thus not only for their essential equipment, instruments, chemicals and other material goods but also for access to information the Third World countries are abjectly dependent on the advanced countries. And almost always these services and goods have to paid for in scarce hard currency.

Most of what I have said thus far is well known. And if I have cited examples from India it is because that is the area I known well. However, I must add a caveat. India is not an ideal example of 'Paradisia'. In fact, in some respects India is as good as the advanced countries. For example, in high tech areas such as superconductivity, cold fusion, liquid crystals, radioastronomy, molecular biophysics etc. Indian researchers are tackling problems in emerging research fronts. The situation in most other Third World countries is considerably worse.

III - WHAT COULD BE DONE ?

Having described the general characteristics of peripheral countries, let me proceed to mention some of the possible approaches to bring in peripheral country research into mainstream science. There can be initiatives of different kinds : by individuals, voluntary groups, international organizations, governments, etc. There are many already in place. And others could be thought of. Improving the quality of science done on the periphery and making it easily assimilable in mainstream science is a complex task and it would be better to divide the problem into several component tasks. Each of these components can then be tackled by the most appropriate kind of initiative to be decided on the basis of feasibility, costs, etc. For example, raising the level of peer review in a country is essentially to be tackled internally. It is too sensitive an area to brook outsider interference !

However, it will not be wise to tackle one problem or the other in isolation ; that will not lead to an optimal solution. Two related problem, vis. improving access to information and better dissemination of research done in peripheral countries, will get top billing in my scheme of things. Related to these objectives is the task of increasing Third World scientists' participation in international and bilateral programmes.

The Third World Academy of Sciences, with its headquarters at Trieste, Italy, has a programme of gifting scientific journals and books to needy libraries. A voluntary group formed earlier this year in the USA, called Indian Descendent Engineers and Scientists (IDEAS) is willing to consider a similar scheme of donating books ans journals to needy Indian institutions, and to support Indian scientists visiting the USA and Canada to attend conferences. International organizations such as ICTP, Trieste, help a number of talented Third World scientists spend some time in the congenial surroundings of ICTP where they can work with talented scientists from other parts of the world including both advanced countries and other developing countries.

Bilateral programmes such as the Indo-US Subcommission on Science and Technology make it possible for several Indian laboratories to do collaborative work with US laboratories in a variety of fields. The flow is not always one-sided as might be imagined. In fact, the projects are chosen so carefully by the US team as to maximise their benefits ! About three years ago, the NSF carried out an elaborate exercise - including commissioned reports by experts, meetings of experts, a bibliometric study on the strengths and weaknesses of Indian science by an expert in scientometrics, and questionnaire surveys - decide on areas in which joint projects would be most beneficial.

Then there are projects such as the UNDP-sponsored "Transfer of Knowledge through Expatriate Nationals" which began in Turkey in 1977, and which is currently in operation in about 30 countries. TOKTEN provides a means for using the services of highly qualified and competent professionals abroad in S&T related fields in their home countries. It was initiated in India in 1980. In the first ten years of the programme, between 1980 and 1989, 257 expatriate Indians, mostly from the United States, visited India for periods ranging from 2 or 3 weeks to 12 weeks (average, a little over 4 weeks), at a cost to UNDP of about US $ 1.1 million. The Indian TOKTEN programme has been evaluated twice, first by a joint UNDP-Government of India team headed by Professor M C Madhavan of San Diego State University, USA (which covered the period 1980-

1987), and more recently by a purely Indian committee headed by Professor A K Sharma which evaluated the entire programme de novo covering the period 1980-1990 June. Both the Madhavan Committee and the Sharma Committee are unanimous in their verdict, viz. the TOKTEN project is well conceived, well implemented, and it should be continued and its scope expanded. The Tokten-India project has been perceived, without any exception, by all user organizations as very useful in many respects including transfer of technology, development of new processes, transfer of information and knowledge about emerging areas of research, introduction of novel approaches in ongoing research projects, etc. Every TOKTEN expert seems to have taken his assignment seriously and has indicated a definite willingness to participate in follow-up activities and to continue assistance to the host organizations. In many cases, collaborative research projects have been developed and regular contacts maintained with the experts. In a few cases, several Indian scientists visited the experts' laboratories in the USA to learn more about the new techniques or attend special training courses. A number of experts have also given rare chemicals/biochemicals, computer programmes and publications not easily available in India.

According to the report by the Sharma Committee, the contributions of TOKTEN consultants cover a wide spectrum of fields - physical, biological, and engineering sciences, medicine and technology. "The contributions are enormous, significant, and habe greatly benefited various national programmes geared towards development." There are two advantages to the TOKTEN programme. First, the cost is far less than any comparable 'consultancy' programme where visiting experts provide equivalent service. Second, and probably even more significant than the first, the transfer of knowledge and other benefits takes place under psychologically much more conducive atmosphere than when Western experts visit Third World countries. I do not have information on how other TOKTEN programmes - in countries like the People's Republic of China, Egypt, etc. - have been evaluated. But the Indian experience appears to be one of unqualified success. Such programmes should, therefore, be strengthened. In fact, India has launched other programmes, somewhat similar to TOKTEN but without the assistance of UNDP. One of them is TIES (Talented Indian Engineers and Scientists), aimed to tap the skills and goodwill of non-resident Indian experts.

Let us now turn our attention to initiatives calculated to improve information provision per se. In a paper published in Journal of Information Science in 1981, I have given several suggestions which I believe are valid even now. In short my proposals include : (1) creating an awareness among both researchers (users) and librarians and information officers of the central role played by information in R&D, (2) helping the users learn to search information more efficiently, (3) introducing new information technologies (on-line retrieval, off-line batch mode retrieval, use of CD-ROM databases, etc.). We will not go into the details for want of time.

The other problem of disseminating whatever is done in the developing countries is not all that straightforward. Often we hear Third World scientists complain that their own earlier work is not taken note of and subsequent work reported from some laboratory in the West is being cited in the literature. Sociologist Harriet Zuckermann and scientometricist Tibor Braun feel that no deliberate mischief or conspiracy is involved. Such things happen even when the work is published in highly circulated international journals.

Most journals published in Third World countries are poorly circulated and often what is published in them go unnoticed by researchers elsewhere. Unless these journals are covered by all the relevant secondary services there will be no chance of them being noticed by workers elsewhere. It is for this reason Mike Moravcsik assembled about 30 experts in Philadelphia in 1985 and tried his best to persuade ISI, Philadelphia, to cover many more Third World journals in SCI at least on a trial basis for a few years. Somehow, the plan did not work. We realize that philanthropy cannot always work ; in certain things hardheaded financial decisions are to be taken. Getting more Third World journals covered will cost money and we have got to find a source to fund the project.
However, we must realise that Third World scientific communities should ultimately have to become self-supporting. One cannot live on blood transfusion for ever. Any initiative which will make developing countries eternally dependent on outside support should, therefore, be eschewed.

LE "GRANUM SALIS" DE REALISME DES INDICATEURS DE SCIENCE
LE ROLE DU CONTEXTE HISTORIQUE

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RESUME

Cet article voudrait souligner la nécessité de la prise en compte de la formation historique des communautés scientifiques dans la conception et l'utilisation des indicateurs de science. La science conçue de façon eurocentrique considère les pays de la périphérie comme des appendices de la science centrale. Or les études historiques nous montrent aujourd'hui que la diffusion de la science a suivi des modèles différenciés et que la pratique scientifique n'a pas connu de modèle général. L'auteur examine dans le cas des pays latino-américains cette spécificité et suggère de la prendre en considération dans la construction d'indicateurs de l'activité scientifique.

ABSTRACT

This article wants to attract the attention on the necessity of taking into account the specific historical context of the creation of a scientific community when constructing and using scientific indicators. Science has been generally conceived as a mere extension of central countries. This europeocentrism is contradicted by recent historical studies that show the diversity of models of the development of science as well as the diversity of scientific practices. The author examins the latin-american case and suggests to take this specificity into account when constructing science indicators for developing countries.

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Les reproches qui ont été adressés aux indicateurs et aux bases de données scientifiques élaborés par les pays "centraux" sont nombreux, notamment à propos de la sous-représentation de la science des pays périphériques et des difficultés qu'il y a à penser la réalité de la recherche de ses pays à partir des indicateurs conventionnels.[1] La science est en effet pensée en termes trop

[1] Voir, par exemple, Y. Chatelin et R. Arvanitis, Stratégies scientifiques et développement. Sols et Agriculture des régions chaudes, Paris, ORSTOM, 1988.

européocentriques. Ainsi, l'activité de recherche de ses pays reste mal connue et surtout est masquée par la prétendue universalité de la science. Or, les études historiques des sciences de ces dernières années nous montrent un aspect nouveau et différent de la science en prenant explicitement en compte le contexte dans lequel se développe l'activité de recherche. Aujourd'hui nous disposons de données qui nous permettent d'affirmer que la diffusion des sciences dans le monde a suivi des modèles différenciés et que la pratique de la science n'obéit pas toujours à un modèle unique.[2] Il est donc nécessaire de tenir compte de la singularité historique pour saisir la véritable nature de la science dans les pays en voie de développement.

Cette communication veut souligner l'importance de la formation historique de l'activité scientifique périphérique dans l'analyse de sa production scientifique.

1. Nous serons tous d'accord ici pour reconnaître le travail pionnier de Derek de Solla Price, comme par exemple Little Science, Big Science (1963). Ses travaux sont devenus des classiques de la bibliométrie, mais aussi de l'histoire des sciences (Science since Babylon). Price était un historien des sciences et des techniques: voici donc un auteur que l'on ne peut pas soupçonner d'indifférence à l'histoire des sciences. Il a même toujours affirmé que sa véritable profession était l'histoire des sciences et il s'essaya à en découvrir les lois de développement. Or, malgré cela, Price est un cas significatif d'auteur qui conçoit l'activité scientifique en dehors de toutes considérations culturelles, géographiques et historiques, attitude largement responsable de l'irréalisme actuel des indicateurs portant sur l'activité scientifique des pays périphériques.

Comme nous le savons tous dans cette Conférence, l'intérêt de Price pour l'analyse quantitative et objective de la croissance de la science couplé à l'étude de son histoire devait permettre de combler le fossé entre deux cultures, celles de l'humanisme et celle du scientisme. Les "humanités des sciences" d'après l'expression de Price, devaient permettre la formation d'un homme de science plus cultivé et en finir avec cette espèce que Price qualifia "l'idiot scientifique". Cette motivation fut courante parmi les historiens de la science du début de ce siècle comme en témoigne par exemple George Sarton qui parlait également d'un humanisme nouveau, fondé sur la connaissance de l'évolution de la science.[3]

Mais cette perspective cache la diversité culturelle des différents contextes socio-historiques sous l'apparence d'une uniformité de l'expérience scientifique.[4]

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[2] Voir J.J. Saldaña (ed) Cross cultural Diffusion of Science: Latin America, Cuadernos de Quipu 2, México, 1987.

[3] G. Sarton, History of Science, in Sarton on the History of Science, edited by D. Stimpson, Harvard University Press, 1962.

[4] N. Reingold, La uniformidad como diversidad encubierta: la historia de la ciencia de Estados Unidos, 1920-1940, Nuevas tendencias en la Historia de las Ciencias, A. Lafuente y J.J. Saldaña (eds), Madrid, CSIC, 1987.

Seule l'histoire des sciences récente a su mettre en évidence l'importance du contexte pour comprendre la formation historiquement différenciée des sciences dans chaque société. Pour Price, la science, ainsi que ses mécanismes sociaux de fonctionnement, était une et universelle. Et, bien entendu, le modèle scientifique appartenait au seul reconnu comme tel, celui de l'Europe.

Cette position est contradictoire: quel pourrait être, en effet, l'intérêt de l'histoire des sciences pour le sociologue ou le bibliomètre, si on se borne à affirmer que la science d'autrefois n'est qu'un maillon dans la chaîne qui conduit au présent ? L'histoire des sciences est-elle d'une quelconque utilité pour la scientométrie ? En fait, Price fut obligé d'avouer que l'histoire n'a pas grand chose à voir avec la caractérisation de la science actuelle: "As a historian of science", disait-il dans Little Science, Big Science, "I find myself doing annual battle to justify and uphold the practice of spending more than half hour time on the period before Newton, whereas every contemporary scientist knows that what really counts is science since Einstein". (p.2) Il s'agit d'une espèce de schizophrénie intellectuelle qui ne trouve pas de solution en dehors de cet humanisme prôné par Price et ses contemporains. Cette vision s'accommode aussi d'une vision restreinte de la science comme activité héroïque de la culture européenne, de nature cumulative et progressiste.

Derek Price connaissait pourtant assez bien les cultures anciennes, notamment les cultures précolombiennes méso-américaines comme celle des Mayas. Il fut très impressionné par le Chac-Mol et j'ai eu l'occasion de l'entendre en parler avec enthousiasme lors de sa dernière visite au Mexique en 1981. Il était également au courant de la culture mexicaine et dans une certaine mesure de son contenu scientifique, puisqu'il avait longtemps correspondu et gardé une amitié avec Enrique Beltrán, le promoteur infatigable de l'histoire des sciences au Mexique. Il aimait visiter les musées au Mexique et lors d'une visite antérieure il avait vu un astrolabe au Musée d'Histoire de Chapultepec, ce qui lui a permis de faire une conférence sur l'histoire de cet instrument à l'Université.

Quelques années auparavant, en 1963, Enrique Beltrán organisait le premier colloque sur l'histoire des sciences au Mexique et il demanda à Price son aide pour le faire connaître aux Etats Unis. La réponse de Price contenait une critique à Beltrán: le "localismo" (chauvinisme) de la réunion axée sur des sujets mexicains ou latino-américains. Il s'agit d'une démarche -disait-il- d'un "stalinisme" similaire à celui développé en Russie qui voudrait que tous les progrès de la science eussent lieu en Union soviétique.[5] Evidemment, pour Price, l'histoire des pays autres que ceux de la Révolution scientifique ne pouvait être qu'une histoire de précurseurs ou de contributions à la science européenne. Et même ce dernier projet serait-il par trop "localista".

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5 Discurso del Dr. Enrique Beltrán, Presidente honorario vitalicio de la Sociedad Mexicana de Historia de la Ciencia y la Tecnología, Actas de la S.M.H.C.T., vol.1, 1989, pp.177-178.

2. L'activité scientifique en Amérique latine est ancienne et ses origines se trouvent dans les grandes civilisations pré-colombiennes, en particulier celles des Andes et de méso-amérique. Depuis le XVI-ème siècle la science de la Renaissance et la science moderne fut régulièrement cultivée dans ces régions et institutionnalisée vers la fin du XVIII-ème siècle en Nouvelle Grenade (Colombie), au Pérou et en Nouvelle Espagne (Mexique). Au XIX-ème siècle la science fut largement soutenue et se répandit dans les autres nations américaines, lors de leur indépendance, souvent dans un souci pragmatique. Dans notre siècle, et surtout après les années trente, la science académique fut instituée et joue encore de nos jours un rôle significatif dans le développement de ces pays.[6]

Or le cas de l'Amérique latine est significatif car il montre: a) l'existence de traditions scientifiques dans d'autres régions du monde, non considérées dans les études traditionnelles sur la science; b) que ces traditions sont fortement liées à une culture différente enracinée dans son milieu naturel et social; c) que dans la diffusion de sciences à l'échelle mondiale le rôle des conditions locales ne fut jamais passif, ne fut jamais celui de la réception passive de la science produite par le "centre"; d) que la formation de la pratique scientifique dans cette région est le résultat d'un processus historique particulier dont il faut tenir dans les études sociales de la science.

Actuellement en Amérique latine, en dehors de l'histoire des sciences qui enregistre des progrès significatifs tant du point de vue empirique que conceptuel,[7] les études sociales de la science n'ont pas fait un effort suffisant pour "penser" avec des moyens théoriques et des instruments analytiques propres leur objet.[8] De ce fait les travaux scientométriques ont ravivé cette idée de l'universalité de la science. En utilisant les mêmes instruments pour "observer" la science que ceux élaborés pour les pays centraux, sans effort d'adaptation ou d'innovation, on est retombé dans le schéma d'analyse où tout se passe dans un monde homogène.

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[6] Voir à ce propos l'ensemble des travaux reúnis dans X. Polanco (ed) Naissance et développement de la science-monde. Production et reproduction des communautés scientifiques en Europe et en Amérique latine, Paris Editions de la Découverte/Conseil de l'Europe/Unesco, 1990. Une façon d'approcher l'histoire des sciences latino-américaine est la revue Quipu. Revista latinoamericana de la Historia de las Ciencias y de la Tecnología, publiée depuis 1984 avec plus d'une centaine d'articles sur de nombreux sujets.

[7] Voir par exemple les travaux réunis par J.J. Saldaña, El perfil de la ciencia en América, Cuadernos de Quipu 1, México, 1986. Voir également M. Cueto, Andean Biology in Peru: Scientific styles in the periphery, Isis, 80 (1989), no.304, pp.640-658; et A. Lafuente et J. Salas, Ciencia colonial y roles profesionales en la américa española del siglo XVIII, Quipu, 6 (1989), no.3, pp.387-403.

[8] Pour un aperçu, H. Vessuri, The Social Study of Science in Latin America, Social Studies of Science, 17 (1987), pp. 519-554, qui souligne le sentiment d'irréalisme des études sociales de la sciences en Amérique latine (p.548).

D'autres que moi dans cette Conférence s'occuperont certainement des conditions particulières dans lesquelles la pratique scientifique se déroule dans les pays du Tiers Monde. Je me bornerai à signaler que ces conditions sont différentes de celles des pays du centre, ce qui explique également que les motivations et les sujets d'études soient différents. Malheureusement cette différence est trop souvent "oubliée" dans les travaux scientométriques. Ceux-ci reprennent le schéma, élaboré d'après la théorie des systèmes, des input et des output; ainsi, ce que certains ont nommé l'écologie du système, son contexte, son histoire, est laissé de côté.

Il est vrai que jusqu'à très récemment, on ne disposait que de très peu d'informations sur le contexte social et historique des pays latino-américains. Aujourd'hui encore cette information est loin d'être entièrement satisfaisante. Mais des progrès importants ont été réalisés durant les années quatre vingt. Voici donc une information neuve, décisive pour les définitions précises des terrains d'études aussi bien pour l'analyste de la science que pour celui qui prend des décisions dans ce domaine. A plusieurs reprises[9] l'irréalisme des politiques de planification de la science en Amérique latine a été signalé, irréalisme dû à l'ignorance du contexte socio-historique des sciences.

Une fois que l'on a pris conscience de ce fait - ce dont témoigne cette Conférence - il faut aller plus loin. On peut se poser la question de ce que l'on peut apprendre de l'histoire des sciences latino-américaines. Il s'agit là, à mon avis, d'un point fondamental. Il est nécessaire de considérer tout d'abord que la formation historique de la pratique de la science ainsi que son espace institutionnel, social, politique, etc. est singulier. Il est donc indispensable d'introduire cette spécificité dans les méthodologies d'analyse. Ensuite, il faut reconnaître que la coupure qu'effectue le sociologue pour connaître l'état actuel de la science est la résultante d'un état antérieur qu'il faut saisir dans sa dynamique.

Les indicateurs de sciences doivent donc être spécifiques et ne peuvent être comparables que sur un plan très général à ceux des pays de niveau de développement différent. Il semblerait que les indicateurs sont ou bien porteurs d'informations utiles et réalistes, et en ce cas spécifiques à la réalité qu'ils décrivent, ou bien ils sont généraux, formels et abstraits et en ce cas ne permettent pas de rendre compte des réalités sur lesquelles ils sont censés réfléchir. Jusqu'à présent nous n'avons eu que l'expérience des indicateurs qui considéraient la science périphérique que comme un pâle reflet de la science centrale, et nous n'avons pas obtenu l'image de notre pratique scientifique telle qu'elle se fait. A quoi bon peut-il nous servir le fait de savoir que la science latino-américaine représente le 1% de la science mondiale, si notre problème principal est de faire de la science un facteur de développement pour nos

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9 Par exemple ici même au siège de l'Unesco, lors du colloque Science et Empire, en Avril dernier, il fut discuté du rôle de l'histoire des sciences dans les politiques scientifiques dans tout sorte de pays.

sociétés ? Arriver à comprendre la nature de notre pratique scientifique est pour l'historien des sciences que je suis, un défi professionnel et je suis persuadé qu'avec les autres études sociales de la science nous pourrons le relever.

ACCESS AND RETRIEVAL OF INFORMATION AS COORDINATES OF SCIENTIFIC DEVELOPMENT AND ACHIEVEMENT IN NIGERIA

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ABSTRACT

In a pioneering study on the first generation Nigerian Universities between 1975-79, using the science indicator of publication count of the scientists derived from the ISI database, the data showed a real growth in scientific output. The growth correlated well with Federal Government funding of the Universities and the nation's Gross Domestic Product (GDP). The decline and often erratic funding stemmed the rate of growth in most of the Universities. The fastest growing science, Biochemistry, recorded a modest growth; nutrition was identified as the major front of research, but high infant mortality rate (an index of underdevelopment) was unabated. Retrieval of information to aid prosecution of relevant research and lack of access to scientific information have resulted in intellectual isolation of Nigerian scientists and inapplicability of research findings. The pathetic state of scientific growth and relevance in Nigeria is typical of the Developing Countries (DC). The situation calls for the importance of the science indicators in strengthening the coverage of Third World science and supporting the scientific development in the DC. Refining the science indicators for suitability in measuring science in these countries is also advocated.

RESUME

La première étude réalisée sur la quantification de la science dans les Universités Nigérianes de la première génération (1975-1979), à partir de l'indicateur du nombre de chercheurs dérivé de la base de données de l'ISI, a mis en évidence une croissance réelle de la production scientifique. On a également observé une corrélation étroite entre les dépenses du Gouvernement Fédéral pour les Universités et le Produit Intérieur brut (PIB). La diminution des budgets et leurs irrégularités ont été à l'origine d'un déclin de la production scientifique dans la plupart des Universités. Le domaine de plus forte croissance, la biochimie, n'a connu qu'une croissance modeste; de plus dans le domaine de la nutrition considéré comme un des fronts de recherche les plus importants, le taux de mortalité infantile (un indicateur de sous-développement) n'a pas diminué. Le manque d'accès à l'information scientifique a eu comme conséquence l'isolement des chercheurs Nigérians et l'inapplicabilité de leurs résultats de recherche. La croissance de la science au Nigeria et son manque de pertinence sont caractéristiques des pays en Développement (PED). Cette situation nous fait prendre conscience de l'importance des indicateurs de science qui doivent permettre de renforcer le soutien de la science du tiers monde.

L'auteur se fait également l'avocat de la mise au point d'indicateurs de science plus adaptés à la mesure de la science de ces pays.

INTRODUCTION

The neglect of science in the Developing Countries (DC) can only be at a great peril. It is quite evident that the sheer quantum of scientific output in the Industrialized Countries is significant in advancing human knowledge and enhancing life on Earth. However, recent advances in communication science have shrunk the World into an indivisible whole. There are no more regional but global problems. The contribution of DC scientists and the pace and output of their work will ultimately determine the growth of science in the World. The global concern for the environment, the destruction of the Amazon and other Tropical forests, earthquakes and desert encroachment; nuclear, volcanic and oceanic eruptions and the AIDS epidemic, to mention but a few, are no respecters of National boundaries or socio-economic demarcations. The realization of one world science has prompted the need to support science in the DC (Moravcsik, 1964 and 1966).

Science indicators are potent tools in measuring the size of science (Solla Price, 1969). It has been used in quantitative and qualitative assessment of science in some cities and countries (Inhaber, 1974; Garfield, 1978). One of the problems of the administration of science in Nigeria is the lack of precise knowledge of its size. When the fifty most active countries in terms of absolute number of publishing scientists was computed, Nigeria ranked 38th after correcting for the size of the scientific productivity, which was above average over the years (Kovach, 1978). Similar analysis using only developing countries showed Nigeria to be a close second to Egypt (Garfield, 1978). In a developing country like Nigeria with a strong economic base due to oil revenue, funds must be properly channelled to research that ought to lay the foundation for future prosperity. Although research policy is mostly a political decision, it is important to identify the appropriate centres of research in the country so that these centres may be the beneficiaries of research funds when political considerations are less weighty. In this regard, the measure of the size of science in six Nigerian old Universities was computed over a period of ten years from 1970 to 1979 (Adamson, 1981a). Although some research work is carried out in the several specialized Research Institutes, it has been shown that in Nigeria, as in developed or developing countries, the bulk of research is carried out in the Universities.

It is, therefore, the objective of this paper to recapture the size of science in the first generation Nigerian Universities as an illustration of the role of Nigerian scientists in data gathering and dissemination, their training, motivation and working conditions as factors that may mediate refining of science indicators for the DC.

NIGERIAN SCIENTISTS

The researcher is the generator of scientific information. His ability to contribute to world information databases, access and retrieve same are dependent on his competence and the social milieu in which he operates.

Training :

Virtually all first generation Nigerian scientists during the colonial period had their training in Britain or at the University College, Ibadan, which was affiliated to University of London. The British system of education was imposed generally during the colonial rule and any other Scientists produced from other systems, particularly the few that went through the American system, were regarded as academically inferior and are often denied employment in the country. In terms of contribution to the world databases, the average British scientist is wont not to publish, compared to his American counterpart. The legacy of this attitude is still reminiscent in some older British-trained Nigerian scientists who would only publish at the completion of their research work. Such publications are often sent in a series to an International journal. Older Nigerian scientists often took great pride in having 3-4 papers in an issue of such a journal. The fewer counts of publication of these first generation scientists is, in the main, due to this attitudinal effect. The citation analysis of these scientists i.e., those at University of Ibadan between 1948 and 1962, will be interesting and may reflect many of the social factors influencing science indicators in the country as well as the DC.

Training of Nigerian scientists became more diversified after independence with acceptance of significant number of scientists trained in the USA. A University fostered by University of Michigan, USA, was also tolerated in the year of Independence in 1960. Trickles of some scientists who received their training in the USSR and other East European countries also came into the milieu. The British tradition of education was actively encouraged at Ibadan and there was conscious attempt to surpass it. Scientists at Ibadan argued over the need to achieve International standards which was, in fact, "British standard" (Ukoli, 1985). The more pragmatic American-trained scientists, on the other hand, were advocating science relevant to solving the immediate problems of underdevelopment. For these American-trained scientists, there was a lot to do and, consequently, a lot was published.

Publishing Scientists:

The American-trained scientists published most of their works in American journals which were, at the time, regarded as less reputable International journals. The publication count of publishing scientists consequently reflected a significant increase for Nigeria largely contributed by these American-trained scientists. Thirty years after independence, over 80% of the first generation scientists have retired and the divide between the attitudes of Nigerians trained under the British and the American systems had virtually been obliterated. On the International scene, the attitude of the British scientists itself towards rapid publication became similar to the Americans and Nigerians trained in Britain perceived this shift and now publish like the American-trained scientists.

A third generation of Nigerian scientists trained by the second generation of scientists in Nigeria came into the scene. This generation was beset with problems of material resources which affected their perceptions and activities. The Nigerian scientists on the whole, especially the second generation, are as good as their counterparts all over the world in perception and publication attitudes. The International slogan of "Publish or Perish" even hold in the country to varying extent. It is therefore difficult to advocate a different science indicator for these Nigerian scientists. It would be resisted, albeit, ignorantly. When the high rejection rate of articles from the DC was decried (Gordon, 1979), and a proposal that a new Journal for the Encouragement of Research in Life Science (JERLS) in the developing countries be created (Campbell, 1977), it was rejected on the grounds that it would not be recognized either in the developing or developed countries. This line of thought was a gleam from the debate on International relevance of science by the first generation of Nigerian scientists. It is, however, clear that the second and third generations scientists could not perform as well as their counterparts overseas because of prevailing socio-economic factors. The lack of a culture of science in the country and shortage of materials and infrastructural support were clearly staked against them. Since the practice of science itself is about competition and publication and recognition are only accorded to those who first achieved breakthroughs, Nigerian scientists would not settle to be second best. A factor could be worked out to multiply publication counts and citation analysis of DC scientists to reflect the precarious state in which scientific results publishable in "reputable International Journals" are rated.

Background of Scientists and their motivations:

The first choice of the brightest science students is for the professions of Engineering or Medicine. The others who are not less qualified but could not get into the professions are admitted into Science degree programmes in the Universities. Most of such science graduates eventually end up as teachers or as Administrators in the Civil Service of the country. Outstanding science graduates are usually given scholarships by the Government to pursue higher degrees overseas (UK and USA), but lately, locally. It would, therefore, appear that due to lack of a science culture and with only a handful of scientists as role models, Nigerians do not primarily opt for science. Those that, however, become scientists receive adequate training which can enable them to carry out independent research. Most Nigerian scientists are imbued with the desire to achieve excellence in research or at least maintain the standard of their post-graduate training. They are also motivated to solve the problems of the country in the areas where indices or under-development are high. Usually, the responsibilities imposed on themselves are disproportionate to their level of experience. It is remarkable that with the spirit fired by independence of the Nation, Nigerian scientists have responded to the exeptations by carrying out research and recording excellent publications.

Working Conditions of Scientists:

The research facilities bestowed by the colonial administrators of the country and early post-independence acquisitions were up-to-date for prosecution of scientific research. Funding and remuneration of scientists at the time were also satisfactory. With independence and gradual harmonization of the University with the Civil Service, the culture of science that was being built in the Universities gradually became eroded by bureaucracy. Being a scientist was no more a way of life but a means of employment. Erratic and decline in Government funding of the Universities bred scientists with inimical motivations to scientific endeavour. Lack of water, unreliable electricity supply, ill-maintained and obsolete equipment, inadequate research grants and funds to attend conferences were the working conditions of the scientists. All these affected publication counts of scientists and science indicator of publication counts dropped in the most prolific Universities. These are some of the factors that must be put into consideration in determining science indicators for developing countries.

New Breed Scientists:

Three types of research scientists evolved in Nigeria as a result of the precarious conditions under which they work. While the annotated sketch (Fig. 1) appropriately describes the three types of scientists, their prospects and publication patterns, the compartmentalization and mode of operation are flexible. One can thus find scientists in the Universities that function as Government Research workers and vice-versa.

The Information Gap:

In measurement of Biochemical Research in Nigeria, it was shown that a real growth was obtained over a period of 1975-79 (Adamson, 1981b). It was also shown that research in nutrition was also one of the major fronts yet the real growth in nutrition research did not reflect any remarkable improvement in infant mortality rate. Information access and retrieval are problematic to achieving appropriate application of research findings. It is not uncommon for Government to award contracts to foreigners to carry out feasibility studies on local problems only for the contractors to come to Nigeria to initially carry out manual information retrieval of available data related to the contract by visiting local libraries, Universities and through personal contact for unpublished data. These local scientists are later recruited for prosecuting the job.

The inability of most Nigerian scientists to use the present day information systems hampers their productivity. The beauty of the modern information system is that it is current, and technically obtained at the speed of an electronic flash, but it is expensive. Hardware computers) and software (programmes) are required to use the modern day information system. The hardware is not only prohibitively expensive in the DC but requires low temperatures for optimal functioning. The cost of providing low temperature where the ambient temperature is tropical is enormous and against the backdrop of irregular electricity supply, high down time and frequent breakdowns are common features of the few computers. Highly trained computer engineers are also hard to come by. Training of computer scientists, systems analysts and other middle level personnel of the computer industry is in its infancy. The country itself is yet to be computer literate. Some of the new breed scientists who constantly visit laboratories abroad are, however, adept at the use of computers. Some even have PCs of their own and fully appreciate the importance of power of the computer in their work but they are few and far in-between. These "International" scientists also appreciate the importance of science indicators and insist on listing their departmental addresses in joint publications of work done abroad. As for general awareness of science indicators in the country, the author was shocked when a decade ago he presented a paper on the measurement of science in Nigeria at a science conference. The view of the audience was that the exercise was futile and non-academic in nature. It was argued that further pursuit of this "non science" could put the country in a bad light as being underdeveloped. To the credit of the participants, however, pertinent questions relating to the slant of science indicators in favour of USA and UK were raised. Strikingly were issues of english language as medium of communication and rejection of science dealing with local problems by international journals.

CONCLUSION AND RECOMMENDATIONS

There is a tremendous resistance to the use of science indicators to measuring productivity or evaluating the state of scientific research in Nigeria. Awareness strategies of the importance of science indicators would seem to be the first step to developing suitable science indicators for the DC. Information science has to be appreciated, for presently, it is regarded as an aspect of library studies based in the Arts and Humanities and a wide gulf exists between the arts and the sciences in Nigeria. Unfortunately, scientists interested in scientometrics are regarded as those that could not cope with the rigours of their science discipline.

The selection of journals for building the information databases and inherent deficiencies have been stated (King, 1987; Garfield, 1990; Gaillard, 1991) of which irregularity of publication (partial death) is a major consideration. Outright mortality rate of Nigerian journals is high and this is vexing. It is, however, an economic issue. Fortunately, Governments, Non Governmental Organisations, Foundations and societies are concerned about the low scientific output of the DC. Financial support, grant and seminars on journal production will be welcomed to ensure regularity and quality assurance of the DC journals. The Indian example in journal publication may be a model for the DC. The emphasis is not on glossy perfect finish of the West but on quality articles in regular journals even if on a newsprint. It is for this reason that India is the super-star in scientific output among the DC. Scientific information gap is minimal in India compared to other DC and science, whether basic or applied, relate to the problems of the country. Another strategy for strengthening the information resource base is to encourage scientists in the DC that have computers, for example, those in the Universities, to form PC clubs which may develop to networking, exchange of diskettes, trouble shooting of hardware problems etc. Such clubs may be supported and used to reach the larger scientific community of the Universities and may lead to building local databases which could be networked internationally. The catalyst to facilitating the use of science indicators and modification thereof for the DC lies in scientometricians of the Developed countries visiting the DC and organizing workshops, at least, in the Universities. The importance of information databases, access and retrieval as important tools for development and recognition of scientists would then become evident. The potential for CD-ROM technology in less developed countries (Nichols and Majid, 1989) and other information technology adapted for the third World (Moravcsik, 1985) can then become a reality.

Note

The author regrets his inability to cite all relevant articles, especially those of Dr. Eugene Garfield of ISI, Philadelphia, Prof. Abdus Salaam of the Third World Academy of Sciences, Professor T. Braun, Editor, Scientometrics, who through his review of the author's paper in Scientometrics fired his interest and many more who, along with Professor M. J. Moravcsik are the heros of Third World science. Justice could not be done to their contributions by citation because of inability to access and retrieve information from any database or the local libraries.

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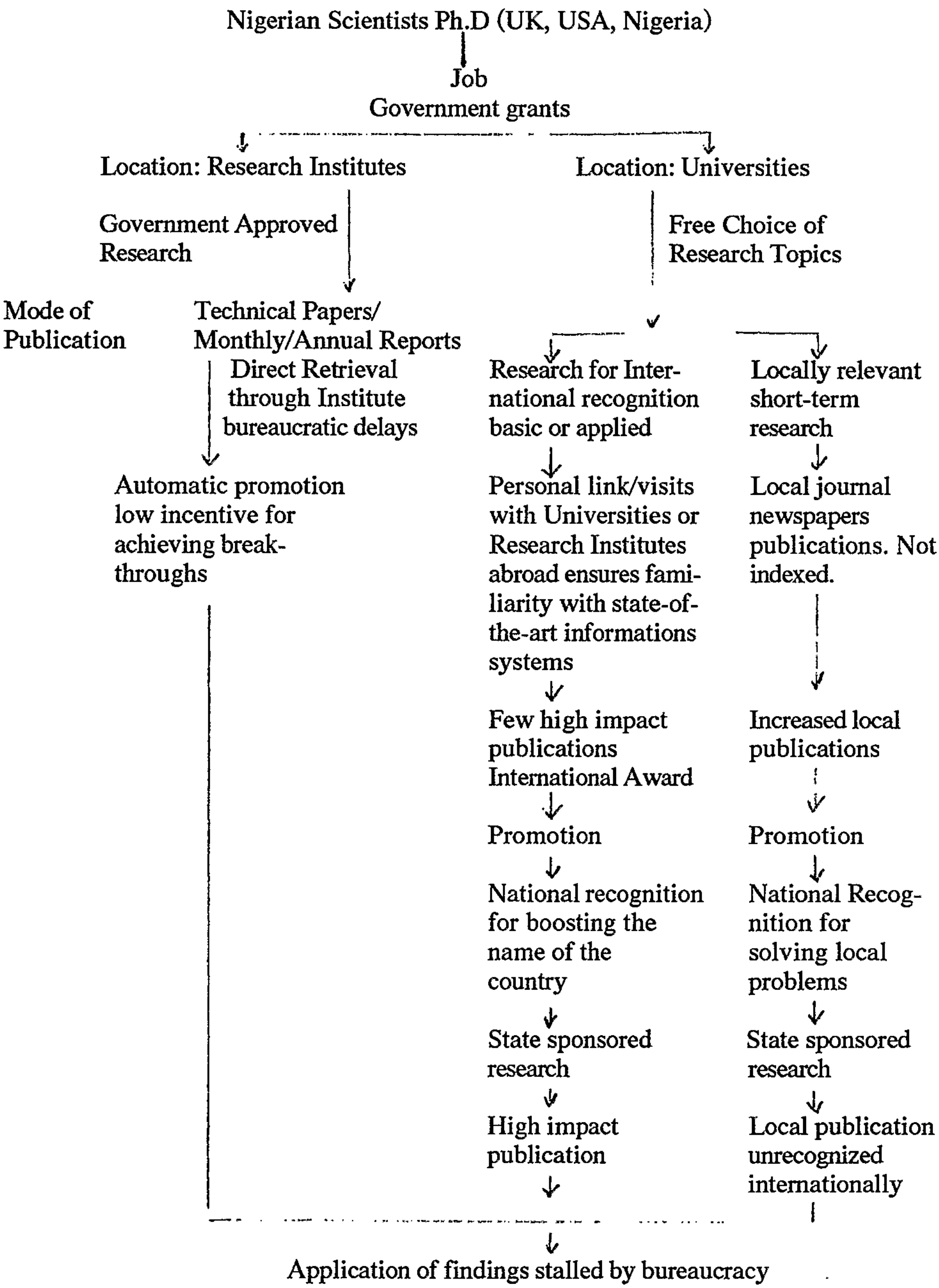

Fig 1: Nigerian Scientists, Location and Publication Pattern.

COLLECTIVE INDICATORS AS ALTERNATIVES FOR SCIENCE AND TECHNOLOGY MEASUREMENT IN DEVELOPING COUNTRIES

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ABSTRACT

This article adresses the questions arising from the assessment of the scientific performance of developing countries in terms of available indicators. Various alternative indicators measuring the contribution of science to the nation are proposed.

RESUME

Cet article examine les problèmes que pose l'utilisation des indicateurs conventionnels pour mesurer les performances scientifiques des pays en voie de développement. Des indicateurs différents sont suggérés qui tenteraient de mesurer la contribution de la science dans le contexte d'un pays donné.

INTRODUCTION

Citation based indicators that are used for the evaluation of performance of science and technology (S&T) are only measuring what is measurable rather than what is valid[1]. The limitations of citation counts for measuring quality as well as performance of developing countries are now well known. Various alternatives have been proposed (the immediacy index, the affinity index, the openness index)[2], which would permit the assessment of developing countries without having to use exclusively the citation data base (SCI). Our experience in India is that the Indian journals which are poorly represented in the SCI, are definitely in a better position when they are evaluated with these others indicators. We have notices that Indian journals have high values for the openness indicator and high affinity index for others journals in the same field.

However, these indices do not measure all the moral and ethical dimensions of the scientific endeavour, since they most often imply that science in the developing countries is a mere appendice of the mainstream countries[3]. This difficulty is particularly apparent when using evaluation based on the SCI, because of its limited coverage of local journals, at the micro-level.

CONTRASTING MICRO LEVEL VS. MESO AND MACRO LEVEL INDICATORS

Vinkler[4] has proposed the micro, meso and macro level as reference standards for examining the S&T performance, based on the individual, the theme and the organisation as a whole. At the micro level, the developing countries have a low impact on the scientific activity of mainstream countries. However this does not mean that S&T originating from these countries with low "impact factors" have no relevance to the advancement of knowledge. There can be other, social, ethical and behavioral patterns which are also responsible for such a situation. If one now turns to the meso or macro level, the picture is not as alarming as it appears at the individuals level.

TABLE 1. PUBLICATION DATA OF THE NATIONAL LABORATORIES OF INDIA (1988)

Lab	Paper	IF	Avg. IF	SCI	NSCI	Ratio	Indian	Foreign	Ratio
CBRI	8	2.181	0.273	5	3	1.667	2	6	0.333
CCBM	26	32.690	1.257	25	1	25.000	11	15	0.733
CDRI	172	102.214	0.594	117	55	2.127	88	84	1.084
CECRI	133	19.482	0.146	10	117	0.081	120	13	9.231
CFRI	35	12.758	0.365	11	24	0.458	23	12	1.917
CFTRI	100	49.145	0.491	72	28	2.571	44	56	0.786
CLRI	42	35.463	0.858	42	22	1.909	27	37	0.730
CSMCRI	64	54.924	0.858	42	22	1.909	27	37	0.730
IICB	60	78.909	1.315	55	5	11.000	17	43	0.395
IICT	120	91.086	0.759	96	24	4.000	44	76	0.579
ITRC	130	63.326	0.487	87	43	2.023	57	73	0.781
NAL	39	15.164	0.389	26	13	2.000	15	24	0.625
NCL	153	113.492	0.742	130	23	5.652	32	121	0.264
NPL	144	101.355	0.704	107	37	2.892	56	88	0.636

The output of chosen institutions from developing countries have been examined by a number of authors in the past. For example Garg and Rao[5] have examined the scientific productivity of an Indian Physics Laboratory and have shown that on the whole, the scientists of this laboratory publish a large portion of their papers in international journals, and some Indian journals, all covered by the SCI. This situation is not true of this laboratory alone, The data pertaining to the National chemical laboratory of India shows that 70 to 75% of their publications are in journals covered by the SCI. This is the situation of various leading laboratories in the country. Table 1 shows the data for various national laboratories of India to substantiate this contention. It may seem ironical that the scientific output of indian laboratories is not available for Indian journals. An analysis by Krishnan and Viswanathan[6] reveals that the leaders of Indian Science, fellows of the academies and members of editorial boards of Indian journals, publish the bulk of their work in international journals, so that communication of science among Indian scientists takes the circuitous route of international journals. The impact factor per paper of the Indian national laboratories is given in Table 2.

TABLE 2. PUBLICATION DATA AREAWISE FROM SELECTED NATIONAL LABORATORIES (1987 DATA)

PHYSICS Laboratory	Total no. publications	Total IF	Avg. IF
CECRI	3	1.502	0.50
CEERI	4	2.925	0.73
CGCRI	16	11.730	0.73
CLRI	4	8.732	2.18
CMRS	3	4.997	1.66
CSIO	4	1.301	0.33
IICB	1	3.300	3.30
NAL	10	7.296	0.73
NCL	30	26.934	0.90
NEERI	5	1.699	0.34
NPL	84	41.716	0.50
CHEMISTRY			
CCMB	2	0.798	0.40
CDRI	40	22.745	0.57
CECRI	78	19.221	0.25
CFRI	23	2.323	0.10
CFTRI	7	7.680	1.09
CLRI	66	15.282	0.23
CSMCRI	14	16.110	1.15
NCL	81	70.581	0.87
IICT (RRH,H)	62	65.413	1.06
RRL (Jt)	17	14.542	0.86

It can be seen that the average impact factor for most of these laboratories are higher than that of any Indian journal. It is thus apparent that, at the meso level, Indian laboratories are in no way lagging behind and that their performance is not as poor as the one reflected by the impact factors of Indian journals.

Another useful and relevant measurement of S&T performance can be -also at the meso level- through the analysis of a specific area or sub-field of science and technology. Data are given in Tabes 2 and 3. As can be seen, the performance is much higher than results revealed at the micro level.

TABLE 3. PUBLICATION DATA OF THE NATIONAL LABORATORIES (1987 Data)

Area / Subject (field)	Total	Total IF	Avg. IF
PHYSICS			
Acoustics	10	1.593	0.16
Astronomy & Astrophysics	2	0.203	0.10
Crystallography	5	3.369	0.67
Material science	53	34.189	0.64
Optics	9	5.458	0.61
Physics	21	7.370	0.35
Applied Physics	26	20.526	0.79
Atomic, Molecular Physics	7	14.363	2.05
Condensed matter physics	19	28.786	1.51
Spectroscopy	1	1.700	1.700
TECHNOLOGY			
Biotechnology & Applied microbiology	21	16.207	0.77
Computer and Cybernetics	9	3.729	0.41
Chemical engineering	47	23.416	0.50
Civil engineering	21	12.947	0.61
Material science ceramics	26	8.129	0.31
CHEMISTRY			
Chemistry	43	24.210	0.56
Analytical chemistry	16	17.528	1.10
Applied chemistry	90	13.700	0.15
Inorganic chemistry	10	11.344	1.10
Organic chemistry	135	128.456	0.95
Physical chemistry	26	40.145	1.54
Electrochemistry	68	11.273	0.16
Energy & Fuels	38	8.203	0.22
Polymer science	26	18.925	0.73

Rather than considering the individual publications one should therefore use groupe and total publications to evaluate India's performance. Additionally, in the case of developing countries, one should look at the citation from a different perspective. One should consider the citations received for the knowledge generated within the country itself since its relevance is higher. If one examines the "self-citation" of a country by researchers of that same country, one would see that India is not unfavorably situated. This may not show the impact of the information that is generated but certainly reflect the consistency of the research activity. The analysis would thus take into account the fact that the developing countries cannot afford to wither away their resources in fashionable and frontier areas without maintaining a continuity in the research efforts.

At the macro level, an appropriate and valuable indicators for evaluation the S&T performance could be the doctoral dissertations submitted to the various institutions/universities of the country. In fact, this would cover an important portion of the scientific effort in any country. The data pertaining to doctoral dissertations in natural and applied sciences submitted to 100 or so institutions/ universities in India are given in Table 4.

TABLE 4. DATA ON THE DOCTORAL DISSERTATIONS SUBMITTED TO THE INDIAN UNIVERSITIES

BRANCH	1980-81	1983-84	1984-85
Agriculture	500	691	576
Animal Husbandry	98	144	153
Anthropology	20	11	16
Astronomy	14	14	9
Biochemistry		127	110
Biology	75	36	54
Botany	389	442	382
Buildings			1
Chemistry	768	792	687
Earth sciences	142	148	131
Engineering	227	277	261
Environmental sciences		101	57
Forensic sciences			2
Mathematics	267	277	261
Medical sciences	243	263	227
Microbiology		38	30
Paleontology	6	11	8
Physics	270	357	304
Technology	110	110	94
Zoology	422	368	345
Total	3551 (105)	4213 (107)	3698 (112)

The data show that Indian Scientists and Technologists are active almost in all areas of research and as is true in the case of all countries, India is strong in some specific areas. The reasons for these choices should be traced down to the traditions left behind by individual scientific leaders as well as the necessities and requirements of the community.

A RESEARCH PROPOSAL

Science in developing countries is mostly or heavily dependent of the individual's efforts though the collective system seems to sustain this activity. This may be also true for developed countries. The generation of a scientific community rests also upon some individuals whose inspiration, dedication and motivation permitted to create a research group. This group usually appears to have set traditions and some particular behavioral patterns without much lateral interactions with other groups for various social and cultural reasons. Maybe this is also the reason why performance at the micro level in developing countries seems to be difficult to evaluate or even if it is done, the result is not encouraging.

One way of circumventing these effects would be to trace a growth tree with respect to a particular group or to a particular domain, and evaluate the impact of findings on the subsequent efforts within the group or area of research within the country. This method of evaluation would overcome the shortcomings normally associated with the non-availability of information. This normalization procedure would also have the following advantages:

1. It would be capable of reflecting the intrinsic values of a given scientific community though it would not evaluate the relative standard of this community on a global scene.
2. It would be, at least theoretically, possible to construct indicators measuring activity, productivity, progress, quality, importance or impact for those limited situations. These indicators would be of course highly site specific, but at the same time they would allow an evaluation of that specific community in relation to the needs of the country as well as in relation to the pursuit of the particular goals of this group.

The scientific effort in developing countries very often centers around certain leaders in science who, because of their peculiar position and status in society, can form, sustain and nurture a scientific community around them. Evaluations are thus necessary at this level: in India, for instance, the performance of the communities grown by these leaders of science would probably raise better results than the overall performance of the country. These groups are still in a state of insulation with respect to other scientific groups in the country. Arunachalam and his co-workers[7] have shown an intellectual "island effect" which is a common feature in middle level and peripheral countries. Science published in national journals are insular and make very little cognitive contribution to the rest of the world. This insulating effect can be seen through the maps showing the interactive cooperative links in science. These maps contain some principal and regional clusters of countries with strong links: USA, Western Europe and Canada. More moderate links appear with European countries, USSR, Australia and New Zealand. Countries like India, South Africa, Brazil, Argentina and Chile do not seem to be linked to any of these principal countries. There exists a sort of seclusion either imposed, or internally developed.

This isolation must be taken into account when evaluating science on the basis of citation counts. Konrad and Wahl have recently advocated for some collective indicators for developing countries in terms of generativity, potential and receptivity to absorb scientific results. They proposed a procedure in order to obtain suitable quantitative measures for these three indicators for 30 countries and a socio-economic database. This method of computation, highly desirable, still lacks some important aspects like the relevance and need for S&T activities for the country and whether these efforts are in tune with the local scientific tradition.

It would be worthwhile to create some indicators based on the scientific tradition of the country as well as the existence of specialized skills. However one could argue that there are no input parameters available. One could investigate those aspects by means of perceptual indicators on the capacity to generate suitable human resources, the capacity to provide a suitable infrastructure for science and scientific education, the capacity of industry to rapidly transform the results of R&D into production and the capacity of society to be informed on the scientific activities. These four questions could well be measured by perceptual indicators in the case of developing countries.

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NOUVEAUX INDICATEURS EN SCIENCE ET TECHNOLOGIE: QUELQUES REFLEXIONS A PARTIR DE L'ETUDE D'UN PETIT PAYS

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RESUME

L'approche actuellement requise en matière d'indicateurs en S&T vise à introduire un changement de direction, tant dans les méthodes traditionnelles de traitement et de recueil des statistiques, que dans la conceptualisation et l'appréciation des dimensions pertinentes de l'objet à mesurer. Il ne s'agit pas seulement d'un problème de nature méthodologique: la nouvelle approche concerne les principales mutations intervenues dans le cadre conceptuel pour la construction d'instruments adéquats de mesure en S&T. L'attitude ambiguë de beaucoup de chercheurs à l'égard des indicateurs standards ne favorise pas la recherche d'options concrètes de remplacement ni ne permet de relever ce double défi, à savoir: la quantification du plus grand nombre possible d'aspects de la S&T, sans pour autant négliger ses dimensions qualitatives essentielles. Du point de vue opérationnel, l'incorporation de mesures composées, d'indicateurs de divers domaines, de paramètres de dispersion et corrélationnels, et de mesures de désaccord, constitue une stratégie, entre autres, adaptée au recueil de données dans le contexte d'informalité, de faible institutionnalisation et d'interconnexion faible entre les unités de recherche et les acteurs concernés par la recherche, contexte qui est propre à la S&T en Amérique latine.

ABSTRACT

A new approach is needed in Science and Technology indicators. This approach has to change our methods of information gathering and processing. This is not a mere methodological problem, because this new appoach concern basic features of the S&T system. An ambiguous attitude adopted by various researchers does not permit to respond to the double challenge of transforming our methods and adopt new concepts of qualitative importance. From an operational point of view one should adopt composed indicators, comparative measures, dispersion and deviation and correlated multiple indicators; this could be one possible strategy adapted to the features of the S&T system in Latin America, of feable institutionalization, informality and loose interconnection between research units and actors.

I. INTRODUCTION

De nombreux travaux ont su mettre à jour les limitations des indicateurs quantitatifs conventionnels dans le domaine de la science et de la technologie (S&T), perceptibles dans les pays périphériques comme dans les pays centraux. Logiquement il aurait donc fallut les rejeter ou en élaborer d'autres. Cependant, la plupart des chercheurs adopte une position plus ambiguë: ils continuent à se servir des indicateurs disponibles comme s'il s'agissait d'un moindre mal, mais rares sont les efforts entrepris en vue de mettre au point des instruments plus fiables qui aboutissent à des résultats concrets.

Il nous semble qu'une telle ambiguïté constitue un obstacle si l'on veut entreprendre d'élaborer un système d'indicateurs de S&T plus satisfaisant. Considérer les indicateurs conventionnels "mauvais mais nécessaires", c'est méconnaître premièrement que les indicateurs traditionnels -dont les plus polémiques concernent la discipline dite "bibliométrie"- sont fiables et valables pour mesurer ce qu'ils prétendent et veulent effectivement mesurer, dans le cas des pays développés (PD); et deuxièmement que l'insuffisance de ces mesures à rendre compte d'autres paramètres ou des caractéristiques différents de ceux pour lesquels ils ont été conçus, n'est pas propre aux pays en développement (PED). C'est un grave problème pour l'ensemble des études sociales de la science. Etablir une ligne de démarcation entre PED et PD en matière de réflexion sur les indicateurs de science pourrait donc induire en erreur.

Les différents moments du développement d'une discipline scientifique impliquent une combinaison particulière de précision et de pertinence.[1] Il est possible de concevoir quatre modalités de relation entre indicateurs et référents: a) indicateurs précis de référents pertinents; b) indicateurs précis de référents non pertinents; c) indicateurs non précis de référents pertinents; d) indicateurs non précis de référents non pertinents (Moreno, 1982).

Les efforts en matière d'indicateurs de science devraient permettre d'aboutir à la première de ces quatre hypothèses, tout en reconnaissant que cela pourrait entraîner une analyse critique de la deuxième -bien que les indicateurs soient plutôt insuffisants que non pertinents-. Il faudrait en outre un développement conceptuel novateur, qui fasse intervenir des variables "suggestives" et les rende mesurables.

L'élaboration d'indicateurs pertinents pour les PED suppose un travail préparatoire, en amont, où seront explicitées un certain nombre de notions

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[1] "... toute science est fonction, à un moment donné, de deux variables: l'adaptation du système conceptuel pour rendre compte des problèmes pertinents d'un point de vue extra-scientifique, et la précision qui permet de définir un tel système et d'établir des relations entre des concepts différents. Une science est d'autant plus mûre qu'elle peut offrir plus de pertinence et de précision. Or, toute discipline jeune doit aboutir à une solution de compromis... Bref, virtus in medius". Simon Schwartzman, 1987 (original en espagnol).

préalables, diffuses et "impressionnistes", relatives à la constitution historique et aux traits particuliers du secteur S&T pour chaque pays. Ces notions préalables sont généralement basées sur des statistiques partielles et des études sectorielles qui, on le sait, ne constituent pas dans les PED un univers systématisé, cohérent et exhaustif d'informations de base.

Par ailleurs, tout semble indiquer que nous sommes maintenant au moment le plus opportun pour procéder à une révision du cadre conceptuel de production des indicateurs, tant dans les pays centraux que dans les pays périphériques. Et cela, pour les raisons suivantes:

a) Aujourd'hui plus que jamais, les évaluations portant sur la S&T s'avèrent essentielles, selon des critères tant extérieurs qu'intérieurs à ces activités. Cette exigence croissante d'évaluation survient en même temps qu'une reconnaissance généralisée de la crise qui frappe la planification traditionnelle et propose sa substitution, dans les PD, par de nouvelles fonctions: analyse stratégique, prospective et évaluation (Barré, 1987). Dans les PED, cette fonction n'existe guère et elle n'est pas socialement légitimée.[2]

b) La reconnaissance du fossé qui sépare les PD et les PED en matière de S&T est devenue un lieu commun. Certaines tendances aujourd'hui à l'échelle mondiale rendent possible et nécessaire un espace commun de réflexion sur les nouvelles formes de prévision, de planification et de régulation. Citons dans le désordre: les processus de "technologisation de l'économie", de "scientifisation de la technologie" et/ou de "mondialisation de la technologie et de l'économie" (Petrella, 1989); les changements du nouveau paradigme technologique qui entraîne de nouvelles incertitudes, une situation de multipolarité, des déséquilibres commerciaux et financiers, et la contingence des relations causales autrefois vérifiées. Cette déstabilisation des systèmes socio-économiques et la perte de la cohérence intérieure engendrent des contradictions et la mise en question des fonctions et des méthodes traditionnelles de planification; et, enfin, dans ce cadre les produits commercialisables auront probablement une plus grande composante de Recherche et Développement (R&D). En conséquence, la répartition et la productivité des ressources intellectuelles seront de plus en plus importantes. Le patrimoine des connaissances des PED serait incorporé à la "décentralisation et à la délocalisation à l'échelle mondiale de la production interne de connaissances dans des laboratoires de recherche de l'entreprise, situés à l'étranger, où peuvent être mises à profit localement les compétences du personnel S&T et la qualité de la recherche universitaire" (Mytelka, 1984, in Barré, 1987).

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[2] Ce qui est absolument paradoxal, car ce sont justement ces sociétés qui requièrent le plus grand nombre d'informations pour allouer des ressources limitées et renforcer les faibles structures de S&T. De plus, des travaux d'évaluation et de rationalisation qui ne demandent pas de gros investissements en capital sont nécessaires pour optimiser ces ressources. La nécessité d'une plus importante spécialisation dans les petits pays fait l'objet d'une excellente analyse par Walsch, 1986.

Ces processus sont à l'origine d'une prise de conscience croissante de la nécessité de mettre en place des politiques volontaristes, capables de contribuer à internaliser positivement le nouveau paradigme technologique. A cela s'ajoute la remise en cause des modèles de développement aussi bien dans les PED, qui auront été les premiers à dénoncer l'erreur de l'équation entre croissance et développement, que dans les PD. De plus, les conséquences indésirables des progrès accomplis en S&T, les connotations éthiques et politiques de l'activité scientifique et technique et, en général, les attitudes relevant du "public concern" révèlent également un certain mécontentement dans les pays industrialisés. Tout cela favorise de nouvelles approches, des politiques et des stratégies différentes de développement, afin d'éviter une "pratique illusoire de la planification" en S&T (Avalos et Antonorsi, 1980).

Pour cela, les études sociales de la science, et notamment l'évaluation en S&T, nécessitent plus de légitimité. Il est également nécessaire de faire en sorte que la critique des notions conventionnelles aboutisse à la construction effective de nouveaux indicateurs.[3]

II. Les indicateurs de la S&T: "toujours maudits, toujours nécessaires"

Avant de continuer, il convient d'élucider les choix implicites qui justifient un travail de construction d'indicateurs en matière de S&T.

Tout d'abord, le rejet pur et simple de la mesure des activités de S&T (ou de toutes autres) provoque des effets, indésirables et imprévus, de marginalisation, de dépréciation, antiprogressistes, de la S&T.[4] En effet, de nombreuses évidences prouvent que la mesure des activités de S&T dans les PED n'aboutit pas nécessairement à une dévalorisation de la science dans le Tiers Monde (Cf. Sancho et al., 1988, in Sancho, 1990; Chatelin et Arvanitis, 1988; Gailard, 1989 et 1990). Il n'est donc pas possible d'ajourner éternellement la mesure des activités de S&T.

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[3] A cet égard on pourra rappeler que la critique de certains indicateurs économiques comme par exemple le PIB n'ont pas entraîner leur abandon. Pourtant ce cas exemplaire car il existe de nombreuses et bonnes raisons de le critiquer, d'autant plus qu'il est souvent apparenté à un indicateur de "welfare": "... radically different activities that are priced similarly are treated identically in calculating GNP, so that the production of poison gas appears to be as valuable as hospital treatment requiring the same level of expenditure (...) this was implicit in the criticism that GNP compounds together data on warfare and welfare, production and pollution" (Miles, 1985).

[4] Nous n'entrerons pas ici dans le débat qui consiste à se demander si cela est le résultat d'un certain attachement au paradigme de Merton par opposition aux nouvelles tendances de la sociologie de la science. Voir Velho (1988 et 1989).

De plus, il faut rappeler que dans un monde toujours plus interconnecté -dans lequel se généralisent les paradigmes de la S&T, en raison de leur propre développement- la possibilité offerte par un indicateur d'établir des comparaisons au niveau international s'avère une condition importante. Le travail préparatoire de conceptualisation et de réflexion sur les indicateurs à utiliser en S&T en Amérique latine ne saurait se borner aux frontières de la spécificité nationale, qui en dernière analyse n'autorise pas l'extrapolation. Ainsi, la réflexion sur les indicateurs dans le contexte des PED doit aboutir à modifier le mainstream lui-même des indicateurs standard.

Ensuite, il est faux de vouloir opposer le quantitatif au qualitatif du point de vue de la fiabilité et de la validité -dans le cas des études scientométriques comme dans les autres domaines. Rien ne prouve que les données qualitatives soient plus fiables, valides et pertinentes que les indicateurs quantitatifs (Velho, 1988). Les multiples dimensions de la S&T demandent du quantitatif autant que du qualitatif, ainsi que l'analyse systémique (Moravscik, 1985). Il est nécessaire de travailler sur des notions précises et homogènes, quelle que soit l'option conceptuelle et opérationnelle envisagée, conseillent la convergence des nouveaux développements et des nouvelles perspectives. Ainsi, plutôt que l'irréductibilité entre les analyses systémique, historique ou inductive, c'est l'imbrication de ces différentes approches qui surgit comme le mode d'explication potentiellement le plus fructueux (Argenti, 1990).

Enfin, le problème de la vérité est toujours intra-théorique et l'efficacité de divers cadres référentiels n'est qu'une question épistémologique de "second ordre", car elle renvoie à une position depuis laquelle la vérité est définie. Les analyses sociales de la science devront cohabiter avec des questions épistémologiques de nature conceptuelle, relatives à la relation entre les disciplines concernées et la réalité.

III. Principaux changements apportés à l'approche des indicateurs en S&T

Nous voilà actuellement aux portes d'un travail conceptuel similaire à celui qui a précédé la nouvelle approche sur les indicateurs sociaux, connu sous le nom de "Social Indicators Approach". Tout comme alors, la nouvelle approche requise aujourd'hui, vise à introduire un changement de direction, aussi bien des méthodes de traitement et de recueil des données statistiques, que de la conceptualisation et l'appréciation des dimensions jugées pertinentes pour l'objet à mesurer. Il ne s'agit pas seulement d'un problème méthodologique; il entraîne également un examen approfondi des principaux changements intervenus dans le cadre stratégique global pour la recherche d'indicateurs en matière de S&T.[5]

Il convient simplement de mentionner les dimensions impliquées par ces changements, à savoir:

a) L'évolution de la **notion de développement**, et par là, de croissance économique, de modèles de S&T, de planification, qui soutendent les mesures actuellement en vigueur. Devant la concentration et l'absence de redistribution de la croissance, il s'est avéré impossible de rendre compte des problèmes auxquels se heurtaient les PED au moyen d'une variable simple de type économique.

b) La nécessité de faire intervenir les **dimensions sociale et politique**. Cet aspect, lié au précédent, suppose de reconnaître que la science et la technologie ne se développent pas pour des raisons purement opérationnelles ou économiques, mais qu'elles constituent bien une "arène où s'affrontent des intérêts" et où jouent différentes rationalités. Ainsi,les processus de croissance sont frappés, dans ce domaine aussi, de contradictions qui ne sont pas perceptibles d'un point de vue économique réductionniste. En ce sens, ce qui pourrait être avantageux pour le système politique, aurait peut-être des incidences négatives sur le système économique, ou inversement. Il en va de même des normes juridiques ou de la structure sociale. Au moment d'élaborer les diagnostics à l'appui d'une politique, la méconnaissance de ces divers plans peut amener des conclusions partielles, voire fausses.[6]

Dans cette perspective, des indicateurs relatifs à la stabilité professionnelle, les tendances migratoires, l'autoperception et la confiance des chercheurs dans la stabilité des institutions démocratiques, ainsi que des "mesures" de la valorisation et de la légitimation sociales de ces partenaires sociaux, sont des variables

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[5] Quant aux leçons à tirer du mouvement des "social indicators" applicables aux indicateurs de S&T les études de Filgueira (1984) et Miles (1984) contiennent des apports précieux.

[6] Ces difficultés ne sont pas seulement de type instrumental (comment introduire les dimensions sociale et politique dans un système intégré). Le mode d'opération des mécanismes politiques, notamment dans des domaines aussi complexes que la politique en S&T, n'est pas suffisamment étudié dans les PED. Pourtant on pourrait citer un des phénomènes les plus évidents qui a des incidences sur la performance en S&T et fait partie intégrante, implicitement ou explicitement, de la politique scientifique et technologique: l'exode des scientifiques et des chercheurs en raison de persécutions idéologiques ou politiques ou l'absence d'un climat de respect d'un minimum de libertés. Dans ce sens, si l'on examine la structure juridique et institutionnelle en S&T mise en place dans les pays d'Europe de l'après-guerre, il est clair que ces pays ont disposé, non seulement d'une croissance économique soutenue, mais aussi d'institutions politiques démocratiques, offrant des garanties inexistantes au cours des périodes précédentes. C'est ainsi que l'Europe a réussi à surmonter l'une des causes traditionnellement associée au drainage des talents, tout en attirant de nombreux scientifiques de premier ordre de l'étranger (Cf. Oteiza, 1989).

importantes de l'engagement des chercheurs et des scientifiques et du renforcement du secteur de la science et la technologie.

c) L'aspect épistémologique, relatif à **l'intentionnalité de l'acte cognitif**, lui aussi abordé par l'approche des "social indicators", est applicable au domaine de la S&T. Selon l'approche statistique conventionnelle, aucune explicitation préalable des inter-relations théoriques qui soutendent les indicateurs choisis n'est fournie. Les analyses possibles à partir de ces systèmes d'informations revêtent nécessairement un caractère ad hoc. Dans la nouvelle approche, on accordera une importance particulière à l'explicitation préalable de la fonction cognitive, conduisant à la mise en place de notions dont on fournira ensuite la définition au moyen de variables particulières.

Bien entendu, cette exigence nécessite un équilibre délicat entre, d'une part, une définition précise d'un corps de notions ou d'inter-relations déterminé -qui en exclut d'autres-, et d'autre part, une approche de type éclectique. A strictement parler, s'il n'existe pas de solutions pleinement satisfaisantes, ce sont les décisions visant à optimiser la combinaison des indicateurs dans un cadre relativement souple de possibilités théoriques qui prévaudra.

d) La nouvelle **tâche de planification**, née des mouvements conceptuels mentionnés ci-dessus, devrait permettre de passer d'une **analyse descriptive** à une **analyse explicative**. L'incorporation des mécanismes sociaux et politiques au sein d'un réseau d'informations intégré, autorise l'examen de ces mécanismes, considérés non pas comme des données extérieures au système social, mais bien comme des facteurs pertinents dans toute explication du changement social.

e) La priorité sera accordée à des paramètres qui -d'un point de vue méthodologique- introduisent des **mesures d'inégalité, de concentration ou de dispersion**, face aux mesures statistiques de tendance centrale (pourcentages, moyennes, médianes et taux). En ce même sens, si nous faisions intervenir **des variables de désajustement ou de distanciation** entre les différentes dimensions, de manière à refléter les tensions ou les conflits jugés clés pour l'explication du changement à l'intérieur du système, les indicateurs d'équilibre, de balancement ou de cohérence ne seront guère utiles.[7] Dans cette optique, on pourrait conceptualiser des caractéristiques des sociétés des PED ne rentrant pas dans les critères classiques utilisés pour les PD et présentant des configurations spécifiques aux divers niveaux de la structure sociale.

f) Il est par ailleurs possible que les systèmes d'indicateurs ne reflètent pas seulement des valeurs globales de l'unité étudiée (par exemple un pays), mais

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[7] Ainsi, un taux élevé d'informalité (ou un faible taux de formalité) des activités de S&T ne signifie pas qu'elles ne se réalisent pas ou que la formalité soit indispensable au bon fonctionnement du système (argenti, Filgueira et Sutz, 1988). On pourrait en dire autant, toutes proportions gardées, de la corrélation entre dépenses et capacité en S&T ou des niveaux de définition d'une "masse critique".

également des paramètres liés à des variables relatives, **contextuelles et relationnelles.** La caractérisation des systèmes en S&T, sur la base des liens existant entre leurs diverses composantes, illustre ces propriétés de type relationnel.

IV. Stratégies proposées pour l'amélioration des indicateurs en S&T

1.- Les limitations des indicateurs standard ont été largement signalées, aussi bien à l'échelle internationale qu'à celle de l'Amérique latine.Les changements proposés ont même inclus des recommandations pour établir un programme conjoint de recherche entre PD et PED sur les nouveaux indicateurs en S&T.

En Amérique latine, l'impact de ces recommandations a été très faible. Les initiatives d'élaboration d'indicateurs dans ce domaine y sont rares et très récentes. Néanmoins, il commence à y avoir des projets qui favorisent de nouvelles approches et des changements substantiels (Velho, 1988).

Alors que la région latino-américaine est surtout composée de petits pays, il y a eu une tendance à transférer des mesures, des recommandations et des politiques conçues pour les pays les plus grands. Ceux-ci, plus fréquemment que les petits, sont devenus des "modèles" de développement en S&T, le Brésil étant ici le cas paradigmatique.

L'intérêt porté par la littérature spécialisée aux petits pays et l'impossibilité de penser l'Amérique latine comme une région homogène, introduisent des dimensions nouvelles à la réflexion sur les stratégies alternatives pour la S&T, leur mesure et leurs effets sur le développement. De même, ces considérations renforcent les précautions concernant l'application des indicateurs transférés d'un pays à l'autre, non seulement dans la perspective PED/PD, mais à l'intérieur de la propre région latino-américaine.

2.- Essentiellement, deux orientations ont été proposées en Amérique latine pour la construction de nouveaux indicateurs:

a) "ajuster" des indicateurs traditionnels;

b) réaliser, avant de penser aux mesures, des études comparatives préalables, portant sur le développement et l'organisation de la science dans la région. Encore une fois, l'option la plus sage semble être une combinaison de ces deux lignes de travail.[8]

L'ensemble de stratégies que nous allons examiner ci-après, destinées à améliorer les systèmes d'indicateurs, constitue un continuum de travail à long terme que peuvent aborder "transversalement" les équipes nationales consacrées à ce sujet. Certains travaux ne requièrent pas de ressources considérables et peuvent aboutir à des progrès significatifs. D'autres, plus coûteux, exigeant une

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[8] Pour une justification de cette option, voir Argenti, 1990.

préparation et une organisation plus poussées, auront des résultats probablement plus riches mais plus tardif.

a) La première stratégie consiste à inclure progressivement dans les systèmes d'indicateurs, des aspects traditionnellement non considérés, qui vont accroître leur capacité analytique. En ce sens, la seule inclusion d'un nouveau point dans les formulaires de recensements et d'enquêtes, a des effets multiplicateurs.

b) La deuxième stratégie suppose une plus grande périodicité dans l'élaboration des registres et la présentation de l'information. Les enquêtes partielles placées entre deux recensements consécutifs pourraient assurer plus de continuité aux statistiques. L'incorporation ad hoc au formulaire de nouveaux indicateurs peut également être envisagée.[9]

Ces deux stratégies comportent une perspective à long terme et risquent de se heurter à la résistance (ou à l'inertie) des organismes chargés des registres statistiques, en Amérique latine.

c) La troisième stratégie propose d'organiser les statistiques continues selon des critères différents de ceux qui sont en cours. Il existe un ensemble hétérogène d'informations partielles, provenant de recensements et d'enquêtes, qui offre un grand potentiel actuellement inexploité. L'élaboration de mesures composées ou complexes à partir de l'information existante, l'adoption de concepts clés, souvent utilisés dans l'analyse socio-économique, et la construction de mesures basées sur des concepts de type contextuel ou relationnel, feraient partie de cette alternative.

d) La quatrième stratégie, l'amélioration et la coordination des services sectoriels d'enregistrements statistiques, ne demande pas l'affectation de ressources importantes et permet l'homogénéisation des critères et de la présentation de l'information.

e) La cinquième stratégie comprend la création d'informations de base sur des sujets pour lesquels il n'existe pas de données et exige l'allocation de ressources spécifiques.

g) Enfin, la sixième stratégie propose la création de banques de données ou d'archives centrales, afin de systématiser les données de sources multiples et de donner suite à d'éventuelles demandes de renseignements.

V. Un projet de construction d'indicateurs: la mesure des activités en S&T en Uruguay

Il n'y a pas lieu de faire un exposé exhaustif à ce sujet. Il convient ici seulement de mentionner certains éléments du processus d'élaboration-mesure

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[9] L'inclusion du supplément Innovation de deux pages inséré dans l'enquête annuelle des entreprises en Uruguay à partir de 1991 est un exemple de cette option.

qui ont enrichi la discussion relative aux indicateurs en S&T, lors de l'enquête effectuée par nous sur le potentiel scientifique et technique de l'Uruguay.[10]

Le réseau d'institutions et d'activités en S&T est conventionnellement perçu comme un système d'unités et d'interactions entre ces unités. Face aux statistiques, les systèmes d'indicateurs présentent des avantages, puisqu'ils supposent des interactions entre ces indicateurs et qu'ils sont rassemblés selon une signification fonctionnelle. Quant à la structuration du système, elle dépend de la relation entre les indicateurs et le cadre théorique et conceptuel qui les soutend.

On peut dire que les propositions existantes concernant la mesure des activités en S&T (OEA, UNESCO, OCDE, etc.) n'ont pas atteint le niveau équivalent à un véritable système d'indicateurs. Elles partagent pourtant avec ces systèmes un certain nombre de supposés, à savoir que l'objet mesuré est un système institutionnel, formel et fortement interconnecté.

En Uruguay, l'enquête a révélé une **faible institutionnalisation** à tous les niveaux: unités de recherche, disciplines scientifiques, chercheurs, système de S&T, institutions, ressources financières, liens entre l'offre et la demande de connaissances. De même, on a constaté une faible correspondance, voire un "désaccord" entre le titre ou la formation professionnelle acquis et le domaine de spécialisation de l'unité et des projets dans lesquels les chercheurs sont engagés. Ces traits du système supposent l'élaboration de nouveaux concepts (à partir tout d'abord d'une interprétation contextuelle des indicateurs conventionnels) permettant des discriminations. Sur la base d'une mesure de "désajustement" (ou de déviation), appliquée à la conduite de la recherche, on peut parvenir à un indicateur, non conventionnel, "d'institutionnalisation" de cette activité.

En résumé, il ressort des éléments mentionnés que le système de S&T en Uruguay n'est pas fortement institutionnalisé, présente un fort degré d'informalité une relative absence d'interconnexions qui constituent la représentation implicite du système selon les indicateurs conventionnels. En ce sens, les traits du système uruguayen ne peuvent pas être traduits par des mesures conventionnelles. Ils requièrent d'autres indicateurs capables de les mettre en contexte, ainsi que de nouvelles mesures et une interprétation critique des résultats.

En Uruguay, les indicateurs traditionnels ont eu tendance à surestimer les ressources en S&T et le potentiel national, tout en négligeant les mécanismes informels et les "distorsions" qui marquent le fonctionnement réel du système. La prise en considération des modalités informelles en R&D, montre un autre

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10 Cf. les publications portant sur cette étude: Argenti, Filgueira et Sutz, 1987, 1988, 1990.

Uruguay, à la fois plus et moins performant que celui découlant des indicateurs standard.[11]

CONCLUSION

1.- L'ambiguïté à l'égard des indicateurs quantitatifs de la part de nombre de chercheurs ne favorise pas les nouvelles approches. L'utilisation des mesures conventionnelles comme "mal nécessaire" et la faible recherche d'autres systèmes concrets sont le reflet d'une attitude trop confortable qui ne favorise pas la S&T dans les pays en développement.

2.- La définition d'indicateurs nouveaux est beaucoup plus qu'un problème technique: c'est également une tâche qui suppose une "solution de compromis" entre la précision et la pertinence, et fait intervenir des représentations, des objectifs et des "capacités d'action" concernant le système ciblé.

3.- Leur fabrication est certainement difficile en pratique. Leur mise en place doit privilégier: a) des mesures et des indicateurs composés, par opposition à des mesures simples à une seule variable, b) l'intégration de plusieurs domaines (économique, social, culturel et politique); c) des indicateurs d'output et non seulement d'input; d) l'opérationalisation à partir de constructions statistiques et de paramètres de dispersion, concentration, distribution, correlationnels et de mesures d'accord (ou de cohérence); e) l'analyse des propriétés collectives des unités vs. les individuelles.

4.- Du point de vue instrumental, le choix ne se pose pas entre les analyses quantitatives de la science et celles du type historique, ethnographique, etc. Toute compréhension de la dynamique de la S&T embrasse les spécificités nationales dans les "styles" de réalisation de ces activités (Jamison, 1982).

5.- En dépit de différences importantes, les traits qui caractérisent les pays d'Amérique latine en S&T, sont une faible institutionnalisation et une informalité marquée. L'étude de ces aspects exige de nouveaux indicateurs qui rendent compte aussi bien des "désaccords" à l'intérieur du système, que des aspects extérieurs qui déterminent fortement la possibilité d'aménager et de consolider le secteur de S&T.

6.- Dans les PD, les indicateurs conventionnels sont également remis en question. En ce sens, il se peut que les réponses aux questions issues de la mesure de la S&T en Amérique latine, soient également valables et significatives pour les pays avancés. S'il en est ainsi, ce qui apparaît pertinent et spécifique pour une réalité particulière devrait être susceptible de généralisation et de standardisation. Les rapports entre PD et PED dans la construction d'indicateurs

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[11] La question de savoir lequel des deux traits, "sous-développé" ou "petit" détermine le plus les caractéristiques du système de S&T en Uruguay -essentielle et ouverte- ne fait pas l'objet de la présente communication.

nouveaux ne devraient pas être ceux d'un effet "démonstration" des premiers aux seconds, mais un apprentissage mutuel.

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AMBIGUITIES AND DISCREPANCIES IN THE CRITERIA FOR EVALUATING TECHNOLOGICAL RESEARCH IN MEXICO[1]

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ABSTRACT

This paper examines the different definitions given by researchers to technological research. It is shown that the definitions are ambiguous, and that competing view points appear through the evaluation process. Their importance in the evaluation processes are considered, as well as the need for different criteria from those used to evaluate basic research. Definitions as well as specific criteria (utility, applicability, impact) are discussed. It is suggested that in the evaluation process a fight for legitimate institutional space and resources takes place opposing academic institutions to newly developing technological research activities.

RESUME

Cet article examine les différentes définitions attribuées à la recherche technologique. On montre l'ambiguïté des définitions proposées par les chercheurs et leur utilisation dans le processus d'évaluation de la recherche. Leur importance ainsi que la nécessité de développer de nouveaux critères d'évaluation (utilité, applicabilité, impact) sont exposées. Il est suggeré qu'une lutte se déroule au sein des instances d'évaluation pour l'acquisition d'un espace légitime et l'attribution des ressources opposant la recherche académique traditionnelle et les nouvelles activités de recherche technologique.

INTRODUCTION

The function of science in a developing country is the subject of permanent debate as the development of an internationally recognized scientific community requires time and considerable resources. Few developing countries have a surplus of the latter and there is frequent reluctance to make this sort of investment when the benefits for these societies are unclear.

There are two basic arguments: first, that a competitive scientific community has intrinsic values as it produces scientific knowledge and fosters the

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[1] A slightly different version of this text has been published in spanish by the same authors in M.A. Campos and J. Jimenéz (eds.), El sistema de Ciencia y Tecnología. Problemas y perspectivas, UNAM, Mexico, 1991.

development of higher education. According to this position the fundamental need is to create conditions favorable to the formation and development of a scientific community in the peripheral countries. Those supporting this point of view concentrate on fulfilling international requirements for the recognition and diffusion of scientific work (the publication of books and articles in reputable journals) without judging whether or not the knowledge produced has any immediate applicability or utility.

The second position emphasizes the importance of producing knowledge with practical uses, or of so-called technological research. The argument in this case is that the promotion of applied science is fundamental as this strategy can lead to the production of technologies which can be incorporated into the productive system. The fundamental criterion of evaluation for this type of work is wether the technological product (prototypes, patents, designs, etc.) aims at solving typical problems faced by the developing countries that is, evaluation focuses on utility.

The need to establish evaluation criteria that act as parameters for assessing the value of scientific and technological work and allow a fair evaluation to be made of the different activities, has become increasingly important. Research funding, the awarding of prizes and social recognition, as well as the assignement of grants and other types of research support have come to depend more and more on decisions made by agencies and organizations external to the institutions where the researchers actually work. The appearance of these decision-making agencies is closely inked to the policies promoting national scientific and technological development, although the demands of the scientific community have also played a role in their creation. We were asked to do this study by one of the grant-awarding agencies in order to facilitate their evaluation procedures.

Budgetary restrictions resulting from the economic crisis in Mexico since the mid-eighties have imposed an urgent need for the various committees to use explicit and clear evaluation criteria, as resources continue to diminish and the number of researchers and groups applying for economic support continues to grow. Generally speaking, the problems of evaluation do not arise when general, abstract criteria are discussed, but rather when the attempt is made to apply these criteria to concrete cases. Hence, the consensus that was achieved at the moment of definition, is lost at the moment of interpretation. The result is a multitude of meanings for the same criterion of evaluation.

This interference is a critical issue since the result of the evaluation determines vital questions such as the possibility of implementing programs of work, of continuing with a particular line of research, as well as having a substantial effect on the motivation of the researchers and their attitude towards their work.

This paper presents the results of a diagnostic study of the problems found in applying criteria to evaluate technological research. We interviewed more than twenty persons working in academic institutions, centers for technological and other organizations which offer consulting and other services. All the members of this group have worked actively for the development of the scientific and technological community in Mexico. They have participated in various committees and have occupied administrative posts inside and outside the government as well as having been researchers themselves.

Our study detected four types of problems:

- epistemological problems, that is, problems relating to the definition and specificity of the activities evaluated;
- problems arising from the type of work evaluated, that is, whether it is individual or interdisciplinary;
- problems relating to the incidence of factors external to the research (economic, political, institutional) and which have nothing to do with the researcher's training or the quality of his work;
- problems deriving from the form of organization and the particular mechanisms that characterize each evaluation process;

We will describe the epistemological problems here since these are found in the majority of the situations where evaluation occurs.

The epistemological problems of evaluation criteria

The first evidence that we found of this type of problem was the diversity of terms used to designate the activities involved in the tasks that articulate scientific and technological development. The following are frequently encountered: *technological research, technological development, technological innovation, technological transfer.* Such heterogeneity does not cause any difficulties in the everyday development of these activities, since every group or institution adopts its own definitions which serve as guidelines for their work.

However, when evaluations are carried out and different codes are superimposed, a series of difficulties arise, preventing or interfering with the achievment of a consensus a to the value of a piece of work. This is a result of the heterogeneity and the ambiguity of the definitions used as a basis of conceptualization of the various activities involved.

1. The first **ambiguity** consists of the absence of a clear differentiation of boundaries and of a clear indication of the interaction existing between "technological research" and "technological development" (See the definitions in annex).

Some people start out with a concept of technological research as the act of combining elements of basic knowledge in order to achieve new applicable knowledge. This process comprehends the identification of the applicability of basic knowledge to the solution of concrete problems. Thus, technological development is the application of solutions suggested by technological research, adapting them to a particular circumstance and the needs of a particular user. From this point of view, the differences between technological research and technological development is question of scale: technological research is the product of a laboratory, while technological development is produced in the factory.

Another conceptualization proposes that technological research is a complete process whose product is *applied or applicable knowledge*, whether or not this knowledge is ever used - for reasons that have nothing to do with its quality or intrinsic utility (economic or political reasons, the absence of a user). Thus technological research could be considered as an activity that is autonomous vis à vis technological development.

Yet another viewpoint is that technological research is a stage of technological development, the latter being a complex process which includes research and other tasks like organisation, administration, design, transfer and commercialization.

The problem for evaluation posed in the concepts we have outlined is found in the difficulty of establishing the difference between the concept of research and that of *adaptation* when they are both included as part of technological development. This situation arises because in Mexico, technological development tends to be defined as including a large component of adaptation, or, is actually synonymous of adaptation.

The "principle of technological reality" does not imply only the need to define the concept of adaptation, but also remits us to the concept of "copy", which is also ridden with other ambiguities.

2. Hence the **second ambiguity** is found in the definition and the relationship between *research, adaptation* and *copy.* There is a consensus that "copy" should be understood as *replica* and as using a technology designed in another context exactly as it is when purchased. The important point here is that consensus exists that copy is not technological development but, given the conditions under which copy occurs in Mexico, it should be accepted as part of technological development as it provides the opportunity for training technological researchers (The "Japanese" model).

From the same point of view, adaptation -unlike copy- implies *modifying* a technology in order to make it adequate for this particular conditions in which it will be used. In this sense, adaptation is often identified as a research process. The following arguments are used:

- adaptation assumes or requires a certain amount of research and experimentation that is not of a trial and error nature, but which aims at identifying the particular characteristics of a concrete problem, the design of a solution and the identification of the specifications that are adequate for the context in which the solution will be used.
- adaptation assumes innovation in that it produces something new: the adequate way to resolve the problem.

Thus, what justifies qualifying adaptation as research is that it produces *new knowledge* which is *useful* and *applied.* These arguments give rise to discrepancies at the moment of evaluation because there is no agreement in the responses to the following questions: What is new knowledge ? An original idea, in the sense that it constitutes progress in the field (as is the case with basic research), or adaptation of something already known but that allows existing knowledge to be applied to a concrete situation ?

What is useful knowledge ? Something that finds a market and is sold, a process of adaptation that implies learning to do things that were not known before in Mexico, knowledge that solves a problem but that is not applied for reasons independent of the producer, or the solution of problems not involving research in the strict sense of the word but which is important to the country and can be applied ?

The argument that support each response generate discrepancies at the moment of evaluation because there is never an agreement regarding a basic question in all the debates: *which of all the activities involved in technological work are research activities and which are not, independently of their relevance to the country and the quality of the work ?*

3. The **third ambiguity** is found in the difficulty in establishing a clear and precise boundary between *technological development* and the *exercise of a profession.*

This difficulty derives from the fact that the process of technological development involves a series of routine activities that consist of taking a set of processes, techniques and available knowledge and applying them to a particular case. That is, technological development includes a series of activities that everyone identifies as the "exercise of a profession" as, for example, agronomy, computer science and, to a lesser extent, engineering.

In the case of agronomy the problem is that the specific work of the discipline presupposes a type of experimentation, seeking to adapt techniques to particular conditions. There is no consensus as to whether these activities constitute research or are simply the normal activities corresponding to the profession.

Another issue is that new technologies aimed at lowering costs which might be widely used, are not recognized as new technologies at the moment of evaluation since they have not been published according to the rules governing scientific publication.

For example, the fundamental problem in computer sciences is whether or not work on modelling or programming should be recognized as original contributions' or technical back-up to research.

Evaluation criteria

If we start with the premise that technological development is the production of goods and services for the improvement of products and processes, the activities involved assume specific characteristics that are different from those in scientific research.

Technological development supposes interaction with the user: the latter can be identified at two levels: society and the individual. The impact, utility, and the recognition of the products of technological work are shaped by this interaction, just as the interaction between scientists constitutes the means for the diffusion and validation of the products of scientific work.

The results of technological development should have an application, and this application should have an impact: it should solve a problem or satisfy a need. It is in this sense that we can identify the aim of technological work as the production of goods and services, rather than the production of knowledge.

Therefore the specificity of technological activity means that specific criteria, not included in the evaluation of scientific knowledge, should be introduced. The traditional criteria for scientific knowledge, that is *quality* -making an original contribution to the field- and *productivity*--publication of reports or final results in media accepted by the national and international scientific communities- are joined by the criteria of **utility**, **applicability**, and **impact**.

According to our study, these are defined by reference to the attributes of the technological product. These are:

- **technical and economic feasibility**: the technological product should not only solve a problem but it should do so in a form that is adequate given the operating conditions of the productive sector in the country;
- **relevance**: the technological product should solve problems and satisfy priority needs related to the development of Mexico;
- the technological product should be **competitive** that is it should represent an advance over existing products in terms of cost improvement and other attributes;
- **commercialization**: the technological product should achieve commercial distribution and use;
- **impact**: the technological product should not only solve a problem and satisfy a need, it should also have users.

These attributes, however, are not conceptualized by means of precise indicators that might serve as guidelines for evaluation, which lead to heterogeneous interpretations. The problem of evaluation can thus be phrased as which products should be evaluated and what requirements should they fulfill.

Various types of products are found in the process of technological development and their characteristics affect the evaluation. These products can be grouped in two types: partial products and final products.

1. **Partial products**

-**protocol**: specifies the problem to be dealt with and the way it is to be dealt with. The problem posed for the evaluation of this product is that if the methodological proposal is not explicitly formulated, evaluation is impossible.

-**report**: this is a type of progress report of the project. It does not allow the quality of the work to be judged. It reflects on the progress made according to the program of activities.

- **technical report**: this is another type of progress report. The content of technical reports can be evaluated in that the quality of the work can be judged from the achievements reported.

- **publications**: this applies to the diffusion of some relevant aspects of the project. The problem, as far as evaluation is concerned, is found in the characteristics of the publications devoted to Technological work. In this field, the activity includes more than the publication of an article; thus, reports are usually more highly valued than articles and books.

- **prototypes**: this is a product, at a smaller scale, of what would be a final product. It can be evaluated according to criteria of utility, innovation, technical and economic feasibility.

-**design**: this is another type of presentation that implies in one sense a result and in another, something that still has to be done. At the moment of evaluation, the question that gives rise to discrepancy is whether the design is the application of something given or the creation of something new.

- **patents**: this is the certification of a process or product that does not guarantee utility, creativity or quality. For this reason, the majority of informants said that patents did not represent a significant product for the evaluation of a piece of work.

2. Final products

For the purpose of evaluation, some of the partial products can be considered as final products, for instance, prototypes, designs and publications. However, strictly speaking, the only final product is the so-called "technological package", the complete and applied solution to a problem with a commercial use.

The problem posed for evaluation by this perspective, is that if recognition were only granted to "technological packages" , very few pieces of work would be acceptable, since the possibility of achieving the package is not the individual responsibility of the researchers or technologists. Many of the circumstances that limit such a possibility are related to wider problems of technology application and commercialization.

CONCLUSION

The ambiguities and discrepancies that arise at the moment of evaluation of individuals and projects express the co-existence of two different orientations in the evaluation agencies: an epistemological criterion which judges the activities as processes and products of scientific research using parameters of quality and productivity, and a principle of technological reality which identifies as research other activities which are closer to adaptation than innovation and which relies basically on criteria of utility.

This is explained by the fact that the evaluation criteria are not "abstractions". Their content expresses different traditions. Each group and work environment endows its work with certain peculiarities and thus tends toward a particular conception of science and technology.

In this sense we can identify three types of institutions involved in scientific and technological work:

- purely academic institutions, where technological research assumes the same characteristics as basic research and the researchers share the traditional "rules of the game" of the scientific community. Thus they are accustomed to being governed by the latter's evaluation criteria.

- decentralized institutions, where the technological activity is carried out linked with the provision of consulting and other services. This gives the research its peculiarities (the relationship with a client, the confidentiality of results, time and resources stipulated by formal agreements,etc.). It also means that the process includes tasks that are not specifically research tasks. On the other hand, the professional staff of these institutions are not usually trained in the "rules of the game" of academic activity and are evaluated following other criteria.

- centers of technological development, where the activities of research and consulting are carried out in direct relationship with a user. The process is oriented by the rules of the institution and of the agreement with the client. The characteristics of the work are similar to those of decentralized institutions, but there is greater autonomy regarding resources and the rules of the game. The work here is not governed by traditional academic criteria either.

The problem then is **how do you evaluate different traditions with the same rules?** not just with respect to the specificity of the activities corresponding to each, but also with regard to the time scale and the process of formation and development of each. It should be pointed out that the evaluation criteria current in most of the committees existing in Mexico for this purpose are those that are recognized and validated by scientific tradition. At the present time, when technological work is being encouraged, both scientist and technologists begin to share institutional space and to interact professionally. This situation is accompanied by a dispute for recognition and for new "spaces", which involves, without doubt, a struggle for power.

The moment of evaluation is thus one of the "scenarios" where, through the valuation of work and of individual or group performance, concepts are debated and institutional, disciplinary, group , and individual positions are fought over. As a result, the definition and application of evaluation criteria goes far beyond the valuation of a piece of work in terms of its inherent characteristics.

ANNEX

Basic definitions registered in the diagnostic study

TECHNOLOGICAL RESEARCH

• generating new knowledge for the solution of specific problems.
• generating a new way of doing things.
• generating new knowledge that permits the transition from the particular to the general.
• finding solutions to real problems, solutions that were not known previously or that had not been identified as such.
• developing something with existing knowledge that is altered and used for a given end.
• adapting existing knowledge to solve a local problem.
• generating knowledge that means a leap forward can be made in the solution of problems in a more efficient way than any known way up till now.
• improving the applications of what is known, more than getting to know more.
• activity with practical aims, to obtain goods and services.
• generating a new technique that is applied to a new problem that has not been solved by any one up to that moment.

TECHNOLOGICAL DEVELOPMENT

• making a product with a process and a material different from the traditional way, with better costs and attributes as a result.
• using basic applied information, translating it to industrial use by means of designs and products. The product should be competitive: better attributes, lower costs, and advantages from the point of view of service.
• finding technical solutions to different problems, that are economically feasible and of high quality.
• using existing knowledge to propose practical solutions that can be produced economically at an industrial level.
• bringing together known facts to solve a problem.
• adapting existing knowledge, applying it to generate new technology.
• process which consists of: identifying and making a diagnosis of the needs of a user and the particular form of interaction within the system and the culture of the user; developing an alternative that has a real and effective capacity to solve problems that have be detected; effecting a technology transfer, establishing a mechanism of interaction with the user and his system (documentation, advise, training, etc.).

• can be identified to the concept of reverse engineering: finding the changes necessary for a technology to adequate to local conditions and capacities - what is needed in Mexico is to modify the state of practice, more than to advance in the state of the art.
• integrating knowledge derived from technological research or someone's inventiveness into the production process.
• putting an idea into practice, which implies analysis, study, experimentation and modelling. Thus it is creating intellectual contribution, where what is important is not the idea in itself, nor who generates it, but its application.

EXERCISE OF THE PROFESSION

• the search of practical solutions to given problems.
• tacking the available technology and optimizing it for a particular case. This is more the elaboration of a design than the search for answers to basic questions.
• reiterative application of advanced techniques.
• using the knowledge produced by research to deal with given problems.

INFORMATION MANAGEMENT FOR RESEARCH MONITORING

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ABSTRACT

Bibliometric techniques remain an essential basis for the analysis of scientific activities and the construction of meaningful indicators. Although the latter also requires that a suitable reference framework, or conceptual model is available, it is in first place dependant from the availability of data on publications, that is to say ultimately machine-readable records. Using data available on existing publications, a wealth of interesting work has been carried out on the publications patterns of scientists in the Less Developed Countries (LDCs), eg. international versus local publication, type of publication, language of publication, etc. Much less attention has been paid in our view to the basic conditions which command the very existence of publications and of usable records. This paper, which essentially refers to the situation in subsaharan Africa , will attempt to highlight the limitations affecting the communication cycle, the need to establish information management as an integral component of scientific research and its management and possible practical alternatives for ensuring the provision of suitable records. Since there is, to the best of our knowledge, a dearth of empirical studies on these problems, the paper is to be regarded as a personal point of view for discussion, based upon our experience in establishing information systems in these countries.

RESUME

Les techniques bibliométriques sont essentielles pour l'analyse de l'activité scientifique et la construction d'indicateurs pertinents. Bien que cette dernière suppose aussi l'existence d'un cadre de référence ou d'un modèle conceptuel adapté, elle est au premier chef dépendante de la disponibilité de données sur les publications, c'est à dire en fin de compte de références lisibles par ordinateur. Nombre de travaux intéressants ont pu être réalisés sur les modes de production des chercheurs des pays en développement à partir des données disponibles sur les publications existantes; ils concernaient par exemple les rapports entre publication internationale et locale, les types ou les langues de publication, etc .. Il nous semble que les conditions de base qui permettent l'existence même de publications et de références exploitables ont bien moins retenu l'attention. Cette communication, qui se réfère essentiellement à la situation en Afrique sub-saharienne, cherche à montrer les limitations qui affectent le cycle de la communication, la nécessité de faire de la gestion de l'information une partie intégrante de la recherche et quelques approches pratiques qui permettraient d'obtenir des références utilisables. Ces problèmes n'ont à notre connaissance fait l'objet que de très rares études empiriques; cette communication expose un point de vue personnel pour contribuer à la

discussion en se fondant sur une longue expérience dans l'établissement de systèmes d'information dans les pays considérés.

1.LDCs LIMITATIONS IN THE INTERNATIONAL SCIENTIFIC COMMUNICATION PROCESS

In order for a scientific publication to be mentioned in other publications or major databases, it is necessary that:
1. a formal paper be prepared,
2. the paper be accepted by a recognized journal or conference,
3. the source document (journal or proceedings) be considered by a data base, and the paper be eventually selected by the publisher of the data base,
4. the reference be indexed under meaningful terms,
5. the document be obtained in time by the person who want to use it.

Prevailing conditions in the LDCs and practices in the international scientific communication system present many obstacles for the publications of LDCs scientist to successfully go through these steps.

The major ones lie probably with the first step. In order for a formal paper to be prepared, there ought to be:
- a researcher trained in the writing of scientific articles, aware of the standards and style conventions of the major publishers (which by the way differ noticeably);
- a researcher able to write and communicate in a major communication language if his/her mother tongue is not one, or is not the predominant one in his/her discipline;
- publishable results, what in turn is dependant from well designed projects and a steady provision of the resources required for their implementation, on the one hand, and availability of relevant and up to date literature on the other hand;
- a provision for publication in the research project programme and budget (time, funds for document production and distribution and/or for participation in conferences);
- a policy of publication in the researcher's institution, even if it is primarily concerned with the immediate transfer of results to the users community (eg. in the case of adaptive agricultural research);
- incentives for the research staff to publish (eg. recognition of publications in individual evaluation, promotion, etc.);
- equipment and supplies for the typing, editing, duplication of the paper;
- eventually clerical staff to prepare the document;
- a researcher having personal connections with fellow scientists who could review the paper and provide an authoritative feedback;
- communication facilities which allow for the latter interaction to take place in due time.

In many LDCs these conditions are not met in most instances. As a matter of fact, a noticeable portion of the LDCs research results is not recorded in formal documents or is recorded in internal reports. Non conventional documents seem to be the dominant form of formal communication (1, p. 71).

In order for the paper to be accepted by a recognized journal:

- the researcher should be aware of those journals which are more likely to be interested in his/her topic, or informed in time of the conference;
- there should be at least one journal by assumption, but this is precisely not the rule, since journals, especially high status ones, are commercial ventures from organizations in the industrialized countries which naturally aim at satisfying the needs of their majority clientele, scientists in the industrialized countries; few journals with an international circulation are interested in LDCs related topics, thus making the competition more acute among the potential authors;
- the researcher or his/her institution should preferably be known from a member of the editorial board, or organizing committee, or someone having connections with it;
- communication facilities should allow for mailing the document, receiving the comments and sending back the revised version in due time;
- funds should be available for paying the page charge or conference fees and travel if appropriate.

Again it is difficult for these conditions to be met in LDCs. Assuming the document has been published, in order to be entered into a major data base related to its subject it should:

- appear in a publication which is regularly or specifically screened by the data base producer;
- be in a language and script which the data base could handle;
- in most instances, unless published in a "cover-to-cover" journal (because of the notoriety or special relevance of the journal all articles are systematically entered into the data base), be selected for inclusion.

An article on an LDCs related subject is not likely to appear in a publication which is regularly screened or to be selected, if it does. Publications issued in the LDCs, even of high quality, may be omitted simply because of a lack of awareness of the data base publisher, language barrier, delays in mail delivery, irregularity in the publication of the journals. Again, database production is a commercial venture which has to respond to the demand of the major segment of the market, the scientific community in the industrialized countries. In addition journal articles represent the predominant source of records while most of the literature produced in LDCS for many disciplines remain, especially in its initial life, in the form of non-conventional documents. The proportion of the documents cited in databases which have been produced in LDCs can be roughly estimated at around 10 % (2, p. 71); even in international cooperative databases which strive for an extensive coverage of this literature, such as AGRIS, the LDCs share remains around 25%.

Because databases are designed for a public in the industrialized countries, they use classification and indexing schemes which are best suited for this audience on the one hand, and are organized according to the size of the related literature, on the other hand. A topic which generates a very small percentual of publications will not be indexed under a specific entry. The particular terminology used in the LDCs in order to describe local objects, phenomena and concepts and geographic terms are therefore eventually grouped under broader entries which do not necessarily make apparent the connection with those terms or have a reference to them. Some fields of investigation may even be represented by so few entries or believed so marginal that they are practically omitted, as was the case for instance in the first version of AGROVOC (3) with water resources in agriculture or range management. This phenomenon is of course less sensible in basic sciences than applied or social ones. In any case, data base searches on LDCs related topics are slightly more complicated and may result in higher rates of misses.

Once the reference has been identified, the interested person has to obtain a copy of the document within reasonable delays. If the document has been published in a major source and he/she works in an industrialized country, this may go without much problem while, if he/she is located in an LDC, it is much likely that no nearby library will have the document, either because of shortage of acquisition funds or because of delays or losses in the delivery. If the document has appeared into a special or local source, it is not likely to be available anywhere except in a few organizations of the considered country. Obtaining copies supposes that the correct mailing address of the institution where the document could be found or from which it originates is known, the request is received and properly processed, the requester is in a position to pay, when not prepay, the copy, the institution is in a position to make a copy and to mail it back (i.e has envelopes and stamps) so that it will be received within reasonable delays. Even in industrialized countries, such trivial steps do not go without problems, at least for what concerns the effectiveness of mail services and the interference of customs offices, whose interpretations of the international convention on the free flow of scientific documents is often erratic. In LDCs, the outcome of each of the above mentioned steps in the process is unpredictable.

Data concerning research infrastructures and programmes (institutions, research staff, facilities, funding, etc.) are not compiled at the international level, except in a few cases such as UNESCO's science and technology statistics, agricultural research (ISNAR, CARIS, SPAAR) and programmes with international support (IDRIS) (4). They may not be available either at the national or institutional level in a form which would be both reliable and suitable for secondary analysis.

2. THE NEED FOR INFORMATION MANAGEMENT

Scientific research is not only heavily dependant from information activities as input to and output from the projects but can be regarded as one of the information industries (5). In any case the acquisition and use of information, the production of new information, its formalization into documents, their dissemination and various additional forms of communication occupy a central place in the research process. The research cycle, including research management, and the communication cycle are intrinsically interwoven and the former would not exist without the latter. In this respect, it is sad to note that if few studies of the communication cycle such as those of Garvey (6) or King (7) were attempted for the industrialized countries, they have no equivalent for the LDCs.

Even though the availability and visibility of scientific literature from LDCs are subject to influences from the industrialized countries, they also have in first place deep roots in the LDCs themselves. A number of socio-cultural factors play an inhibiting role (8). A cultural bias is not less apparent in the assessment of LDCs publications by the scientific community of the industrialized countries. To the extent scientific research is carried out in organizations, either universities or research institutes, which for their vast majority belong to the public sector in the LDCs, one should also pay attention to the institutional factors which influence the overall communication or information cycle. There appear to be many drastic limitations for what concerns the manpower resources, the organizational set up and the provision of financial and material resources. Other noticeable constraints result from the overall socio-economic conditions, especially in that they do not allow for a regular support of research activities and for the effective operation of basic public services such as mail, transport and telecommunications, what not only results in additional costs and production losses (9) but also in constant burdens which have a demobilizing effect.

If one considers the series of roles and functions in the communication cycle as they were adapted by Borko and Menou (10), a realm of problems may be identified, of which the list below may give some idea, although it is neither systematic nor exhaustive. The information users have to specify their information needs with regard to subject, methods, challenges and plan of the projects, resources and strategies of the institutions. The major limitations associated with this function are: insufficient definition of socioeconomic constraints for the usability of research results; deficiencies in research planning; changing leadership, organization and objectives; inability to specify needs; unawareness of national and international past and current research. The users have further to obtain information where they face such limitations as: unawareness of sources; disorganized files and collections; inefficiency of information services; inability to submit clear requests; unreliable communication and postal services; prevalence of bureaucratic procedures; unavailability of funds especially hard currencies; delays and insecurity of delivery. Users have finally to exploit information where they face such limitations as: lack of training in information analysis and evaluation; language barrier; lack of equipment and supplies; loose planning, monitoring and evaluation procedures.

The information producers have to outline their papers, record data, elaborate, organize, write, type, file their papers and related data. The major limitations faced for the fulfillment of this role are: lack of training in scientific and technical writing; lack of equipment and supplies; insufficient skills in communication; language barrier; low qualification of support staff; lack of training in records management; bureaucratic procedures in reporting.

The publishers have to prepare galleys, edit, print, distribute, file the publications and manage editorial boards. The major limitations faced for LDCs research institutions to fulfil this role are: lack of equipment and supplies; low qualification of support staff; difficulties of communication with authors; lack of standing publication budget; irreliability or unavailability of contract printers: unreliable postal services; extra cost of dispatching because of geographic location and dispersion; deficiencies in publication policies; lack of training in publications management.

The information services have to obtain information, process items, shelve documents, store, retrieve and disseminate information, answer queries, repackage, consolidate, print and distribute information products, provide copies of primary documents. The major limitations faced in this role are: lack of acquisition budgets; loose connections with producers; shortage of skilled manpower; inefficient procedures; duplication of work imposed by participation in incompatible documentation systems; inadequate premises; lack of equipment and supplies; lack of budget for current expenses; lack of reliable procurement and maintenance agents on site as well as abroad; inconsistent dissemination policies; loose connections with and remoteness from the users.

The research team leaders and managers of research institutions have to organize information functions and flows, establish procedures, allocate resources, supervise information activities, maintain internal and external linkages, evaluate the information system. The major limitations faced in this role are: lack of training in information management; persistence of obsolete formal procedures; excessive bureaucratization; irregular and insufficient funding; dependance from foreign assistance; deficiencies in publication policies; low level of interpersonal and interi-nstitutional interaction.

Most of the information functions and the problems they encounter are usually dealt with as separate areas. Research planning, monitoring and evaluation, computer facilities, telecommunications, printing facilities, editing, distribution and sales of documents, extension activities, special libraries or documentation centers, data collections, technical archives, etc. will be subject to individual decisions, attached to different departments or set up as particular units. They are in addition considered as ancillary services whose resources are eventually obtained from the provisions for overhead expenses. If it is true that information has become in the modern society the most important strategic resource, this should be even more true for scientific institutions. The question is not to secure an acceptable level of resources to all these functions nor even to assemble them into a coherent set forming a purposeful corporate memory. A memory connected to a deficient brain can hardly be used. What is required is a composite, organization-wide system integrating the various specialized information subsystems, which would retain the appropriate level of autonomy and decentralization, on the one hand. On the other hand, there should be a single and high level authority for the management of the entire system as an integral part of the overall management of the organization and collective mechanisms for establishing standards, planning and monitoring the operation of the system and adjusting its activities to the national and institutional strategies.

Information Management, as summarily described above, is a requisite for the research institutions, like any others, in LDCs to increase productivity. Without it, the availability of scientific literature from LDCs is not likely to increase noticeably. It is also perhaps the basic condition for the data to be effectively collected, which are required for strategic planning of research, project planning, monitoring and evaluation by scientists and managers in LDCs and for scientometric studies. Information management should thus deserve the highest priority from both national authorities and technical assistance agencies. One can not however avoid some fundamental questioning when noting for instance that a basic text on agricultural research policy and management in LDCs (11) does not devote to information activities more than a few pages out of several hundreds, which provide little more than general comments on the importance of having access to international literature, or that a report on the assessment of a LDC national agricultural research system does not devote more than one paragraph to information management (12, p. 13).

In order for information management to become a standard feature in the scientific research organizations of LDCs, the following actions may be considered. All categories of staff should be adequately trained in the use of information technology, implementation of the information activities which they have to fulfill under the prevailing conditions and in information management. To the extent a sufficient number of qualified information specialists staff can not be provided, the various tasks it normally performs should be taken care of by other categories of staff which should be trained accordingly. Mechanisms, both national and international, should be established in order to secure the permanence of a minimum nucleus of trained information staff within each research institution (eg. by buying the information products they generate rather than acquiring them on a donation or exchange basis). Simple rules should be established within the national research systems for the generation, recording, distribution, storage and dissemination of all types of information. Standard software packages should be selected and adapted or developed for the integrated implementation of the various information tasks, taking into account the specific requirements of the research institutions in LDCs. The acquisition of information technology and information management capabilities should be included in a systematic and coordinated fashion into the international cooperation projects, as opposed to the current specialized and project and function specific approach (13).

3. ALTERNATIVE WAYS TO IMPROVE THE AVAILABILITY OF DATA

Publications may be regarded as the most straightforward medium for the communication of most data which are required for the analysis of scientific activities since they could indicate:
a) original title of the publication;
b) language of the publication;
c) full name of all members of the research team, which is necessary in order to discriminate homonyms;
d) the permanent affiliation of each member of the team;
e) the nationality of each member, which may be added to the standard entries by using the ISO code of countries;
f) the principal investigator;
g) the institution(s) where the research was carried out;
h) the source(s) of funding for the research;
i) the programme(s) to which the particular project whose findings are reported is related;
j) the amount of funding allocated to the project;
k) the total duration of the project and the phase to which the published findings correspond;
l) the subject of the research through a significant title and its eventual enhancement, and an informative abstract;
m) the methodology of the research;
n) the other publications and communications resulting from the research, through the citations;
o) the previous related work and its above characteristics, through the citations.

The primary publications do not presently include all these data. Some are omitted in most cases, like nationality or permanent affiliation, others are not systematically recorded, like those related to funding, programmes and project or other publications. Most are not presented in a standardized fashion. It would thus be advisable that the LDCs research institutions establish standards by which their publications could carry all the information required for further monitoring and analysis of research activities. These standards should preferably be unified at the national, regional and international level. The inclusion of the data which are not commonly mentioned (eg. c, d, h, i, j, k above) and the comprehensive recording of the others would not impose much additional effort upon the authors. A standard cover page with all the entries required for the recording of the above indicated information could for instance be pre-printed, distributed to the authors and used as a basic source for the monitoring of publications. Stocktaking and distribution data may eventually be added in order to further integrate the management of information.

Databases can only record in each reference the data which can be clearly identified in the primary document. Should the above listed data be available, international bibliographic standards and their particular application in each data base, whether local, institutional, national or international, may however prevent their inclusion. For instance the original title may be mentioned only if it is in the carrier language of the database, the given name is often represented only by an initial, the number of authors cited may be limited, the affiliation may be indicated only for the first author, who is not necessarily the principal investigator, temporary attachment to another institution is treated as affiliation in place of the permanent one, the number of citations is not always recorded and the references are not recorded, links among the publications resulting from a single project are not always recorded, most of the other data are neglected, although, in principle, they could at least enter into a note field. Such limitations have clearly a cost-effectiveness rationale in addition to systems constraints. Bibliographic databases are meant in first place for providing references in response to subject oriented queries and not for the analysis of research activities. The major databases, with stocks over the million records, can hardly consider any significant change in their format and procedures unless they switch for an entirely new system.

The provision of such data on LDCs research output can only be the responsibility of LDCs research institutions themselves and possibly those institutions in the industrialized countries which are directly involved with scientific research in LDCs. The documentation services in the research institutions of LDCs face drastic limitations with regard to their manpower resources, material facilities, financial resources and support. The range, quality and effectiveness of the services they can offer to the users are thus far from satisfactory what in turn reduces their ability to liaise with the authors and collect their papers and encourages the latter to look for solutions of their own for both control of their own information and access to external one. These trends are reinforced by the over centralization of information services, on the one hand, which is in contradiction with the prevalent individual and institutional culture (14), and their use of inadequate documentary systems and procedures. The establishment within each organization of flexible documentation networks which could ensure an appropriate level of bibliographic control at all levels, from the individual researcher up to the central services and the progressive aggregation and enrichment of the records in cooperative databases is a first requirement. This however can only be achieved if a suitable format such as BABINAT (15), specially designed for this purpose, is available and suitably adapted.

The documentation networks in the LDCs research institution should further develop particular routines with a view to ensure a more comprehensive recording of the relevant data, as earlier mentioned. In particular, when processing papers produced by their organization, they should create records for the quoted literature which would bear a special identification and be linked with the citing papers. This clearly implies an additional work, whose magnitude should however be tolerable (roughly for an institution producing 100 papers per year with an average of 50 citations, this would represent 3 man/months) but would yield invaluable benefits both for information access and for the monitoring of research activities. The fact that a noticeable portion of the scientific output is at best recorded in the form of non-conventional documents, often internal ones, and thus are not included in bibliographic files, will however remain. Such types of literature could be consolidated by first specifying a series of types of documents and their characteristics (eg. project or section notes, occasional papers, etc.), second establishing suitable mechanisms of review which could ensure the required quality level for each category, third creating bibliographic records for those documents, once at least one copy is stored in an identified location and remains available, fourth including those records into the input sent to international information systems. It should be noted that other forms of scientific output such as participation in education and training programmes, in extension programmes, in national seminars, etc. could also be subject to some form of summary recording and become accountable.

The implementation of the above suggestions can hardly be practical without the use of modern information technology. In this respect, it is fascinating to observe that the appropriateness of information technology in LDCs is still much questioned (16) on the basis of the many cultural, social, human, economic, logistic, technical, administrative and environmental obstacles it faces, which nevertheless apply as well for the more traditional techniques, and certainly for the operation of sophisticated scientific equipment which is nowadays very easily provided to these countries and not so well utilized (17, p. 68). To the extent information activities along the communication cycle involve a large proportion of successive exercises of data gathering, recording, organization, processing and dissemination which immobilize scarce qualified manpower in repetitive data manipulation, information technology, especially stand alone or networked microcomputers, could provide an unique answer.

Assuming that bibliographic records on LDCs scientific production would become more readily available as a result of the above suggested actions, the problem of their international dissemination will not be solved. With compatible electronic records, it is relatively easy to produce compilations such as institutional and national bibliographies and to circulate them. Specific products could also be developed in cooperation as demonstrated by SESAME (18) for instance. The optical disk technology is even likely to allow in the near future for compiling mixed databases, including the full text of papers, which may be more easily screened by the producers of large databases. The latter would also be in a much better position to reuse the data with reformatting routines. In the case of international cooperative information systems, such as AGRIS, the data elements which are presently missing as previously discussed, could easily be preserved if moved into a notes field which will be saved in the international data base even if it is not available in the standard search routines and printed products.

The implementation of such measures could not go without the allocation of sufficient funding by both national and international organizations, which will be harder than ever to obtain in the forseeable future. The funding available is however not insignificant. The question is more of the share granted to information management, what ultimately points to the concepts and mentalities of those in charge of scientific development in LDCs. As long as information activities will "go without saying", thus without specific and/or adequate allocation of resources, little change will occur.

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DEUXIEME PARTIE

STRUCTURATION DES CHAMPS SCIENTIFIQUES, EVALUATION ET CONDITIONS DU DEVELOPPEMENT SCIENTIFIQUE

DES AXES DE RECHERCHE POUR UN PROGRAMME INFOMETRIQUE DE VEILLE SCIENTIFIQUE ET TECHNIQUE

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RESUME

La veille scientifique et technique est à la mode. Les décideurs semblent de plus en plus convaincus que la position concurrentielle du laboratoire, de la firme ou de l'institution qu'ils dirigent en dépendent. Les producteurs de banques de données peuvent espérer de ce fait conquérir des nouveaux marchés pour leurs produits d'information. Quant aux documentalistes, ils sont appelés à acquérir des nouveaux savoir-faire, ainsi que témoigne la multiplication de cours visant à les initier aux techniques de la bibliométrie. Cependant, toute mode est sujette à caution. Elle implique qu'après une période initiale d'engouement, l'intérêt tombe et les investissements se font ailleurs. C'est la raison pour laquelle nous nous proposons dans cet article de considérer la question suivante : la veille scientifique et technique est-elle une mode ou un axe de recherche légitime?

ABSTRACT

The need to monitor scientific and technological trends is now generally recognized. Techniques designed to carry out bibliometric analysis of large scientific and/or patent databases are now being widely developed. Decision-makers are showing considerable interest in experimenting their usefulness for policy planning purposes. Database producers can thus expect new markets for their information products. Documentalists will have to acquire new skills, as it appears througj the numerous bibliometric courses now taught to them. But as every fashion, after an initial burst one can expect a loss of interest and a reorientation of investments in other areas. In this paper, we will attempt to identify the basis for transforming current interest into a full-fledged, long-term research program.

INTRODUCTION

La compétitivité est de plus en plus comprise comme une question d'écoute: écoute des marchés, des technologies et des recherches scientifiques, mais aussi écoute des hommes qui, par leurs stratégies individuelles, font le lien entre ces différentes considérations et déterminent ainsi collectivement les voies d'innovation de demain (Riboud, 1989). D'un côté, la collecte des informations;

de l'autre côté, des structures de prise de décision. Entre les deux, une série de traitements visant à mettre en forme l'information pour aider à raccourcir les délais entre l'analyse d'une situation et l'adoption d'un plan d'action.

La veille scientifique et technique peut être définie en termes d'une recherche de la meilleure adéquation possible entre l'offre et la demande d'un produit d'information. Ce produit est celui qui aidera un système productif (1) à prendre les décisions qui sont essentielles pour défendre ou améliorer sa position concurrentielle (Avenier, 1989). Afin d'évaluer l'état des recherches dans ce domaine, nous nous proposons d'adopter trois points de repères.

Le premier est conceptuel. Il s'agit de préciser la nature de la demande pour les produits de veille scientifique et technique. Etant donné que se pose le problème d'une production "sur mesure", il s'agit de savoir si on peut néanmoins identifier des catégories de besoins qui sont relativement stables. Le second repère est technique et concerne les conditions de production d'indicateurs qui sont susceptibles de satisfaire les différents besoins identifiés. Enfin, le troisième est scientifique. Un investissement dans la mise en place d'un dispositif de veille scientifique et technique se justifie en grande partie par un calcul de rentabilité. Une relation directe est supposée exister entre l'information et l'efficacité d'un processus de prise de décisions. Mais comment déterminer si cette hypothèse est fondée ou non?

I. LE CADRE CONCEPTUEL

L'identification des besoins à satisfaire dans le cadre d'un programme de veille scientifique et technique qui est fondé sur la bibliométrie suppose qu'on parvienne à :
- distinguer entre différents types de contextes décisionnels;
- préciser l'intérêt des publications pour le développement d'indicateurs permettant de décrire l'activité scientifique et technique;
- comprendre le rôle que les résultats d'une analyse bibliométrique peut jouer en vue de réduire les incertitudes liées à l'évolution rapide de l'environnement concurrentiel des systèmes productifs.

Les points de vues sont divergeants sur ces différentes questions. Nous nous efforcerons de donner un aperçu des débats en cours.

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(1) La notion de système productif est employé pour désigner l'activité sociale qui consiste à mettre en oeuvre un savoir-faire spécifique pour transformer des flux captés à l'entrée du système en une série de produits qui peuvent être mis en circulation à la sortie. De ce fait, elle doit être considérée comme une notion générale, pouvant s'appliquer à la description de l'activité d'un individu qui s'efforce de valoriser ses propres savoir-faire, d'un groupe qui, comme le laboratoire de recherche, s'intéresse prioritairement au traitement des flux immatériels ou l'organisation qui, comme tout système productif, souhaite que sa production rencontre une demande.

La description du contexte décisionnel

Dans la littérature qui concerne l'évaluation de la recherche, une distinction est habituellement établie entre deux contextes de prise de décision (Chabbal, 1987). Le premier est celui qui concerne le lancement, la poursuite ou l'arrêt d'un programme de recherche. Les décisions de ce type supposent une évaluation des performances qui ont été obtenues ou qui peuvent être escomptées. Cette évaluation est entreprise dans le cadre d'objectifs clairement définis. Quant au deuxième type d'évaluation, il s'agit, au contraire, d'aider à déterminer ces objectifs dans un environnement qui se caractérise par une évolution rapide des recherches, des technologies et des marchés. Le but n'est plus de mesurer les performances mais de décider des orientations de la R et D qui sont susceptibles de contribuer à l'établissement de *la stratégie future d'une* entreprise, *d'un laboratoire ou d'un pays.*

Une première distinction importante est donc celle qui existe entre des évaluations de performance et des évaluations stratégiques et prospectives.

L'exploitation des bases documentaires

La signification des indicateurs tient de la représentation qu'on se fait du phénomène observé. Les indicateurs bibliométriques servent à étudier l'activité scientifique et technique. Il convient donc de poser la question du rôle que jouent les publications dans un processus de développement des connaissances. Sont-elles le point final d'un processus de recherche, le moment où les chercheurs mettent en forme de façon définitive les résultats de leur travail, afin de les présenter à leurs collègues et au monde extérieur pour évaluation (de Solla Price, 1963)? Sont-elles, au contraire, l'expression d'un "vote", un indicateur des micro-décisions qui pourraient entraîner la réorganisation de la structure thématique des recherches de demain (Turner, 1990(1)?

Ce débat est important quant à ses conséquences sur le plan statistique. Dans le premier cas, la publication est considérée indépendamment de ses conditions de production. Par exemple, le bibliométricien ne tiendra aucun compte du fait que l'acte d'écrire revient à prendre position dans un champ scientifique qui se caractérise par des conflits, des structures de domination, des écoles de pensées (Bourdieu, 1975). Il assimilera l'augmentation du nombre de publications à l'accumulation d'un stock de connaissances, chaque publication étant considérée comme la pierre qu'un individu ou une équipe, travaillant à un moment donné dans un lieu géographique précis, ajoutent à la construction de l'oeuvre collective de la science. Un élément discret, donc, qui peut être compté et agrégé en fonction des catégories d'un plan de classement, ou selon divers critères temporels, géographiques et institutionnels.

Dans le deuxième cas la situation est différente. Il s'agit de comprendre la publication comme une contribution à la dynamique d'évolution d'un champ scientifique, comme un facteur de consolidation ou de remise en cause des structures existantes. Le "vote" consiste à privilégier certains sujets qui sont jugés plus porteurs que d'autres, à s'aligner sur les positions des uns et à s'opposer aux positions des autres, à mettre dans la balance, en somme, une force de travail qui peut contribuer soit à renforcer, soit à renverser le rapport de forces dominant du champ (Latour, 1989). Le bibliométricien ne peut, dans cette optique, considérer les publications comme des éléments discrets à compter et à agréger comme il entend. Entre les publications existent des relations de ressemblance et de dissemblance qui précisent leur contribution à l'économie générale d'un champ de recherche. Il convient d'essayer de les décrire à l'aide d'outils d'analyse multidimensionnelle appropriés (Courtial, 1990).

Réduire les incertitudes du contexte décisionnel

Les bases de données constituent une source d'information sur les résultats de recherche déjà obtenus. Elles sont donc utiles lorsqu'il s'agit de comparer les résultats obtenus lors de la mise en oeuvre des programmes avec les résultats escomptés, à condition bien sûr que les délais de mises à jour des bases soient réduits au maximum (Bauin, 1990). Cependant, lors du lancement d'un programme nouveau ou de la redéfinition des contenus de recherches existants, il faut préparer l'avenir. Comment établir un lien entre ce qui a déjà été fait et ce qui doit encore être entrepris en vue de rester compétitif ou de le devenir davantage. La difficulté réside dans les incertitudes qui pèsent sur la qualité des analyses stratégiques et prospectives. Ces incertitudes sont grandement augmentées dans des situations en évolution rapide lorsque, comme c'est souvent le cas actuellement, tout change: les marchés, les savoir-faire et les technologies. Comment s'assurer que les décisions prises aujourd'hui porteront leurs fruits demain?

Il n'y a évidemment pas de recettes à fournir en réponse à cette question. Cependant, deux types de réponse méritent attention. Le premier découle de la nature des lois bibliométriques. Celles-ci donnent lieu à des distributions hyperboliques, c'est-à-dire que l'allure de la courbe obtenue est fortement asymétrique, le plus souvent ayant la forme d'une courbe en "J" (de Solla Price, 1976). L'interprétation qu'on donne à ces courbes est la suivante: un petit nombre d'items observés (les journaux, par exemple) est responsable de la production de la majorité du produit obtenu (i.e. les publications effectivement consultées) et vice versa, la grande majorité d'items considérés ne contribue que faiblement à la production de ce produit.

Quand on emploie des techniques quantitatives pour analyser une activité scientifique, on observe qu'effectivement un petit nombre d'équipes a généralement tendance à dominer le secteur par le nombre de leurs publications; ces publications sont, par ailleurs, souvent très fortement citées indiquant que leurs travaux ont un impact scientifique reconnu. Il serait normal de conclure dans ces conditions qu'une décision judicieuse de politique scientifique consisterait à accorder à ces équipes les ressources nécessaires pour développer leurs travaux, leur succès passé étant un bon indicateur des performances à venir. Ce faisant, cependant, les moyens disponibles dans un champ de recherche se concentreraient sur un nombre limité d'élus, cette tendance entraînant des effets pervers puisqu'elle peut conduire à écarter des recherches originales et potentiellement innovatrices.

Pourquoi supposer que la performance passée est un bon indicateur de l'efficacité future? Rien ne permet de dire que les outils conceptuels et méthodologiques élaborés pour traiter un problème posé aujourd'hui vont encore être utiles pour traiter des problèmes qui se poseront demain (Mulkay, 1979). Une politique scientifique devrait être capable d'identifier et de soutenir des axes de recherches qui ne s'inscrivent pas dans les préoccupations dominantes du champ. Cependant, une telle politique comporte plus de risques. Des techniques d'analyse multidimensionnelle de données peuvent éventuellement aider à les réduire. Par exemple, les cartes stratégiques que génèrent les programmes LEXIMAPPE (2) sont fondées sur une convention de représentation destinée à classer les thèmes de recherche caractéristiques d'un fichier documentaire comme étant centraux ou périphériques par rapport à l'organisation générale du domaine étudié. Cette convention infographique vise à éviter les effets pervers que peut entraîner une politique de concentration de moyens sur un nombre limité d'élus, sans pour autant tomber dans le piège de la non-pertinence. L'objectif est d'aider à mieux comprendre les mécanismes déterminant la dynamique d'évolution d'un champ de recherche. Des décisions pourraient alors être prises en tenant compte des contraintes structurales d'une situation donnée.

II. LES TECHNIQUES DE L'ANALYSE BIBLIOMETRIQUE

La collecte des informations

Il est rarement suffisant d'exploiter des banques de données existantes pour développer des indicateurs. La qualité des résultats dépend, en premier lieu, de la construction d'une base "ciblée" ayant une couverture suffisante pour être statistiquement représentative de l'activité qu'on s'efforce de mesurer. Le problème de la construction d'un fichier de travail suppose une analyse critique et comparative des politiques de collecte documentaire mise en oeuvre par les producteurs de banques de données. Ces politiques peuvent éventuellement être

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(2) Ces programmes ont été développés en collaboration par l'Ecole des Mines et le CNRS. Plusieurs articles employant cette méthode ont été publiés dans les Cahiers de l'ADEST, Numéro spécial consacré à la Scientométrie en France, CSI/Ecole des Mines, Paris, juin 1990.

la source des bruits ou des silences systématiquement reproduits au niveau de la collecte documentaire.

La création des listes d'autorité

Les banques de données bibliographiques comportent des nombreuses sources d'erreurs statistiques qui doivent être éliminées avant de pouvoir construire des indicateurs fiables. Un travail documentaire doit normalement être entrepris pour développer des listes d'autorité afin de normaliser le contenu des champs documentaires (noms de laboratoires, de journaux, etc...). Ce travail est de plus en plus un facteur de compétitivité pour les producteurs de banques de données. Avec la mise en service par les serveurs des commandes statistiques, tels que MEMTRI de Télésystèmes ou le ZOOM de l'ESA, on peut désormais envisager de faire de la bibliométrie en ligne. La part de ce nouveau marché qui reviendra à chaque producteur dépendra de la qualité de sa base, qualité qui passe par la constitution et le maintien des listes d'autorité.

L'analyse des contenus

Trois techniques de constitution des *fichiers thématiques* sont généralement employées. Il s'agit d'une interrogation à partir des codes de classement, des mots-clés (ou dans le cas du Science Citation Index, des citations) ou du texte intégral moyennant des outils de traitement du langage naturel disponibles sur les serveurs. Chaque technique a ses intérêts et ses inconvénients. La constitution des plans de classement et la réalisation d'une indexation documentaire (par mots-clés ou par citation) sont des pratiques subjectives. Il est très difficile de mesurer l'impact de cette subjectivité sur la qualité des fichiers thématiques. Le développement rapide des banques de documents primaires est peut-être une solution. Elles présentent non seulement l'intérêt d'une mise à disposition plus rapide des informations en vertu de la suppression du travail d'indexation qui rétarde la mise à jour des bases bibliographiques; mais elles suppriment également le recours aux lexiques préalablement établis qui ne se recoupent que partiellement avec le langage de la science en action. Cela dit, il faut bien reconnaître que les outils de traitement du langage naturel disponible auprès des serveurs sont assez rudimentaires. Ils se servent de techniques statistiques pour aider à structurer l'accès documentaire, alors qu'au niveau de la recherche, on considère que l'utilisation de descripteurs conceptuels et de règles d'exploitation sont nécessaires.

Les méthodes statistiques

Il convient de faire une distinction entre les méthodes quantitatives et les méthodes qualitatives d'analyse statistique. Les premières nécessitent une définition préalable du contenu d'un fichier thématique. Ce contenu doit en principe correspondre aux limites du champ de recherche à analyser. Les techniques exposées dans les sections 2.1., 2.2. et 2.3. ci-dessus ont pour objectif d'assurer cette correspondance et, donc, d'éliminer les sources de bruits et de silences qui sont susceptibles de compromettre la qualité des résultats statistiques obtenus.

Dans le domaine des analyses stratégiques et prospectives, il est souvent impossible de partir d'une définition préalable des recherches menées dans un champ donné. L'objectif dans ce cas est précisément de modifier les contenus de la recherche en introduisant des nouveaux sujets d'étude, en créant des liens entre secteurs qui s'ignoraient auparavant, ou encore en favorisant l'émergence de nouveaux thèmes. On ne peut pas dire a priori quelles sont les limites d'une activité de recherche, l'objectif de l'analyse étant justement de les fixer. C'est une problématique de ce type qu'implique le recours à des méthodes qualitatives d'analyse statistique Les statistiques de base nécessaires pour utiliser ces techniques sont le nombre de documents dans un fichier N, l'occurrence Ci de chaque objet i (les mots, les codes de classement, les citations,...) et la cooccurrence Cij d'un pair d'objets. Utilisant ces statistiques, tous les indices d'association entre deux objets peuvent être calculés. La qualité du résultat suppose que l'indice utilisé pour l'analyse soit localement stable et homogène. Du point de vue des analyses qualitatives, la stabilité locale d'un indice d'association joue le même rôle que la constitution d'un fichier de test représentatif dans le cadre des analyses quantitatives (Michelet, 1988).

L'infographie

La veille scientifique suppose la possibilité de développer des indicateurs bibliométriques qui sont synthétiques, faciles à comprendre et à suivre dans le temps. Le problème infographique a une double dimension. La première est technique et concerne l'agrégation. Quelle est la perte d'information qu'entraîne le processus d'agrégation conduisant à l'adoption d'indicateurs synthétiques? La seconde est graphique : comment peut-on tirer profit de l'évolution des nouvelles technologies de l'information pour visualiser la dynamique de l'évolution scientifique et technique à partir de l'exploitation des flux documentaires?

L'infométrie

L'information est un facteur d'aide à la prise de décision. Cette hypothèse de travail n'est généralement pas remise en doute lorsqu'il s'agit d'entreprendre un programme de veille scientifique et technique. Au contraire, il semble aller de soi que la qualité des décisions prises sera fonction de la qualité des informations servant à leur élaboration. Ceci est tellement vrai qu'à l'heure actuelle le marché pour les produits de veille scientifique et technique est caractérisé par une économie de l'offre. Des investissements importants sont envisagés pour réunir des compétences et créer des enseignements permettant de développer des dispositifs de veille scientifique et technique en France.

Cependant, on connaît les pièges d'une économie de l'offre. Les enquêtes les montrent en ce qui concerne l'industrie des bases de données, une industrie qui, elle aussi, est bâtie sur le principe qu'une offre d'information rencontra toujours une demande. Ces enquêtes convergent toutes sur le fait que les bases documentaires constituent la solution la moins employée lorsqu'il s'agit de trouver une source d'information permettant de faire avancer un projet scientifique ou technologique (Allen, 1985; Michel, 1990). On peut se demander si l'offre de produits bibliométriques dans le domaine de la veille scientifique et technique aura plus de succès. En tout cas, il est clair qu'il faut se méfier des évidences. La relation exacte entre information et prise de décision est complexe et nécessite qu'on s'efforce d'évaluer sa nature exacte. C'est l'objectif de l'infométrie : il s'agit d'essayer de déterminer les conditions d'une adéquation entre une offre et une demande d'un produit d'information.

III UNE APPROCHE SCIENTIFIQUE DES PROBLEMES DE LA VEILLE SCIENTIFIQUE ET TECHNIQUE

Les études bibliométriques donnent lieu à des comparaisons. Le problème technique posé est d'éviter qu'une variable non-contrôlée se trouve avoir des distributions systématiques dans les différents fichiers documentaires analysés pour fausser ces comparaisons. Par exemple, on sait qu'en utilisant des bases de données pour des comparaisons internationales, la langue de publication est un biais. Le nombre d'articles des pays qui ne publient pas la totalité de leurs résultats en anglais est sous-estimé par rapport à celui des pays anglophones. Mais, même en supposant qu'il soit possible de constituer des fichiers homogènes, quelles conclusions peut-on tirer d'une telle comparaison. En montrant, par exemple, que l'activité mesurée par le nombre de publications françaises est plus faible dans un secteur-clé que celle de ses principaux concurrents, qu'apprend-on? Faut-il encourager un investissement supplémentaire dans le secteur afin de remonter la pente?

Lorsque cette question est soumise aux experts, elle sert à alimenter un débat politique. Dans un tel contexte, l'intérêt de l'analyse quantitative ne découle pas de son objectivité supposée. Il réside dans la possibilité qu'elle laisse aux protagonistes de l'utiliser aussi bien pour défendre leurs propres prises de position que pour mettre en doute celles de leur adversaires (Palumbo, 1987). Ce n'est pas un facteur discriminant d'aide à la décision. Afin qu'elle le devienne, une meilleure compréhension du fonctionnement des différents systèmes de recherche comparés est nécessaire. Un nombre relativement faible de publications peut s'expliquer par des ressources insuffisantes au départ, ou par une mauvaise exploitation de celles qui sont disponibles ou, enfin, par un manque de fiabilité au niveau du choix des indicateurs et des dispositifs de collecte de l'information mis en oeuvre.

Les raisons de la non-pertinence d'une démarche bibliométrique sont donc nombreuses. Elles trouvent leur source dans la difficulté d'interpréter des résultats observés indépendamment d'une bonne compréhension de la façon dont un système transforme les ressources dont il dispose en "outputs". Il ne suffit pas de constater la co-variance des courbes mesurant la quantité d'entrées et de sorties des différents systèmes étudiés. Il faut essayer d'élucider les conditions qui déterminent la production de publications dans un contexte donné. Partant d'une compréhension de ces conditions, on peut prendre position sur la question-clé de la veille scientifique et technique : que faut-il savoir pour agir? Le problème de l'établissement d'une meilleure adéquation entre l'offre et la demande de produits d'information suppose la formulation d'une théorie sur l'utilité de ses produits pour la définition et la mise en oeuvre des stratégies cognitives et sociales (3).

CONCLUSION

La veille scientifique et technique est-elle une mode ou un axe de recherche légitime? Il est encore trop tôt pour répondre clairement à cette question. Cependant, un danger existe: celui de bâtir un programme de recherche sur un lieu commun. Ce danger est aggravé dans le contexte actuel par un double phénomène: l'existence de nouvelles technologies et de nouvelles méthodes de traitement de l'information d'une part, et un problème grandissant pour déterminer le positionnement institutionnel des services documentaires aux sein des entreprises d'autre part. Des raisons techniques et sociologiques existent pour investir dans les programmes de veille scientifique et technique. Cependant, la justification économique des tels investissements est ailleurs, se situant plutôt au niveau de l'amélioration des processus de prise de décision. Tant qu'on n'est pas en mesure d'évaluer l'efficacité de ces investissements, le risque est grand de voir tomber l'intérêt qui existe pour la bibliométrie à l'heure actuelle. C'est la raison pour laquelle il semble urgent d'essayer de bâtir une théorie des usages de l'information dans des processus de prise de décision.

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THE EVALUATION OF PLANT BIOMASS RESEARCH: A CASE STUDY OF THE PROBLEMS INHERENT IN BIBLIOMETRIC INDICATORS

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ABSTRACT

Following a critical review of the use of bibliometric indicators in peripheral countries, the results from a study of eight countries are presented. The aim of the project was to evaluate research groups working in the broad field of plant biomass in the areas outside the USA and the EC. The assessment had two key elements: the measurement of scientific productivity and the investigation of factors affecting research performance. Research groups were identified from a range of information sources. Data on funding, information access, staffing, publication policy and degree of awareness of other research groups in the field were collected during the course of interviews. Two approaches - bibliometric analysis and peer review - were examined as a means of constructing indicators for assessing research output. Neither of the two indicators employed proved to be a particularly successful method of evaluating research, and this finding is discussed in relation to publication patterns, the nature of the research community and the research field under study. Finally, the use of a 'peripatetic expert' was found to have some value as a means of assessment.

RESUME

Après une analyse critique des usages des indicateurs bibliométriques dans les pays de la périphérie, les résultats d'une étude effectuée dans huit pays périphériques sont présentés. L'objectif du projet dont sont issus les présents résultats était d'étudier les groupes de recherche qui travaillent sur la production énergétique à partir de la biomasse, hors des pays de la Communauté Européenne et des Etats Unis. L'évaluation contenait deux aspects: mesurer la productivité scientifique et rechercher les facteurs qui affectent les performances scientifiques. Les groupes de recherche furent identifiés à partir d'un ensemble de sources d'information. Les données sur le financement, l'accès à l'information, les ressources en personnel, les politiques de publication et le degré de connaissance des autres groupes de recherche dans ce domaine furent rassemblées par des interviews. Deux approches -bibliométrie et revue par les pairs- ont été employées pour construire les indicateurs d'évaluation. Aucune des deux méthodes n'a vraiment donné de résultats satisfaisants afin d'évaluer la recherche et ce résultat est discuté en fonction des stratégies de publication, de la nature de la communuaté scientifique et du domaine

particulier. Enfin, l'utilisation d'un "expert itinérant" s'est révélé d'une valeur certaine en tant que moyen d'évaluation.

1. INTRODUCTION

Evaluation of science is controversial as its products are varied and difficult to define. As well as producing new knowledge, scientific laboratories may generate new scientific questions, create new technical devices and train students. The absence of an absolute scale against which such products can be measured means that any assessments can only be based upon comparisons with other groups.[1] Because scientific outputs are not easily measured on compatible scales, several authors have stressed that evaluations should compare laboratories working in the same field and producing the same type of scientific outputs.[2,3,4] The measurement of knowledge requires a proxy measure of output and impact, and bibliometric data (derived from publication and citation counts) have been used in several evaluation studies. The idea that bibliometric data provide reasonable surrogate measures for scientific products has been confirmed by the comparative use of literature-based and non-literature-based indicators such as peer review.[5] The technique of converging partial indicators was developed through evaluating large, capital-intensive basic research facilities in the West, such as the Cambridge and Jodrell Bank radio astronomy centres.[6,7,8]

Bibliometric indicators have gained wide acceptance in the field of research evaluation and are used by many OECD countries as one of the inputs in the formulation of science policy. However, a major objection to the universal acceptance of citation analysis as a valid means of evaluating science arises from the fact that the only available source of citations, the Science Citation Index (SCI), covers only a fraction of the total number of journals published.[9] Moravcsik estimated that scientists in developing countries produce around five per cent of the world's scientific literature and suggested that perhaps half of the scientific output of the Third World which meets the international standards of excellence is included in the SCI.[10,11] The SCI coverage of Asian, Latin American and African journals is particularly weak.[12,13] Moreover, the applicability of bibliometric indicators to the context of science conducted within developing and newly-industrialized countries has been questioned. Cano and Burke, amongst others, have called for a distinction to be made between scientometric techniques designed to measure the development of an infrastructure suitable for encouraging the growth of science and technology on the one hand, and techniques devised to optimise resource allocations for a well-established science base on the other.[14] Others have stressed the need for caution in using SCI data in the context of developing countries (DC) and newly-industrialized countries (NIC) given the very different problems that they face.[15,16,17] It must be emphasized that science indicators, based on bibliometric analysis, were developed by science policy researchers primarily for the purpose of measuring scientific outputs in a climate of approximately "steady-state" funding against the background of a well-established science base.

There have been very few attempts to undertake detailed investigations of a scientific field in a developing country using citation data from sources other than the SCI. In her study of Brazilian agricultural science, Velho concludes that factors which account for the negligible proportion of citations to literature from peripheral countries by both Brazilian and DC agricultural scientists are social rather than cognitive.[18] Data from her study and another by Castro[19] demonstrate that the percentage of Brazilian papers on agricultural science published in foreign journals is less that 15%. In contrast, Spagnolo has demonstrated that academic Brazilian scientists in chemistry and electrical engineering do tend to publish quite frequently in journals covered by the SCI although their rate of citation is rather poor.[20] Velho has argued that the coverage of developing countries by ISI needs to be corrected by a factor of four or more rather than the generally accepted factor of two favoured by Moravcsik and others.[21,22] Using a different approach, Yuthavong employed two indicators based on a national publication and an abstract series in an attempt to quantify the productivity of Thai scientific institutions. While one of the indicators yielded reasonable correlations with SCI-covered articles, they gave no indication of research impact and utilization.[23] A combination of SCI and non-SCI publication data was used by Garg and Rao to estimate productivity in an Indian physics laboratory.[24] The value of this methodology would have been enhanced by comparison with other laboratories and citations analysis. However, the difficulties of compiling citations using manual techniques has been emphasized by Lancaster et al. in their survey of over 1300 scientific papers from Cuban scientists.[25] Studies by Rabkin and Inhaber, Rabkin et al., and Arunachalam and co-workers have made use of the SCI to underline the under-representation of science in peripheral countries.[26,27] For example, even in small NICs such as Singapore where most scientific papers were published in western English-language journals, the science citation record was poor.[28] However, practical solutions to address the limitations of bibliometric techniques in LDCs have yet to be established.

The research project reported here, commissioned by Shell Research Ltd UK, had two specific aims: to identify research activities in the field of plant biomass production for liquid fuel conversion in areas outside of the United States (USA) and the European Community (EC); and secondly, to evaluate the research performance of selected groups. The rationale for excluding the USA and the EC concerns the way in which scientific information is disseminated in different parts of the world. In general, scientific publications from the West, namely North America and Western Europe, are well-represented in published abstracts and on-line databases. This is in contrast to the situation for NICs and DCs. The project aimed therefore to explore methods of gaining access to the output of non-Western research groups. Once relevant research activities had been identified, the information was synthesized to provide a comprehensive overview of research activity in the field. As regards the second aim, the project attempted to explore the use of partial indicators in a heterogenous research field which extends across developed, developing and newly industrialized countries. Given the limitations of these techniques, this component of the project was inevitably exploratory, but could nevertheless be expected to yield valuable information about the structure and organization of the field in a diverse group of countries.

The focus of this work was on plant biomass production rather than conversion, and all types of plant material were considered although the coverage of woody biomass was restricted in view of the extensive research on fuelwoods. Apart from methanol, research on most classes of biomass-derived liquid fuels was included. The group of countries selected for detailed study included Australia, New Zealand, Japan, Thailand, India, Brazil, Argentina, Costa Rica and Jamaica. African countries were excluded because, with the exception of South Africa, very little relevant research appeared to be in progress or to have been recently completed. Moreover, the response to the initial enquiries was generally poor.

2. METHODOLOGY

2.1. Information sources

Five methods were used to locate relevant information concerning research on plant biomass production: searching of computerized databases; use of national and international networks (i.e. national and international societies and associations); consultation of energy and biomass directories; manual searching of the literature; and personal contacts. Generally, bibliometric databases were found to be heavily dominated by American and European research literature. Papers from DCs and NICs, in contrast, were consistently under-represented and led to very few contacts being made. The other four methods, particularly the use of directories, proved to be more effective in terms of establishing contact with research institutes and government departments involved with plant biomass R&D.

After initial contact has been made, researchers were interviewed using a structured questionnaire which sought information on the following areas: academic and employment experience; project objectives; project funding; information access; publication policy; and awareness of international research groups. The aim of the interviews was to collect information to evaluate individual projects and to assess research group performance. Interviewees were also requested to undertake a peer review exercise, ranking the performance of selected biomass groups around the world.

A total of 84 projects were surveyed and their main features are summarized in Table 1. The questionnaire data were transformed into 104 variables and computerized using SPSS PC (Statistical Package for the Social Sciences, SPSS

Inc., Chicago, USA) software. Currency figures were converted into 1985 constant USA dollars using GDP deflators provided by the International Monetary Fund (IMF).29 Data on the 'total funding' were divided into three categories to facilitate presentation (US$ 0-30,000; 30,001-200,000 and over 200,000).

2.2. Choice of indicators

Two types of output indicators were explored in this study: bibliometric indicators and peer review. Each of these is described in turn below.

2.2.1. Bibliometric indicators

In many scientific areas, scientists around the world not only share the same research interests and theoretical perspectives but they also tend to publish their work in the same journals and to meet regularly at conferences. Examples include scientists working in the specialities of plant cytogenetics, plant molecular biology and agroforestry. The scientific community in such cases can be termed 'homogeneous'. However, the research area of plant biomass production, in the context of renewable energy, does not conform to this description. There are several reasons why the research community is more aptly described as 'heterogeneous'. The first and perhaps the most important concerns the nature of the plant material itself. Researchers working on woody biomass are mainly from forestry institutes and tend to be relatively isolated from those engaged on non-woody biomass research. The scientific community is also split according to the different forms of product from biomass material. For example, those focusing on alcohol production generally have little interaction with researchers investigating potential diesel substitutes such as latex and oils. In view of the heterogeneous nature of the research field, it was not possible to precisely match the projects in terms of size, funding or staff numbers. Nevertheless, a broad comparison could be expected to yield some useful data.

Because of the highly fragmented nature of the biomass research community, publication patterns at the start of the project were largely unknown. Bibliometric indicators, which have been frequently used in developed countries, generally cover only articles in learned journals and certain books, largely omitting technical reports and popular articles which have more importance in DC's and NIC's.30 Detailed publication data were gathered in this study in order to maximize the options available for statistical analysis. Researchers were asked to classify all the publications arising from the project under discussion into six categories - journal articles, conference papers, technical reports, book chapters, newsletters and popular articles. They were also questioned about the language used in publications.

2.2.2 Peer review

The peer-review component of the investigation involved asking researchers to rank eight centres undertaking research on plant biomass production. The list included several internationally acknowledged centres such as the Forest Research Institute in New Zealand as well as various lesser-known institutes like Kasetsart University in Thailand. Scientists were invited to assess the quality of the research on a scale between one and four and to comment on the utility of the work to industry. This peer-review exercise proved to be unsuccessful as interviewees generally felt they were insufficiently familiar with the research centres to evaluate them. A second approach was therefore explored in two countries, India and Brazil, where scientists were instead asked to assess a list of research institutes situated in their own country.

In addition, the "overseas awareness" of researchers - that is, their awareness of overseas groups working in the biomass area - was investigated by providing them with a list of 18 institutes together with associated plant biomass projects. Individuals were requested to indicate their familiarity with the work on a three-point scale. The number of projects identified was then multiplied by the appropriate scale point and added to give a total familiarity score.

3. Results

3.1. Bibliometric indicators

The total number of publications (excluding newsletters and popular articles) produced from the 84 projects under study was 402 (Table 2). Of these, 47% consisted of papers published in scientific journals, with less than half (18%) being published in the 3500 journals scanned by ISI. This low total, representing an average of 0.86 ISI journal articles per project, precluded the use of citations to provide an indicator of scientific impact. A total of 72 journals, covering a wide range of fields, were used for publication, 30 of these (i.e. 42%) being ISI-recognized journals and the remainder (58%) consisting of non-ISI journals. Publication data were missing for 17% of the projects investigated.

The distribution of papers published in ISI-journals revealed considerable variation across countries. For example, no papers of this type were published in Argentina, Japan and Thailand. In contrast, the greatest concentration of papers in ISI-recognized journals occurred in Australia, New Zealand and India, with mean values of 2.3, 1.2 and 1.2 papers per project respectively. A mean of only 0.4 papers in ISI-journals per project was recorded for Brazil.

When these results are compared with the numbers of papers published in non-ISI journals, a different publication pattern emerges which varies markedly across countries. For example, Australia, New Zealand and India, which recorded the highest mean value for numbers of papers published in ISI-recognized journals, exhibited rather different trends for non-ISI journals. In

Australia, the ratio of papers from non-ISI to ISI-recognized journals is 0.4, while in New Zealand and India the ratios are 0.9 and 1.6 respectively. Brazil, Costa Rica and Japan, which published very few papers in ISI-recognized journals, recorded much higher ratios of 4, 9 and 10 respectively.

Although the underlying reasons for these diverse distribution patterns of papers in scientific journals are complex, some general correlations are evident. The preferred language of publication appears to be one factor affecting the frequency of publication in ISI-recognized journals. For example, the majority of Japanese, Argentinian and Brazilian researchers expressed a preference for writing in their native language which considerably reduces the likelihood of publication in ISI-recognized journals. The fact that the English language-speaking countries - New Zealand, Australia and India - published most frequently in ISI-recognized journals, provides further evidence of the apparent effect of language on publication patterns. In the case of Thailand, the situation is less clear. While the preference for using the native language undoubtedly accounts to some extent for the lack of papers appearing in ISI-journals, the low production of papers in non-ISI-journals suggests that other factors may also be involved there.

When ISI and non-ISI papers are compared across countries, three groupings are evident: countries which averaged (i) less than one paper per project (Japan and Thailand); (ii) between two and four (Australia, New Zealand, India and Brazil); and (iii) more than six (Costa Rica) (Table 3). The low output of papers from Japan and Thailand appears to be related to the way in which applied research is undertaken in these countries. For example, in the case of Japan, results of research commissioned by the government-funded Special Project Research on Energy (SPRE) programme were written up in a final report published by the Ministry of Science, Education and Culture. Several researchers indicated that this report was, in their view, the most important vehicle for the dissemination of their results and relatively little significance was attached to circulation of their work amongst the international scientific community. This viewpoint was defended in terms of the specific nature of the work - i.e. the determination of the suitability of agronomic conditions in Japan for potential energy crops, a subject perceived to be of little interest to researchers outside Japan.

Scientists in Thailand expressed similar views, emphasizing that the implementation of research findings and their exploitation for the benefit of national interests were more important than their circulation to other groups either within or outside the country. Researchers in this field were strongly motivated by the potential of their work to enhance living conditions in Thailand, and targeted their efforts far more on achieving certain practical goals rather than preparing research publications.

Projects based in Australia, New Zealand, India and Brazil were much more productive in terms of the output of scientific papers. In each country, the average number of papers per project was broadly similar, even though the type of journal in which they appeared differed appreciably. This suggests that the research community within each country attaches similar importance to the publication of research results in scientific journals. With regard to the low rate of publication in ISI-recognized journals in Brazil, the majority of researchers emphasized the importance of disseminating their findings to the national community rather than a broader international audience. As with Thai and Japanese researchers, this was largely because of the applied nature of the work.

The relatively high output of papers from projects at CATIE in Costa Rica illustrates the influence that one institution can have on publication rates.31 CATIE plays a pivotal role in agronomic and forestry research in Central America and its projects tend to be large and comparatively well-funded. Moreover, several of the research personnel either have extensive overseas experience or are from developed countries. Insufficient data were available from Argentina at the time of writing to comment in any detail. In addition, as only a single, recently initiated project was considered in Jamaica, this country has also been excluded from the bibliometric analysis. A total of 171 papers were published in conference proceedings - not dissimilar to the overall number of scientific journal articles (192). Moreover, the pattern of publication closely mirrors that described above for journal articles. Countries fall into the same broad groupings with Japan and Thailand producing less than 1.5 papers per project, the middle group 1.8-3.3 and Costa Rica 4 (Table 4). These results underline the importance of conference proceedings as a means of disseminating scientific information in the biomass field. This is particularly evident in countries such as Thailand where over twice as many conference papers were produced as scientific papers. However, it should be emphasized that the character of such papers varies very widely. For example, papers published in the Proceedings of the Tropical Society of Japan are confined to a brief abstract only.

The output of technical reports and book chapters was highest in New Zealand and Costa Rica with average values of 1.5 and 2 per project respectively. These were mainly produced by two large government-funded research institutes, the Forest Research Institute of New Zealand and CATIE of Costa Rica. Elsewhere, output in this category was relatively low, with mean values of less than one per project. These results raise the question of whether "success" in terms of the output of publications is associated with specific factors such as those relating to the resources available and the environment in which the projects were undertaken. The next task, therefore, was to investigate the relationship between the number of publications produced and possible factors affecting research performance. In view of the low overall output of scientific papers, publication data for all nine countries were merged. Projects were divided into two categories - those with or without publications (combining the four publication categories mentioned above). Those projects which had been in progress for a year or less were excluded on the grounds that most of them had not had sufficient time to produce a publication.

Out of a total of 68 cases for which information was available, 31% had not produced a single publication of any form, New Zealand being the only country in which every project had yielded at least one publication. Statistical analysis and interpretation was approached cautiously in this study because of the heterogeneous nature of the research groups investigated. Association between propensity to publish and 19 selected variables was tested using Chi-square analysis. Significant associations were found for only three variables - 'overseas experience'($p<0.01$), 'attendance at conferences'($p<0.001$) and 'total funding'($p<0.001$).

To take the first of these variables, of those researchers who had acquired overseas experience during their current post, 84% produced a publication compared to 52% of researchers without overseas experience. While one explanation of these results is that overseas research experience is likely to stimulate the publication of research results, another is that they may merely reflect the greater opportunities for more productive researchers to acquire overseas experience. However, evidence that the former interpretation holds at least to some extent comes from the fact that, for most researchers, the overseas experience was gained before commencement of the project under study.

With regard to the second significant association involving the variable 'attendance at conferences', of those cases where researchers regularly attended such meetings, 86% had produced a publication in comparison to 34% of those who did not attend regularly. Clearly, scientists who frequently attend conferences are more likely to be well informed of developments in their field and this may again stimulate the publication of research work.

The third and final significant association involved the variable 'total funding'. (This category of finance reflected the total funds provided specifically for the project, but excluded salaries of the permanent staff normally provided by the institution.) The three categories of total funding employed here produced rather different publication outputs: for example, in the lowest category of funding, 40% of projects produced a publication compared to 88% in the highest category. This may indicate that the most productive researchers in terms of published output are more successful in attracting large research grants.

There was no association between propensity to publish and the following variables: type of institution; category of post held by the interviewees; duration of project; source of funding; number of researchers involved in the project; number of technicians; collaboration with industry; collaboration with other institutes; collaboration with overseas organizations; use of networks; perceived lack of equipment/spare parts and servicing/funding/expertise/research information; knowledge of similar work elsewhere. This overall result is somewhat surprising as it might be expected that at least some of these variables - for example the numbers of researchers and technicians, and a perceived lack of expertise or research information - would have a significant impact on the propensity to publish. The lack of association may be genuine, indicating that these factors are not relevant to research performance in the biomass area.

Alternatively, it may merely be a reflection of limitations with the methodology or of an inadequate sample size for identifying statistical associations. It is not possible, therefore, to draw any firm conclusions at this stage. As the data on research outputs were generally fragmentary and sparse, they could not be disaggregated by country to permit further analysis of the research output indicators. Nevertheless, the distribution of values for the different variables shows some interesting patterns which vary across countries (the results of this analysis will be published elsewhere).

3.2 Peer Review

As mentioned earlier, the peer-review exercise was unsuccessful with less than 1% of interviewees able to provide any useful comments. Researchers were generally insufficiently familiar with the named institutes to comment on the quality of the research. The lack of familiarity was surprising in some instances, implying the existence of a strong regional effect - i.e. that the plant biomass research area consists of several separate, regionally based, non-interacting research communities. For example, CATIE, an internationally recognized centre for tropical agronomy in North and Latin America, was unknown to all but two researchers in Australasia, India and Thailand. Results from the peer-review exercise involving Indian and Brazilian institutes were again too sparse to permit any statistical analysis, which suggests that even national communities may be regionally fragmented.

The variable relating to 'overseas awareness' was investigated as a potential indicator of research standing. The results were analyzed to establish whether there was any association between the three categories of familiarity and the same variables investigated with the other research performance indicator, propensity to publish. Of all the variables tested, only one yielded an association. The variable 'collaboration with industry' was significantly associated ($p<0.01$) with those researchers who were very familiar with one or more of the research projects from the overseas awareness list. One possible interpretation of this finding is that researchers are more likely to collaborate with industry if they are already very familiar with other research work in the field. Nevertheless, the general lack of association with other variables relating to the resources and environment in which the research is carried out suggests that awareness of overseas research is not a particularly useful measure for assessing research performance. Moreover, overseas awareness is not correlated with more conventional measures of research output such as bibliometric indicators.

3.3 The 'expert review'

The use of a peripatetic expert - i.e. a specialist in the field visiting many of the institutions involved - to evaluate research groups had several advantages over the two other methods and proved to be a reasonably successful method of assessment in this case. Undertaking this research project involved reading well in excess of a hundred scientific papers and research reports, visiting 50 research institutes and inspecting their facilities and interviewing over 100 researchers. It was thus possible to discuss in a systematic manner the performance of research groups, with the views of individual researchers being cross-checked against those put forward elsewhere. This approach proved quite effective and resulted in the production of a list of research groups which were rated most highly. The major problem with this method, however, is that it is difficult to defend the results in an objective manner.

CONCLUSIONS

Previous work has shown that conventional methods of research evaluation generally require the adoption of some proxy measure of quality. In several cases, bibliometric indicators combined with peer review have proved successful especially when used to evaluate carefully matched scientific groups in certain scientific specialities. In this study, the research community proved to be particularly heterogeneous, not only because of the wide range of countries involved but also because of the multidisciplinary nature of the work. Within the scope of plant biomass research surveyed here were specialities from several subfields such as agriculture, botany and forestry with research being pursued on a wide range of biological material. Of the three methods of research assessment employed, two - bibliometric indicators and peer review - did not prove to be particularly useful in this instance. There are four possible explanations for this result:

1.The total number of scientific papers produced in the research area under study was relatively low. Insufficient data prevented the effective use of publication counts as an indicator of scientific output and in addition precluded using the Science Citation Index to give some indication of the impact of scientific papers.

2.The findings arising from the limited amount of bibliometric analysis which was possible suggest that language has a considerable influence on the publication patterns. Several of the researchers published their work in languages other than English - a small proportion of papers being in Portuguese, Spanish, Japanese or Thai. Scientists from non-English-speaking countries are less inclined to publish in ISI-recognized journals than those for whom English is the first language. That this factor had adverse effects has been demonstrated by Velho in her discussion of citation patterns of Brazilian agricultural scientists.32 Drawing on American surveys of proficiency in foreign languages, Velho concludes that Brazilian agricultural literature is not cited by scientists in advanced countries as it cannot be understood by the vast majority and because they have virtually no access to Brazilian publications.

3.Another factor which contributed to the low number of scientific journal articles was the preference of many scientists, especially those from DC's and NIC's, to publish papers in conference proceedings. The reason for this is not clear but it may be related to the fact that it is generally easier and quicker to publish in this fashion as such papers are largely unrefereed. Comments by a number of scientists interviewed in India lends support to this suggestion. The relatively large number of conference papers produced by researchers underlines the importance of this type of publication as a means of disseminating scientific information, particularly in countries such as Japan and Thailand where the output of other types of publication is low.

4.Plant biomass research for energy is an applied research speciality. Consequently, there is less emphasis on outputs in the form of published scientific papers than in fields of more basic research, which in turn gives rise to reduced coverage in bibliometric databases. Certainly, several scientists, particularly those from Japan, Thailand and Brazil, felt that their work was of local relevance only. This aspect is magnified by other factors in some cases. For example, in Thailand, several researchers indicated that the implementation of research findings for the benefit of national interests had higher priority than the publication of scientific papers. This view was bourne out by the bibliometric data with Thai scientists averaging less than one paper per project. In New Zealand, pressure to obtain contracts from industry has apparently contributed to the relatively low rates of publication for some individuals in this research area.33

The correlation between propensity to publish and overseas experience suggests that the latter may stimulate publication output. Other work tends to support this conclusion. For example, the referencing pattern of Brazilian agricultural Ph.D scientists has been shown to be influenced by their educational history, and as Large notes in his study of foreign language barriers in science, "scientists will tend to use information produced by people and institutions known to them".34,35 The association between publication output and attendance at conferences suggests that the scientists who regularly attend these meetings are more likely to be well informed of developments in their field, and this may stimulate the publication of research work. Clearly, these researchers may have a tendency to publish their work in conference proceedings rather than journals. The association between publication output and total funding may indicate that the most productive researchers in terms of published output are more successful in attracting larger grants. However, other factors may be important here. For example, the better endowed and more prestigious institutions such as TERI36 in India tend to attract high quality scientists who in turn often play a key role in the procurement of large overseas research grants.

The failure of the peer-review component of the study reflects the fact that the plant biomass field under study consists of a regionally fragmented research community made up of largely non-interacting groups. Even within a single country such as India, research groups do not appear to form a cohesive community. One of the principal causes of this heterogeneity lies with the multidisciplinary nature of the field. This is particularly evident in the division of scientists into 'forestry' and 'non-forestry' groupings. However, competition between research centres in the case of India was an issue raised during interviews which clearly plays a role in shaping the formal communication system of the research area. Velho noted a similar effect in Brazilian agricultural science which she termed the 'priority of discovery' where scientists from different institutions tend not to draw upon the work of their colleagues.37 Another important factor is the nature of the research. Agronomy appears to be a relatively slow-moving subfield where innovations are less frequent in comparison to fast-evolving fields such as molecular genetics. International exchanges of information by conferences and publications are, therefore, rather low key and attract relatively little interest or publicity.

Although the majority of factors identified as potentially affecting research performance were not significantly correlated with the outputs, this may have been the result of an inappropriate methodology or inadequate sample size. The research community in Japan appeared to be working in relative isolation, with most of the university departments characterized by under-funding, poor technical support and a weak scientific infrastructure. These findings confirm the conclusions drawn from certain other studies of science in Japanese universities. However, according to the recent bibliometric analysis of Braun, the subfield of agriculture in Japan shows high activity (i.e. an above-average share of the world publication total) and high attractivity (i.e. an above-average citation share). Japan also has the second highest world share of publications in agriculture between 1981-85 - the Japanese figure of 16.8% compares with 6.7% for Australia, 3% for India, and 0.38% for Brazil over the same period.38

Although the researchers in Brazil also appeared to be relatively isolated at the international level, many delegations from overseas have visited Brazilian research centres to study the Proalcohol programme. While the Thai research community produced very few publications, their awareness of overseas groups was exceptionally high and this may be related to two factors - the high frequency of postgraduate qualifications obtained in the US and, secondly, the close scientific links between Thailand and Australia. Researchers from India have the advantage of familiarity with the English language and this may have contributed to their closer integration with the international research community. In New Zealand, international integration has been achieved partly through the overseas training of research students and partly through the recruitment of foreign staff.

Finally, it should be noted that the use of a peripatetic expert to evaluate research groups had several advantages over the other two methods and proved to be a reasonably successful method of assessment. In particular, it was possible to distinguish between groups undertaking relatively mundane research and those engaged in more innovative work, and to obtain considerable insight into the quality of the research. However, it must be emphasized that such assessments are hard to justify objectively.

The implications of the findings from this research evaluation study are clear: namely, that the use of the scientific literature and bibliometric databases as a means of keeping ahead of developments in certain research fields is inadequate. This point is of particular relevance to research undertaken in non-English-speaking, developing, and newly-industrialized countries. While database coverage of publications from these areas is likely to improve, alternative methods of gaining information such as the monitoring of key conference proceedings, the maintenance of ongoing personal contacts with leading institutions in selected countries and the use of peripatetic experts, may need to be employed.

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EVALUATION D'UN FONDS DE FINANCEMENT DE LA RECHERCHE: STRATEGIES SCIENTIFIQUES ET PROCESSUS PRODUCTIFS, DANS LES COMMUNAUTES SCIENTIFIQUES DE LA PERIPHERIE

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RESUME

L'évaluation d'un fonds de financement peut constituer un angle d'attaque intéressant pour repérer les phénomènes de structuration du milieu scientifique, les stratégies qui s'y exercent, les processus productifs qui aboutissent. Une enquête questionnaire a été conduite (ex-post) sur 457 opérations de recherche, soutenues au cours de 8 années dans 5 domaines scientifiques par la CORDET (fonds public de financement de la recherche à l'intention des départements et territoires d'outre-mer). L'analyse de leurs caractéristiques en composantes principales fait apparaître 2 premiers facteurs de différenciation: la socialisation scientifique des chercheurs engagés, et la stratégie propre des managers du fonds de financement. Suivant que ces deux facteurs agissent ou non en synergie, les résultats diffèrent (en terme de découverte et de leur application). L'importance de maillage de communautés scientifiques et les conditions de ce maillage ainsi que différents styles de science et types de professionnalisation sont également mis en évidence à travers les résultats. Au delà d'indicateurs de moyens et de produits, il s'avère donc possible, dans le cadre d'enquêtes et par des méthodes renouvelées, de faire contribuer la scientométrie, à la connaissance des processus productifs, et à l'anticipation de stratégies créatrices.

ABSTRACT

An evaluation of a research fund can serve as an interesting starting point to understanding how scientific circles are structured, what their strategies are, and the most valid productive processes. CORDET (public funds for financing research operations in French overseas territories and departments) circulated a questionnaire to survey 457 research projects carried out in 8 years in 5 scientific fields. Analysing the projects via their main components indicated two main factors of differentiation: the scientific socialisation of the researchers and the particular strategy of the fund's managers. Differences in results (discoveries and applications) could be traced back to the presence or absence of synergy between these two factors. Results also provide indications on the importance of the interlinkage of scientific communities as well as on different styles of science and types of professionalisation. Going beyond the indicators of means and

products, it is possible, through surveys and renewed methods, to use scientometrics to enhance understanding of productive processes and preempt on creative strategies.

INTRODUCTION

A la demande du Ministère Français de la Recherche et de la Technologie (MRT), notre équipe (STD/ORSTOM) a participé[1] à l'évaluation d'un fonds public de financement de la recherche: la CORDET[2] (Commission de Coordination de la Recherche dans les Départements et Territoires Français d'Outre-Mer[3]). Cette évaluation qui s'est déroulée de septembre 1988 à juin 1989 s'est révélée riche d'enseignements sur les particularités de l'interface science, politique (de science) et management scientifique. Parmi la batterie d'instruments mis en oeuvre, figure un questionnaire adressé aux responsables scientifiques des opérations subventionnées en 8 années par la CORDET. Nous présentons ici l'analyse de correspondances appliquée aux réponses reçues.

1. UN FONDS DE FINANCEMENT: LA CORDET

La CORDET est un petit fonds public français de financement, destiné à promouvoir des Recherches dans une grande variété de domaines (Sciences de la Terre, Océanographie, Santé, Agronomie et Sciences Sociales), avec une spécificité géographique affirmée (Les Départements et Territoires Français d'Outre-Mer). Disposant en moyenne de 7000 KF[4] annuels, le fonds aura distribué au cours de 8 années (1981-1988), 457 subventions d'un montant moyen de 120KF[5]. Une des originalités du fonds réside dans l'interface voulu avec les affaires scientifiques, non seulement d'acteurs politiques classiques, mais également d'acteurs et d'intérêts locaux, économiques ou sociaux, plus prégnants que dans le cadre d'autres fonds incitatifs.

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[1] Sous la présidence du Professeur Francis WALLART, Délégué Régional à la Recherche et à la Technologie de la région Nord-Pas de Calais, le rôle de rapporteur étant assumé par Jacques Gaillard.

[2] Pour plus de détails sur la CORDET voir: Evaluation d'une procédure publique de financement de la recherche: la Commission de Coordination de la Recherche dans les DOM-TOM (CORDET), Documentation Française, Paris, 245 pages, 1991.

[3] Guadeloupe, Martinique, Réunion, Saint-Pierre-et-Miquelon et Mayotte pour les Départements d'Outre-Mer (DOM); Wallis-et-Futuna, la Polynésie française, la Nouvelle-Calédonie, les Terres australes et antartiques pour les Territoires d'Outre-Mer (TOM).

[4] 1KF = environ 200 US$ en février 1991.

[5] Ce montant moyen varie en fonction des disciplines (entre plus de 150KF par subvention dans les domaines de l'agronomie et des sciences de la terre à environ 70KF dans le domaine des sciences sociales).

L'étude des archives[6] montre que la CORDET, comme tout fonds public de Recherche, est un compromis d'action entre partenaires d'intérêts divergents. Dans le cas présent, et à l'origine, aux lobbies scientifiques ne s'associent guère d'intérêts locaux et peu d'autorités sur place, mais trois Ministères: Enseignement Supérieur, DOM-TOM et Recherche. Ce dernier devient principal bailleur et abrite le Secrétariat Exécutif du fonds de 1981 à 1986. Suite à un retournement politique, il cèdera la place au Secrétariat aux DOM-TOM (SEDETOM) et finira même par se retirer.

L'objectif de départ est nécessairement syncrétique. Il est alors crucial de désigner des stratèges capables d'interpréter les finalités[7], de définir des priorités et de maintenir des continuités (de choix de sujet, de produits attendus...) dans la tourmente des retournements d'alliance, ou des rebuffades de partenaires floués, que ces choix ne manquent pas de produire et que des changements politiques nationaux transformeront. Dans ce rôle décisif d'imagination d'une politique scientifique, de formulation et de sélection de bons projets de recherche, il est difficile que les scientifiques soient absents. Mais, de même que dit-on "la guerre est chose trop sérieuse pour être laissée aux militaires", les bailleurs de fonds (ici des politiques) se défient de leur présence à cette place stratégique. La CORDET illustre les figures extrêmes imaginables. Dans un premier temps (1980-1985), la maîtrise du fonds est déléguée à des groupes de savants. Dans chacun des domaines couverts ils définissent une stratégie (ou plutôt des stratégies autant que de domaines scientifiques[8]) qu'ils prennent intérêt à promouvoir. Dans un deuxième temps (à partir de 1986), le procès d'intention est fait à ces "managers" de négliger l'utilité pratique et les intérêts locaux, au profit de seules valeurs scientifiques. Les commissions savantes sont écartées et des fonctionnaires en

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[6]Cf. R. WAAST, Histoire de la CORDET in Evaluation d'une procédure publique de financement de la recherche: la Commission de Coordination de la Recherche dans les DOM-TOM (CORDET), Documentation Française, Paris, 245 pages, 1991, pp. 37-44.

[7]Le cas présent est extrême: lors des immanquables polémiques entre partenaires du Fonds, à propos de la politique scientifique et de son management (ici de façon critique en 1983, 1986 et 1988 notamment), chacun se refère aux objectifs fondateurs et en appelle de leur respect ou de leur trahison. Or nous n'avons pu retrouver de texte officiel instituant la CORDET. Chacun (en bonne foi) a donc imaginé que ses préoccupations majeures étaient explicites dans l'acte fondateur (symboliquement sacré pour tous), et tenté de convaincre (comme il en était lui-même persuadé) qu'elles y étaient priorisées.

[8]En Sciences de la Terre, il s'agit d'utiliser les DOM-TOM comme bases pour des recherches de pointe en vue d'acquérir notoriété et réputation; priorité sera donc donnée à des programmes de recherche fondamentale et à l'acquisition d'équipements de base logistiques qui serviront à des campagnes internationales réputées d'observation du globe. En Agronomie c'est l'inverse: on privilégiera des recherches appliquées suceptibles de développements économiques locaux . En Santé et en Océanographie on aura une combinaison des deux approches précédentes. En Sciences Sociales la stratégie est encore différente: la préoccupation est de susciter puis de structurer une offre locale de science.

charge sont mis aux commandes[9]. Un nouveau retournement (en 1988) conduit au procès inverse: le soupçon pèse du mauvais aloi d'une science produite sans caution scientifique, donc sans principes de choix cognitifs. Cet épisode détermine la décision d'évaluation dont le présent travail est issu.

2. STRATEGIES LATERALES ET PROBLEMES DE MANAGEMENT

Il faut enfin noter que les paramètres d'action du fonds pour orienter les chercheurs et les résultats sont essentiellement latéraux, comme sont latérales les stratégies des chercheurs vis à vis du fonds. Il ne suffit pas d'offrir de l'argent pour disposer des scientifiques que l'on veut mobiliser; il faut encore réussir à les séduire sur leur propre terrain.

C'est d'autant plus vrai pour un petit fonds incitatif comme la CORDET: les chercheurs visés peuvent se désintéresser des appels d'offre parce qu'ils préfèrent émarger à d'autres fonds ou s'en tenir aux budgets fournis par leurs organismes d'appartenance[10]. La CORDET, relativement peu dotée, illustre richement la variété de ces latéralités, dont il faut donner quelques exemples.

Bien que le fonds ait toujours recruté ses équipes par appels d'offre, largement publiés dans les milieux concernés, 79% des responsables subventionnés[11] disent avoir été alertés par des collègues, par leurs directeurs institutionnels ou par les scientifiques chargés de l'administration du fonds, bref par un réseau scientifique. 80% des chercheurs participants aux projets ont été mobilisés par le responsable suivant de même canaux (collègues, anciens collègues partageant souvent de mêmes intérêts "exotiques", étudiants recommandés par un ami Professeur). L'interconnaissance est donc essentielle.

Parmi les motifs évoqués de dépôt d'un projet figurent:

-pour 39% le souci de "desserer des contraintes institutionnelles" ou de s'assurer des marges de manoeuvre (notamment budgétaires), que l'organisme d'appartenance (et sa politique scientifique de l'heure) ne permettaient pas;

-pour 22% le désir de "travailler avec d'autres personnes", soit dans un mouvement de distanciation (scission) avec son laboratoire d'affectation, soit pour rompre l'isolement par construction d'un nouveau réseau;

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[9]En fait, ces fonctionnaires sont toujours des professionnels de la science détachés au Ministère par des Organismes de Recherche.

[10]En France notamment où les chercheurs des Grands Etablissements Publics de Recherche sont fonctionnarisés et disposent de budgets annuels de recherche non négligeables.

[11]Pour plus d'information voir J. GAILLARD et J.B. MEYER, L'appel d'offre CORDET: le point de vue des chercheurs bénéficiaires in Evaluation d'une procédure publique de financement de la recherche: la Commission de Coordination de la Recherche dans les DOM-TOM (CORDET), Documentation Française, Paris, 245 pages, 1991, pp. 55-68.

-on voit aussi mentionnés le souci d'améliorer son prestige ("rendre plus visible l'intérêt de ses travaux"), celui d'accroitre son statut à défaut de sa carrière, ou d'imposer droit de cité à un style de science à contre-courant;

-la marginalité du fonds offre à certains l'opportunité d'exercer temporairement leurs talents à contre-emploi. Des chercheurs d'établissements de recherche appliquée (notamment directeurs et chefs de projets) prennent distance avec les expertises et travaux de routine, qui sont leur lot courant, en présentant des projets aux intentions théoriques clairement annoncées. Inversement, des Universitaires affichent "l'intention d'application" de leur programme, et le souci d'interaction avec les partenaires sociaux[12];

-15% des responsables de projet déclarent d'ailleurs avoir nourri d'abord l'intention "d'innovation théorique". Un pourcentage comparable de chercheurs (16%) déclare avoir eu comme intention principale (plus conformément aux intentions du fonds) au moment du dépôt du projet initial "d'adapter des techniques pour permettre des innovations commerciales locales". La masse se rallie à d'autres préoccupations: la "description de phénomènes originaux peu étudiés", "l'application à un nouveau terrain d'un modèle ou d'une méthode éprouvés" (ou une combinaison de ces items). Or, la stratégie du fonds a toujours incliné (et surtout au cours de la deuxième période) à la poursuite de résultats appliqués[13]. Mais on retrouve les intentions typiques du milieu scientifique français, dans leurs proportions, et leur lien au grade (ou au statut) telles que les ont révélées H. Reuter et al.[14] ou T. Shinn[15] en des cas différents;

-enfin la conduite des opérations par les équipes subventionnées révèle des "styles de science". Nous entendons par là un idéal et des normes professionnels, qui prévalent souvent dans des branches scientifiques de prédilection. Ici par exemple, les équipes sélectionnées dans le domaine de la Santé (réunissant souvent des médecins tropicalistes expérimentés) affichent plus que proportionnellement une intention moins appliquée et plus théorique. Mais par réflexe professionnel ou par référence aux modèles Pastoriens, elles s'adjoignent souvent des praticiens locaux de la médecine (non professionnels de recherche). Il en résulte un type d'équipe original qui se révélera des plus efficient pour une application effective. Inversement, les Agronomes, qui mettent le plus en avant l'intention de développer des innovations commerciales, sont les moins nombreux à entretenir des relations avec des clients potentiels d'innovations.

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[12]Les agronomes sont nombreux à rechercher des relations avec des chercheurs "purs" et les médecins à montrer le désir - échappant aux conditions habituelles de l'exercice professionnel - d'une recherche spéculative.

[13]Les proportions d'intentions déclarées (théoriques, appliquées) sont à peu près constants dans les différents domaines de science.

[14]H. REUTER, P. TRIPIER, F. AUBERT, D. LAHON, Le travail de recherche dans l'université: structures et déterminants, Université Paris X, 184 pages.

[15] T. SHINN, Hiérarchies des chercheurs et formes des recherches, Actes de la Recherche en Sciences Sociales, n°74, Septembre 1988, pp. 2-22.

Les stratégies mises en oeuvre sont tout aussi latérales. Ainsi:

-Le fonds cherche à attirer des chercheurs mais il a devant lui un milieu structuré où les groupes "récepteurs et libres" sont rares, surdéterminés, et dans le cas de la CORDET souvent marginaux. 80% des responsables de projet font état d'expériences outre-mer antérieures, cursus tout à fait exceptionnel dans la recherche française où la carrière se déroule préférentiellement dans l'Hexagone, avec d'éventuels séjours en Europe et aux USA[16]. Les groupes spontanément intéressés sont ici très particuliers. Leurs dispositions correspondent-elles aux désirs du fonds? Rien n'est moins sûr. Il revient aux stratèges de pressentir le caractère des groupes récepteurs qu'il atteint, puis d'imaginer des moyens pour en persuader de nouveau au besoin. C'est à quoi se sont employés certains aréopages "savants" dans la première phase de la CORDET - usant de leur capital social en milieux scientifiques - comme eux seuls peuvent le faire.

-Le fonds cherche ensuite à gouverner les chercheurs mobilisés. De ce point de vue, les structurations préexistant dans le milieu scientifique peuvent l'importuner. En France, il en est deux évidentes: l'une cognitive qui se traduit dans la découpe des disciplines; l'autre institutionnelle, qui renvoie à l'appartenance des équipes engagées à tel ou tel organisme employeur et à son statut[17]. Un subterfuge du fonds sera, pour atténuer ces allégeances, de prendre explicitement pour critère de subvention la pluridisciplinarité, et/ou le caractère inter-organismes des équipes engagées.

-Le fonds souhaite enfin peser sur les résultats. S'il affiche par exemple un objectif d'application, il peut directement prescrire les sujets à traiter; ou demander plus habilement que l'équipe candidate décrive les applications attendues de son produit. S'il recherche des équipes d'expérience, ou de prestige, il peut demander de décliner le crédit de publication et de récompenses obtenu, ou plus finement exiger la rédaction d'un chapitre de problématique et de méthodologie. Mais ces moyens sont risqués et pauvres. Les plus directs (imposer le sujet) supposent des connaissances scientifiques de la part des juges ou le renoncement à toute innovation (on ne posera que des problèmes déjà résolus). Les moyens les plus fins font appel à une rhétorique à laquelle tout scientifique est rompu: il peut être rebuté, ou s'y montrer fort habile, sans qu'on puisse préjuger du résultat[18].

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[16]Sauf pour les chercheurs des trois principaux organismes spécialisés dans la recherche tropicale (CIRAD, IPOM et ORSTOM).

[17]Les principaux sont les EPIC (Etablissements Publics à caractère Industriel et Commercial), dont la mission est de recherche appliquée; les EPST (Etablissements Publics à caractère Scientifique et Technique), dont la mission est la recherche fondamentale; les Universités; les Associations, les Fondations et les groupes ad hoc et privés.

[18]Un cas extrême, non vérifié dans le cas présent de la CORDET, est celui des innovations dans des technologies de pointe montrant l'intérêt du bailleur à payer les soumissionnaires qui démontreraient l'infaisabilité du problème proposé, plutôt que de se fier aux seules réponses argumentant des voies de réussite et de choisir entre elles.

Aussi le fonds recourt-il plus souvent à des subterfuges qui lui paraissent de bon sens, dans la poursuite de ses objectifs. Par exemple, pour aboutir à des résultats "utiles au développement", les stratèges peuvent prendre pour critère de subvention la vocation de l'Institution qui emploie le responsable scientifique du projet; ou bien ils peuvent privilégier certains domaines de science sur d'autres; ou bien considérer la taille des équipes sollicitantes, en préférant par exemple de grosses équipes pluridisciplinaires bien équipées à de petites équipes nombreuses moins dotées et très diverses dans leurs choix de sujets. On peut également jouer aussi du montant du financement et de leur durée (renouvellement ou pas de la subvention). On peut enfin renoncer aux appels d'offre (qui sont une façon de réorienter par contrat les chercheurs), en sollicitant directement des équipes dont les orientations sont appropriées aux objectifs recherchés[19].

Dans le cas de la CORDET, après la crise de 1986 résultant dans la mise à l'écart des stratèges savants, la faveur ira, afin de promouvoir des recherches utiles pour les besoins locaux, plutôt à des recherches dans les domaines de la Santé et de l'Agronomie, dans le cadre d'opérations coûteuses menées par des groupes interdisciplinaires et interorganismes de forte taille, souvent sous maîtrise d'oeuvre d'EPIC.

3. L'EVALUATION: UN QUESTIONNAIRE ET SON ANALYSE[20]:

Objectif syncrétique, rôle crucial des stratèges, latéralité des motivations des chercheurs et des paramètres d'action du fonds: ces caractères essentiels sont souvent les non-dits des études de politique scientifique, comme de sociologie des sciences. Pourtant c'est à eux que tiennent des problèmes majeurs de management. Les principes de choix adoptés par les stratèges savants produisent-ils réellement moins d'utilité locale? Ceux des fonctionnaires en charge ont-ils entraîné une baisse du produit scientifique? Existe t'il des critères (de bon sens ou cachés) qui concourent plus fortement à l'obtention d'un résultat type?

Que produit un fonds de financement et par quelles voies? C'est avec l'hypothèse que les stratégies latérales, celles des chercheurs et celles des stratèges, étaient des paramètres essentiels, et que leur combinaison (en synergie ou en méconnaissance mutuelle), orientait le produit, que nous avons conduit pour partie l'évaluation de la CORDET.

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[19]par exemple fondamentalistes pour un objectif de prestige, ou très proche de la demande entrepreunariale pour un objectif appliqué. La difficulté est qu'on ne peut guère dans le premier cas peser sur le choix du sujet de recherche des équipes pré-engagées, et qu'il est difficile d'organiser les coordinations nécessaires dans le second cas.

[20]Concernant la méthodologie utilisée voir également J.GAILLARD, Introduction méthodologique au rapport d'évaluation, in rapport CORDET publié à la Documentation Française, op. cit. pp. 29-33.

Un questionnaire fut notamment adressé aux responsables des 457 opérations de recherche subventionnées. Compte-tenu de la modicité des soutiens, on conçoit facilement que ceux-ci sont le plus souvent en même temps les promoteurs du projet, et les acteurs directs du travail. Le questionnaire est lourd. Il comprend 8 pages et 115 questions (dont 55 à choix multiples, 55 à réponses limitées mais plus personnelles, et 5 à réponse libre (incluant une liste des publications, une appréciation du fonds, et un descriptif des difficultés rencontrées)[21]. Les questions portent notamment sur tous les éléments de "stratégie latérale" déjà signalés; ainsi que sur les produits livrés et leurs résultats effectifs observés, dans les dimensions diverses mentionnées[22]. Ce questionnaire a reçu près de 2/3 (65,2%) de réponses, après 2 rappels, et en deux mois. Ce résultat est satisfaisant compte tenu de la dispersion et du degré de mobilité de la population étudiée, et du fait que certains destinataires n'avaient plus soumissionné depuis 8 ans. Ce corpus a paru suffisant, puisqu'il était apparié à l'ensemble de la population étudiée (année par année, par disciplines, suivant le statut des institutions participantes, le lieu d'exécution de la recherche, le montant des subventions accordées, la taille des équipes engagées).

Plusieurs traitements des réponses ont été effectués. a)Un premier tri à plat des variables est publié par ailleurs[23]. Il fait notamment ressortir que les chercheurs mobilisés par l'appel d'offre sont des professionnels de la recherche, habitués de l'outre-mer, qui s'intéressent plus à la description de phénomènes originaux, encore peu ou pas étudiés, qu'à la production d'innovations. Ils font état de contraintes budgétaires fortes pour l'accomplissement de leurs travaux, contraintes que la CORDET a permis de desserer. La plupart des chercheurs étaient habitués à collaborer antérieurement à l'appel d'offre. Les écrits et les communications scientifiques, suivis par les actions de coopération sont considérés par les chercheurs comme les produits les plus importants dérivés des programmes CORDET[24]. La contribution des programmes CORDET au développement socio-économique des DOM-TOM et les effets sur la structuration du milieu scientifique local apparaissent comme beaucoup plus limités. b)Le croisement 2 à 2 de variables choisies fait ressortir quelques paradoxes étonnants, au regard des recettes de "bon sens" du management.

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[21]Le questionnaire peut être consulté en annexe du rapport CORDET publié à la Documentation Française, op. cit. pp. 235-242.

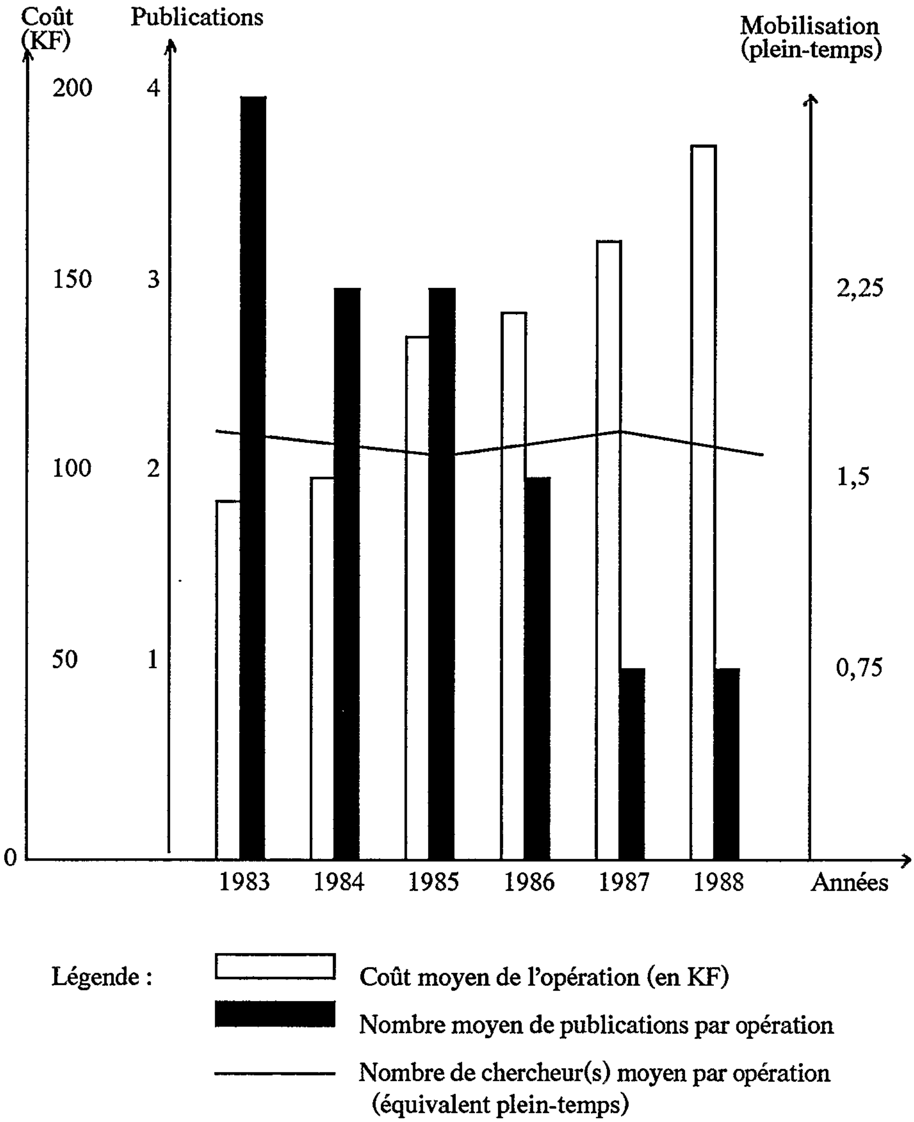
[22]ex. taille ou composition des équipes, intention des chercheurs, organisme d'appartenance, statut dans le laboratoire, montant du financement ... pour aboutir à des produits académiques ou appliqués, pour développer la vulgarisation ou la formation, pour obtenir des résultats en termes de prestige scientifique, d'extension de réseaux , d'intéressement à la science de nouveaux publics, d'innovations commerciales ou sociales effectivement mises en oeuvre.....

[23]Cf. J.GAILLARD et JB MEYER, L'appel d'offre CORDET et ses effets: le point de vue des chercheurs bénéficiaires in rapport CORDET publié à la Documentation Française, op. cit. pp. 55-68.

[24]L'importance relative de ces produits varie significativement en fonction des champs thématiques d'appartenance des chercheurs.

Ainsi, au fil des années le coût moyen par projet augmente, mais la mobilisation (en équivalent plein-temps chercheurs) reste constante, et le rendement en publications diminue (voir figure n° 1).

Figure n° 1. Evolution du coût, du travail engagé et du nombre de publications par opération (1983-88).



Lorsque la mission de l'organisme maître d'oeuvre évolue de l'appliqué au théorique (des EPIC, aux EPST et aux Universités), la proportion d'intentions théoriques (ou appliquées) reste constante, et l'application effective décroit.

Ces paradoxes peuvent s'expliquer a posteriori. Il n'empêche qu'ils ont échappé au management, et provoqué des effets pervers lorsque, les recettes 'de bon sens' se sont opposées aux mécanismes latents.

Le premier paradoxe tient au fait que la préférence du fonds se déplace au fil des ans, au nom de l'utilité et des besoins locaux, vers un style de science ainsi caractérisé: des inventaires ou des expertises dans le cadre de programmes ambitieux, conduites par des équipes lourdes multidisciplinaires et pluriorganismes, sous maîtrise d'oeuvre d'EPIC, dirigés par des ingénieurs, dans le domaine de prédilection des Sciences Agricoles. De telles opérations sont proportionnellement plus coûteuses, dans la mesure où elles exigent plus d'équipement et de coordination. Il faut en outre payer au moins partiellement les salaires (supérieurs) des chercheurs d'EPIC (contrairement à ceux de chercheurs d'EPST ou d'Université). Cependant, les ingénieurs et les disciplines agronomiques ont une tradition de moindres publications (notamment académiques) que celle des chercheurs, et des autres groupes de science. En outre, nombre de "participants" sont nécessaires dans ces montages complexes, pour gérer la liaison interne sans avoir le temps de s'investir dans la recherche et la production qui en résulte. La référence croissante à ce style de science porte donc à des rendements décroissants (au moins en terme de résultats publics, et sans préjuger de la qualité des travaux et de l'intérêt des sujets abordés).

Le deuxième paradoxe est directement lié à l'organisation de la recherche en France où les différentes institutions (Universités, EPST, EPIC..etc) recrutent dans un même vivier. Les missions de ces divers organismes diffèrent. Mais précisément la CORDET donne l'occasion à la marge, à leurs membres de satisfaire le désir que chacun nourrit: celui de quelques activités à contre emploi, complémentant ses activités professionnelles courantes pour exercer la plénitude du métier de scientifique. Ainsi des enseignants aspirent à faire de la recherche et à s'investir dans les affaires du monde; des experts souhaitent produire des résultats de valeur académique reconnue. Les propositions avancées à la CORDET par les chercheurs d'organismes aux statuts différents, doivent moins alors à ce statut qu'à la structuration (à la Française) du milieu scientifique[25]. Quant à la stagnation du passage de la découverte à l'innovation, malgré le changement progressif de style de science, elle tient principalement à l'indépendance profonde de ces deux variables[26].

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[25]Selon le rang qu'il occupe des règles implicites suggèrent à chacun ce que le système attend de lui. Ainsi, un 'directeur de recherche' doit à l'occasion modéliser; d'autres 'chercheurs confirmés' ont à tester contradictoirement des modèles; certains plus 'juniors' ont goût pour la description de faits originaux.

[26]Paradoxalement, le style 'Agronomique' est même moins favorable aux chaînes de relations entre chercheurs et clients (voire entre chercheurs et professionnels) que celui par exemple des

c)Des techniques un peu plus élaborées sont cependant nécessaires pour mettre en scène la multiplicité des interférences entre stratégies latérales du fonds et des chercheurs. Nous avons donc sélectionné des variables et procédé à une classification hiérarchique, puis à une analyse de correspondances. Avant de présenter les résultats, précisons brièvement le principe. Les 301 subventions renseignées sont finalement réduites à 160 opérations scientifiques distinctes (1 opération = 1 programme, 1 équipe et souvent plusieurs subventions successives[27]). Nous n'avons retenu que 19 variables à croiser, chacune pouvant revêtir de 2 à 8 modalités[28]. Avec chacun ses particularités du point de vue des 19 dimensions retenues, les individus (les opérations) se dispersent en un nuage de points. Il s'agit d'en expliquer la forme. Par des procédés mathématiques on définit une mesure des distances entre chaque point et un centre du nuage; puis on vise au travers du nuage pour faire passer un axe, central, minimisant les distances des points à l'axe. On réitère l'opération: il s'agit cette fois de rendre compte des différences entre points qui étaient confondus par projection sur l'axe précédent. On obtient un deuxième axe et on recommence. L'analyse des correspondances met ainsi de l'ordre dans la dispersion des projets. Elle permet de dégager des principes de contraste entre individus. Reste à nommer ces facteurs, à leur donner signification. Car chaque axe (chaque principe) combine plusieurs des propriétés empiriquement observées. La contribution de chaque variable à l'axe est connue, mais le sens de la combinaison peut n'être pas évident. C'est le travail d'interprétation sur les résultats obtenus, que nous présentons au paragraphe suivant. Les programmes d'analyse des correspondances et de classification hiérarchique employés font partie du logiciel d'analyse des données ADDAD qui peut être utilisé sur micro-ordinateur. Il a été mis en oeuvre, avec l'assistance constante et l'aide critique de Christian Mullon, responsable de l'informatique au Centre ORSTOM de Bondy.

4. CINQ PREMIERS AXES DE L'ANALYSE DES CORRESPONDANCES

Cinq axes successifs rendent compte de 30% de la variance (tableau n°1): le premier axe=7,98%; le deuxième axe=6,13%; le troisième axe=5,63%; le quatrième axe=5,46%; le cinquième axe=5,13%. Nous n'avons pas poussé plus loin l'analyse, l'interprétation des axes devenant au delà moins sûre pour de faibles gains explicatifs. Nous présentons les résultats ci-dessous axe par axe. Pour comprendre l'interprétation, on tiendra compte en chaque cas: des variables qui ne cumulent pas avec l'axe; des variables ou modalités qui corrèlent fortement

'Sciences Médicales' dont nous verrons qu'il était dans la CORDET l'archétype concurrent, et qu'il a été plus innovant.

[27]Le plus souvent deux subventions pour une opération.

[28]Voir liste en annexe n°1.

avec l'axe. L'interprétation porte sur un principe de contraste. On l'appuie donc spécialement sur les oppositions typiques d'une modalité isolée, c'est à dire sur les points que l'axe fait apparaître à ses extrêmes. On vérifie qu'ils correspondent aux modalités inverses d'une même variable, et que si possible les modalités intermédiaires se répartissent avec ordre entre les deux bouts de l'axe. On se demande enfin ce qu'ont à voir les unes avec les autres et les oppositions pertinentes ainsi révélées: c'est le travail d'imagination nécessaire pour nommer l'axe c'est à dire en comprendre le sens.

Tableau n°1. Contribution des 5 premiers axes à la variance du corpus

Axe	Intitulé de l'axe	variance	cumulé
n°1	Socialisation scientifique	7,98 %	7,98 %
n°2	Style de science	6,13 %	14,11 %
n°3	Universitaires et chercheurs	5,63 %	19,74 %
n°4	Chercheurs et stratèges	5,46 %	25,20 %
n°5	Juniors / seniors	5,13 %	30,33 %

4.1. Le premier axe: socialisation scientifique.

Le premier axe corrèle fortement avec toutes sortes d'outputs (figure n°2)[29]: la publication scientifique sous toutes ses formes (articles édités, communications, rapports de recherche); mais aussi la formation (de professionnels comme d'étudiants); la diffusion locale d'information scientifique et technique; et l'application effective des résultats obtenus. A l'une des extrémités de l'axe figurent les plus hauts scores (dans chacune de ces variables); à l'autre les plus bas scores, les modalités intermédiaires s'interposant dans l'ordre.

A moindre degré, l'axe est lié à d'autres variables; mais les modalités sont ici plus en désordre; certaines seulement pèsent dans l'explication de la variance; et la part de variance expliquée est plus modeste[30].

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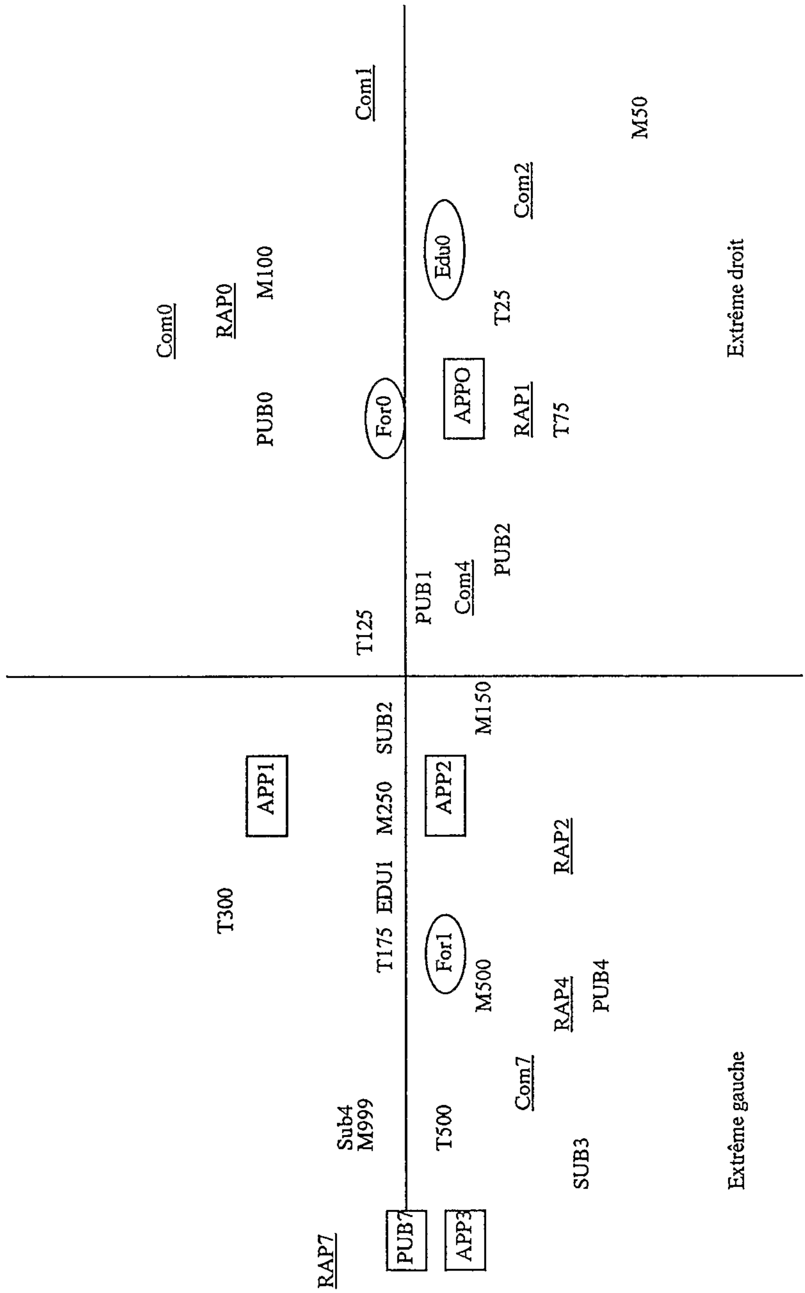
[29]Voir également contribution des variables et modalités à la définition de l'axe 1 en annexe n°2a.

[30]Dans le sens de la croissance des produits semblent jouer par exemple le nombre et surtout le montant des subventions obtenues, la taille de l'équipe et l'importance de l'équivalent plein temps engagé. Ce sont des modalités intermédiaires qui s'opposent. Par peu ou beaucoup d'output se distinguent les très faibles subventions (M50, M100) et des subventions notables (mais non les plus fortes= M500) moins efficaces; les très faibles plein-temps (0,25 chercheur) et tous les autres degrés d'engagement; les binômes et les équipes étoffées (8 à 10 participants); mais non les équipes lourdes dont le score en produits baisse au delà du seuil de 10 personnes impliquées.

Figure n°2. Le premier axe: socialisation scientifique (Position des variables et modalités les plus significatives)



L'axe est par contre sans rapport avec les critères suivants qui n'influent donc pas sur l'output:

-le statut de l'organisme maître d'oeuvre,
-le domaine de recherche,
-les profils d'équipe,
-l'intention des chercheurs[31],
-l'année de soumission à la CORDET[32].

On pourrait interpréter l'axe en termes de 'l'activité déployée' par chaque projet, ou du 'degré de réussite'. Tous les indicateurs d'effet et de produit sont en effet au plus haut d'un côté de l'axe, au plus bas de l'autre[33]. Cette analyse de premier regard à le mérite d'attirer l'attention sur quelques paradoxes. Ainsi, l'application effective des résultats corrèle fortement avec l'intensité de la production académique (à l'inverse de ce que ferait attendre la traditionnelle opposition entre recherches "fondamentale" et "appliquée"); et cette même application corrèle positivement avec une seule intention scientifique de départ: celle d'innovation théorique (mais pas celle d'application!).

D'autres anomalies obligent à revenir sur l'interprétation de l'axe. Ce qu'ont en commun ses composantes essentielles, c'est de témoigner, non pas seulement de produits et d'effets, mais de ces produits qui supposent une activité relationnelle intense. Ne publie pas beaucoup qui veut. La matière, en qualité et quantité, est nécessaire, mais aussi l'assise scientifique et des entrées dans les Comités de revues. L'appel en communication suppose un réseau de liens scientifiques établis. L'appel en expertises (autre effet qui apparait fortement corrélé à l'axe), demande reconnaissance et inter-connaissances dans les milieux économiques. La pratique de la vulgarisation[34] relève du souci de convaincre, d'entraîner dans ses vues des milieux variés. La formation[35] de professionnels et d'étudiants densifie le réseau d'alliances multi-orientées. Même le fait de rendre des rapports nombreux au fonds s'interprète ici par le soin que l'on prend de resserer les contacts avec ses décideurs (la CORDET n'ayant jamais présenté grande exigence en ce sens, ni vraiment organisé de suivi).

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[31] mais l'intention purement théorique est un cas: c'est la seule des modalités qui corrèle fortement avec l'axe dans le sens des outputs importants.

[32] le changement de stratèges et de stratégie du Fonds a donc été peu opérant au regard des performances.

[33] Il s'agit ici d'efficience et celle-ci paraîtrait tenir au montant significatif de subventions maintenues un temps suffisant (l'optimum paraissant de quatre ans). Deux types de projets ressortent comme plus performants: l'un centré autour d'équipes de 2 à 3 personnes avec un financement de 200KF, l'autre autour d'équipes de 8 à 10 personnes financées pour 500KF, quelque soient leur domaine scientifique ou le statut de leurs opérateurs.

[34] Variable AUT (Diffusion d'Information Scientifique et Technique), aussi très corrélée à l'axe.

[35] Variable FOR et ETU, très corrélée à l'axe.

Ce que ce premier axe traduit fortement c'est donc le goût et la capacité à développer des liens: ceci pour structurer une demande de science pour accumuler des ressources (intellectuelles, matérielles, en information), et pour élargir à terme l'activité de recherche. C'est l'axe de la SOCIALISATION, ou plus précisément de la SOCIALISATION SCIENTIFIQUE.

Il n'est pas dit, par contre, que ces dispositions interactives corrèlent avec l'avancement du savoir. Une interrogation de l'ISI sur les citations reçues par les travaux des chercheurs financés (il est vrai limitée à un type de sciences dans un seul territoire: les sciences sociales en Nouvelle-Calédonie), nous a montré l'indépendance, en ce cas, des deux dimensions[36].

4.2. Le deuxième axe: Styles de science.

Un deuxième axe fait contraster, à moindre degré, les opérations menées[37]. Nous le caractériserons comme l'opposition de deux styles de science. Nous entendons par là des conceptions différentes du projet scientifique qui ont chacunes leurs institutions de référence, leurs domaines de recherche électifs, un idéal et des normes professionnels distinctifs. Ces "styles" se disputent vis à vis du fonds la plus forte légitimité, leur modèle inspirant tour à tour la stratégie du fonds, c'est à dire le type de projets et de montages qu'il agrée.

Deux styles extrêmes peuvent être caractérisés:

-d'un côté, sous l'égide d'organismes publics de recherche à vocation industrielle et commerciale (EPIC), et dans le domaine privilégié des sciences agricoles, des ingénieurs dirigent les travaux d'équipes nombreuses, coordonnant organismes et disciplines sur un problème pratique, en vue de résultats qu'ils jugent applicables (publications et communications sont par contre limitées).

-à l'opposé, sous maîtrise d'oeuvre d'organismes publics de recherche à vocation fondamentaliste (EPST), ou sous celle d'Associations, Fondations et Services Hospitaliers, les travaux sont conduits dans le champ privilégié de la Santé, par des chercheurs très liés aux praticiens (ou aux usagers par l'intermédiaire d'associations religieuses ou sociales). Les résultats ne sont pas toujours jugés directement applicables, mais ils sont activement consignés à l'intention de publics savants (publications, communications). Les équipes mobilisées ne sont pas de taille très importante, mais elles conjoignent volontiers chercheurs et praticiens locaux dès l'origine[38].

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[36]Le fonds a ignoré certains brillants producteurs de science, il en a soutenu d'autres qui apparaissent tantôt à une extrémité de l'axe interactif, tantôt à l'autre. Au total, la socialisation (comme l'intervention du Fonds) n'a fait ni bien ni mal du point de vue d'un progrès reconnu du savoir.

[37]Voir contribution des variables et modalités à l'explication de l'axe 2 en annexe n°2b.

[38]Océanographie et Sciences Sociales sont neutres à l'égard de ces deux modèles: elles entretiennent des opérations des deux types; tandis que les Sciences de la Terre inclinent au premier type.

L'axe est sans corrélation avec:
-la formation (d'étudiants ou de professionnels) et l'effort de vulgarisation,
-le nombre de subventions obtenues (mais non leur montant: le premier type a un coût médian plus élevé que le second (300KF vs. 150KF),
-l'appel en expertise ou l'application effective des résultats. Mais la modalité APP2 (Résultats jugés Applicables mais non Appliqués), corrèle seule avec un type: le premier.

L'archétype de chaque style, plus courant dans l'un ou l'autre champ scientifique, peut s'étendre en réalité aux autres domaines. Chacun plaide pour un montage distinctif (équipes légères/lourdes, en liaison ou pas avec des non professionnels de la recherche sur place, à moindre ou plus grand coût ...etc). Portés par deux "arts" (l'agriculture et la médecine), plutôt que par l'opposition entre sciences "dures" ou "molles", tous deux peuvent prétendre à l'utilité. Ils ont imprégné, tour à tour, la doctrine du fonds. La première période (années 1 à 5, sauf l'année 3) porte l'influence du "modèle médical"; la deuxième période (plus l'année 3) marque un retournement en faveur du "style agronomique". Les autres domaines de science ne sont pas moins dotés pour autant. Simplement, le fonds prend pour paramètres d'action des traits typiques de l'un ou l'autre archétype. Il cherche à en promouvoir l'idéal et les normes. Par exemple, en deuxième période (1986-1989), le fonds prend généralement pour critère de sélection, en tous domaines, la taille notable des équipes retenues et leur caractère composite (pluri-organisme, pluri-disciplinaire) en consentant des montants de subvention croissants: par ce modèle "agronomique", il espère accentuer l'attention aux problèmes pratiques et locaux, ainsi que l'opérationalité des actions (image de l'agronome)[39].

4.3. Le troisième axe: Universitaires vs. Chercheurs.

Le troisième axe rend compte d'une autre opposition, entre deux types de professionnalisation[40]:
-l'un des pôles regroupe la maîtrise d'oeuvre des EPIC et des EPST (en particulier en agronomie et sous responsabilité d'ingénieur) avec un produit scientifique sûr mais modéré (1 à 3 publications, 1 à 4 communications);
-l'autre archétype est celui de travaux sous égide Universitaire, notamment en Sciences Humaines, engagés sans visée d'application mais avec des intentions composites, par des équipes où nombre de personnes consacrent parfois peu de temps. Le produit scientifique est soit remarquablement intense (4 à 7 publications, 7 communications), soit traduit l'échec complet sur ce terrain (ni publication ni communication).

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[39]Nos résultats montrent cependant que cette recette de bon sens est vaine: il n'en ressort pas plus de résultats.

[40]Voir contribution des variables et modalités à l'explication de l'axe 3 en annexe 2c.

L'axe est par contre sans rapport:
-avec l'appel en expertise ou l'application effective,
-avec la formation (professionnelle ou d'étudiants),
-avec la diffusion d'informations scientifique et technique, c'est à dire toutes dimensions que nous avons vu relever d'un autre axe: celui de la socialisation scientifique.

L'opposition, qui est plutôt celle des Universitaires/Ingénieurs, des sciences discursives/intuitives, de la modélisation ou du test des modèles, des "arts" et des lettres, renvoie y compris à des problèmes de statut et d'idéal professionnel. Ici encore, le conflit des normes a interféré avec la stratégie du fonds. Toute la première période (et surtout la première année) a été favorable au modèle Universitaire, alors que la deuxième période (mais aussi exceptionnellement et vivement la troisième année) au modèle "chercheur". Ici encore, la prégnance d'un modèle, l'opinion qui lui est favorable, jouent en dehors des résultats attendus.

4.4. Le quatrième axe: Chercheurs et Stratèges: Synergies ou contradictions.

Le 4ème axe oppose essentiellement laboratoires confirmés et montages amateurs ou volontaristes[41].

-D'un côté nous trouvons les profils d'équipes appuyées sur des noyaux de chercheurs seniors, groupant de 3 à 6 personnes, pour un engagement plein-temps significatif, sous une forme proche de "laboratoire complet" (conjoignant des chercheurs de divers grades: directeur/chargé/stagiaire, avec leurs intentions typiques: généralisation ou modélisation/test de modèles/description de phénomènes originaux). Le produit scientifique, fort ou modéré est alors sûr.

-A l'autre pôle se trouvent des opérateurs moins classiques sélectionnés par le fonds "pour voir" ou par volontarisme. Ainsi, "pour voir", reconnait-on des chercheurs isolés, choisis pour leur prestige, ou parce qu'ils assument un sujet cher au fonds; on trouve aussi des techniciens et des praticiens locaux, dont le fonds est curieux de mettre à l'épreuve le talent pratique et le goût de recherche[42]. Par volontarisme, le fonds a soutenu, principalement au cours de la deuxième période, des équipes nombreuses pluri-organismes et pluri-disciplinaires bien dotées, en vue de l'obtention de résultats jugés applicables ou pour des expertises. Par volontarisme aussi, en Sciences Sociales mais aussi en Santé, le souci de susciter une offre locale de science a conduit à subventionner les projets d'équipes locales naissantes ou d'associations de praticiens locaux, qui font figure d'amateurs. L'Océanographie a soutenu des missions exploratoires pour

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[41] Voir contribution des variables et modalités à l'explication de l'axe 4 en annexe 2d.

[42] Exemples: une étude macro-économique, la préparation d'un procédé pour réaliser des fruits confits, ou dans un autre domaine (étude multidimensionnelle de l'alcoolisme), par une équipe de médecins et de praticiens médicaux locaux.

de nouveaux grands programmes, et les Sciences Sociales ont aidé à l'organisation de colloques et à la circulation d'information scientifique. Toutes ces opérations se retrouvent à un même pôle. Elles ont en commun de s'appuyer sur des groupes ou personnes qui y consacrent chacune peu de temps. La production proprement scientifique s'y rapportant est faible (sauf en cas des grosses équipes de deuxième période, mais le rendement par plein-temps engagé est alors décroissant). Cela n'exclut pas que l'amateurisme (qu'il soit porté par des non professionnels ou que les professionnels y soient entraînés par les montages volontaristes que le fonds impose) ait ses vertus, et porte d'autres effets: maillage de communautés, construction de réseaux, maturation d'un Grand Programme.

4.5. Le cinquième axe: deux types d'intérêt pour la science ("Junior" et "Senior")

Ce dernier axe oppose deux types d'intérêt pour la science fortement liés au profil d'équipe[43].

-D'un côté se trouvent des laboratoires complets ou des groupes formés autour de directeurs de recherche, souvent résidant localement, annonçant une intention claire (appliquée ou théorique, rarement composite). Le domaine de prédilection est celui de la Santé. La corrélation avec l'application effective est toujours forte. Le produit est typé: soit très, soit très peu tourné vers la communauté scientifique.

-A l'opposé sont les équipes, et plus souvent les binômes, constitués d'un thésard à temps-plein et de son encadrement. Les objectifs sont composites: avec un goût particulier pour la description de phénomènes originaux et l'application de méthodes éprouvées. Les domaines d'élection sont les Sciences Humaines et de celle de la Terre. Les financements mobilisés sont plus modestes et les produits modérés mais réels dans tous les compartiments (y compris vulgarisation, ce qui n'est pas le cas du pôle précédent).

L'axe est par contre sans lien avec:

-la formation d'étudiants,

-le statut de l'établissement maître d'oeuvre.

La relation à l'année du premier soumissionnement est erratique, et le fonds ne semble pas avoir eu de politique préférentielle en ce domaine.

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[43] Voir contribution des variables et modalités à l'explication de l'axe 5 en annexe 2e.

CONCLUSION

l'évaluation d'un fonds de financement met en lumière les particularités de l'interface Science/Politique et ses problèmes de management. Ce type d'études reste rares et les méthodes font défaut. L'analyse des corrélations des réponses d'un questionnaire adressés aux chercheurs bénéficiaires en est une, riche d'enseignements pratiques. Celle que nous avons présentée et analysée ici montre que:

1) Tout fonds de financement, qui est un compromis d'action aux objectifs syncrétiques, a besoin de stratèges. Leur rôle décisif est de réduire les finalités, de définir une politique et de trouver les chercheurs pour soumissionner.

2) La difficulté du management consiste en ce que le fonds comme les chercheurs sont tenus à des stratégies latérales: leur interaction mérite d'être mieux étudiée car les paramètres d'actions qui paraissent de bon sens peuvent porter des effets imprévus.

3) On a montré par exemple que le fonds ne fait pas toujours ce qu'il croit. Par exemple: développer l'innovation (i.e. l'application effective), en choisissant des équipes lourdes, mieux dotées, pluri-organismes et pluri-disciplinaires, affichant l'intention de recherches pratiques, dans des domaines utilitaires. Ce montage volontariste reflète secrètement la prédominance d'un style de science et d'un style de professionnalisation (le modèle "agronomique"). Mais il ne corrèle pas plus que d'autres (et notamment avec son antagoniste, le "Style médical") avec l'application réelle. Il s'avère plus proche, au contraire, de la Recherche dite Applicable et Non Appliquée (RANA).

4) On a montré de même que les chercheurs ne font pas toujours ce qu'ils veulent. Des contraintes (intellectuelles, institutionnelles) poussent certains groupes récepteurs à soumissionner, et dans l'interaction avec le fonds, ceux qui réussissent le mieux (les plus socialisés) viennent à déplacer leurs centres d'intérêt, à multiplier les dimensions de leur activité (élargissant pour l'avenir leurs réseaux), à modifier leur intention de départ pour obtenir des résultats effectifs en de nombreux compartiments du jeu.

5) L'analyse des interactions fait ressortir une structure implicite, dont les facteurs, s'ils sont perçus, pourraient devenir de bon paramètres d'action pour le fonds. Ainsi, la plus forte liaison avec l'application (mais aussi avec toutes sortes de produits, et d'effets qui les suivent) tient à la socialisation scientifique. On a vu, également, le jeu secret de styles de science ("médical" ou "agronomique") et de types de professionnalisation (Universitaire ou Chercheurs des Instituts de recherche) sur la nature des produits attendus et des effets réels qui suivent. Le profil des équipes rassemblées, leur type (amateur ou professionnel, junior ou senior) pèsent enfin sur le genre des effets (et des produits) obtenus.

Suivant que les stratèges du fonds opèrent en synergie ou à contre-sens de ces champs de forces, orientant le déroulement des travaux, le rendement des actions entreprises peut être optimal ou décroître.

6) Nous plaidons donc ici pour des évaluations régulières des fonds de financement, l'un des meilleurs moyens d'affiner les études de Politique de Science et de rendre plus réalistes celles de Sociologie des Sciences. La méthode ici présentée peut en être un des instruments. Des enquêtes légères sont envisageables, qui clarifieraient pour tous (et notamment pour les responsables) résultats atteints et paramètres d'action; ainsi pourrait-on dans un contexte (national) donné, améliorer les stratégies en étant mieux informé.

ANNEXE 1

Les 19 variables retenues pour l'analyse des correspondances et leurs modalités.

La date et le début de l'opération	ANN	Ann1=1981, Ann2=1982, Ann3=1983 Ann4=1984, Ann5=1985, Ann6=1986 Ann7=1987, Ann8=1988
Le nombre de subvertions obtenues	SUB	Sub1=1, Sub2=2, Sub3=3, Sub4=4et+
Le montant total des subventions (en KF)	M	M50=de 0 à75KF, M100=de 76 à 125KF M150=126 - 200KF, M250=201 - 400KF M500=401 - 700KF, M999=plus de 700KF
Le champ scientifique	GDS	Gds1=Sc. Agricoles, Gds2=Sc. Humaines Gds3=Sc. Médicales, Gds4=Sc. de l'Océan Gds5=Sc. de la Terre
Le statut de l'organisme maître d'oeuvre	STA	Sta1=EPST, Sta2=EPIC, Sta3=Universités et grands établissements scientifiques, Sta4=Autres (Associations, Fondations..)
Le nombre total de personnes engagées	TO	TO1=1, TO2=2, TO5=de3à7, TO9=de8à12, TO15=de13à20,T030=plus de 20.
L'effectif chercheur, en équivalent plein-temps	T	T25=de 0 à 0,49; T75=de 0,50 à 0,99; T125=de 1 à 1,49; T175=de 1,5 à 1,99; T300=de 2 à 3,99; T500=4 et plus.
Le profil de l'équipe rassemblée	PRO	Pro1 à Pro9
L'intention initiale de l'équipe	OB	Ob1=innovation théorique Ob2=description de phénomènes originaux Ob3=Application de méthodes éprouvées Ob4=Applications à débouché commercial Ob5=mixte dont applications commerciales Ob6=mixte ni théorique ni commercial Ob99=mixte avec théorie, sans commercial.
Le nombre de publications Scientifiques	PUB	Pub0=0, Pub1=1, Pub2=2, Pub4=3 à 5, Pub7= plus de 5.
Le nombre de communications scientifiques	COM	Com0=0, Com1=1, Com2=2, Com4=3 à 5, Com7= plus de 5.
Le nombre de rapports de recherche rendus	RAP	Pap0=0, Rap1=1, Rap2=2, Rap4=3 à 5, Rap7= plus de 5.
Les recommandations pour application	RES	Res0=inexistantes, Res1=existent.
La formation d'étudiants	EDU	Edu0=inexistante, Edu1=existe.
La formation de praticiens locaux	FOR	For0=inexistante, For1=existe.
La coopération avec des acteurs locaux (non scientifiques)	COO	Coo0=inexistante, Coo1=existe.
L'intéressement de publics locaux	AUT	Aut0=inexistant, Aut1=existe.
La mise en oeuvre effective de recommandations pour l'application	APP	App0=pas de recommandations ou ignore leurs suites App1=Recommandations inappliquées App2=Application en petite partie App3=Application en grande partie
Le rappel ultérieur en expertise locale	EXP	Exp0=inexistant, Aut1=existe.

ANNEXE 2 Contribution des variables et modalités à l'explication de chaque axe

N.B.
a) Une variable contribue à l'explication d'un axe suivant la part de variance qui lui est imputable sur cet axe (comptée en % de la variance totale). Pour cette étude nous avons choisi les conventions suivantes:
la contribution est dite "très forte" si la part de variance imputable est > 60‰
la contribution est dite "forte" si la part de variance imputable est = de 30‰ à 59‰
la contribution est dite "médiocre" si la part de variance imputable est = de 15‰ à 29‰
la contribution est dite "faible" si la part de variance imputable est < 15‰

b) Il en va de même pour les modalités isolées de chaque variable:
la contribution est dite "très forte" si la part de variance imputable est > 35‰
la contribution est dite "forte" si la part de variance imputable est = de 20‰ à 34 ‰
la contribution est dite "médiocre" si la part de variance imputable est = de 10‰ à 19‰
la contribution est dite "faible" si la part de variance imputable est = < 10 ‰

c) Pour les modalités, la part de la variance est affectée du signe + ou - selon que la modalité tire dans un sens ou l'autre de l'axe. On pourra donc remarquer les modalités les plus fortement opposées par l'axe.

ANNEXE 2a - AXE 1 : Socialisation Scientifique

CONTRIBUTION DES VARIABLES			
Très forte	Forte	Médiocre	Faible
COM (128‰)			
RAP (111‰)			
PUB (81‰)			
M (87‰)			
EDU (68‰)			
FOR (68‰)			
APP (67‰)			
T (63‰)			
SUB (61‰)			
RES (60‰)			
	AUT (44‰)		
	EXP (39‰)		
	TO (36‰)		
		PRO (24‰)	
		OB (26‰)	
		ANN (21‰)	
			GDS (7‰)
			STA (6‰)
			COO (3‰)

CONTRIBUTION DES MODALITES			
Très forte	Forte	Médiocre	Faible
Com7 (+77‰)	Com1 (-24‰)	Com0 (-12‰)	
Rap7 (+42‰)	Rap0 (-26‰)		
Pub7 (+44‰)		Pub0 (-15‰)	
	M50 (-22‰) M100 (-22‰) M500 (+21‰)		Les
Edu 0 (-44‰)	Edu1 (+24‰)		
For1 (+40‰)	For0 (-28‰)		
App3 (+39‰)	App1 (-22‰)		
		T25 (-19‰) T175 (+12‰)	Autres
	Sub1 (-21‰) Sub3 (+27‰)		
Res1 (34‰)	Res0 (-26‰)		
	Aut0 (-22‰) Aut1 (+22‰		
	Exp1 (+25‰)	Exp0 (-14‰)	
		To2 (-15‰) To9 (+13‰)	Modalités
		Pro1 (-12‰)	
		Ob1 (+15‰)	
An1 (+36‰)	An4 (+24‰) An8 (-23‰)		

ANNEXE 2b - AXE 2 : Style de Science

CONTRIBUTION DES VARIABLES			
Très forte	Forte	Médiocre	Faible
GDS (134‰			
STA (127‰)			
RAP (104‰)			
COM (91‰)			
PRO (91‰)			
OB (72‰)			
TO (69‰)			
RES (60‰)			
	PUB (58‰)		
	M (58‰)		
	T (46‰)		
	ANN (45‰)		
		APP (27‰)	
			SUB (14‰)
			EDU (4‰)
			FOR (3‰)
			COO (1‰)
			EXP (6‰)
			AUT (O‰)

ANNEXE 2c - AXE 3 : Type professionnel

CONTRIBUTION DES VARIABLES			
Très forte	Forte	Médiocre	Faible
STA (142‰)			
GDS (11‰)			
COM (132‰)			
PUB (91‰)			
RAP (80‰)			
OB (90‰)			
PRO (79‰)			
ANN (73‰)			
	TO (59‰)		
	SUB (38‰)		
	T (30‰)		
		M (20‰)	
			APP (12‰)
			ETU (15‰)
			FOR (8‰)
			RES (7‰)
			AUT (7‰)
			EXP (6‰)
			COO (O‰)

ANNEXE 2d - AXE 4 :Stratégies du Fonds et des chercheurs

CONTRIBUTION DES VARIABLES			
Très forte	Forte	Médiocre	Faible
PRO (163‰)			
ANN (85‰)			
T (114‰)			
PUB (67‰)			
COM (61‰)			
APP (61‰)			
GDS (61‰)			
M (72‰)			
	TO (50‰)		
	COO (52‰)		
	OB (38‰)		
	FOR (31‰)		
		STA (28‰)	
		RES (27‰)	
		EXP (23‰)	
		SUB (22‰)	
			RAP (12‰)
			EDU (3‰)
		AUT (30‰)	

ANNEXE 2e - AXE 5 : Sciences "Junior / Senior

CONTRIBUTION DES VARIABLES			
Très forte	Forte	Médiocre	Faible
PRO (136‰)			
GDS (112‰)			
COM (93‰)			
PUB (85‰)			
RAP (85‰)			
M (83‰)			
T (77‰)			
	STA (52‰)		
	APP (51‰)		
	AUT (38‰)		
	ANN (41‰)		
	TO (46‰)		
	OB (36‰)		
		RES (26‰)	
		COO (17‰)	
		SUB (17‰)	
			EXP (1‰)
			EDU (1‰)
			FOR (1‰)

IMPACT OF STUDIES PUBLISHED IN THE INTERNATIONAL LITERATURE BY SCIENTISTS AT THE NATIONAL UNIVERSITY OF MEXICO

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ABSTRACT

A total of 2192 articles published in the international literature with UNAM (National University of Mexico) first author affiliation and registered by the CICH (Centro de Información Científica y Humanística) BIBLAT database from 1978 - mid-1987 were included in our analysis. Distribution of articles according to the main subject areas of the 692 different journal titles used was as follows: Physics 24.1%, Medicine 19.7%, Biology 19.4%, Chemistry 9.7%, Engineering 8.9%, Exact Sciences 7.3%, Geosciences 4.7%, Psychology 0.96%, Agrosciences 0.27%. Thirty-seven percent of articles were published in journals with a known impact factor for 1987 of ≤1, 46.1% (920) in journals within the range of >1-3 average citations/article and only 16.4% (327) in those titles with a factor >3. Fifty-four percent (1082) of studies appeared in journals whose total citation count for 1987 was ≤5000; 7.3% (146) in journals cited >50,000 times in that same year. UNAM scientists therefore as a group tend to publish in journals whose articles are not frequently cited in subsequent publications thus limiting their impact and visibility in the international scientific literature.

RESUME

Un ensemble de 2192 articles publié dans la littérature internationale, indexés dans la base de données BIBLAT du CICH (Centro de Informacion Cientifica y Humanistica) de 1978 à mi-1987, avec l'UNAM (Université Nationale du Mexique) comme affiliation du premier auteur ont servi de référence à notre analyse. La répartition de ces articles selon les principaux domaines des 692 différents journaux concernés est comme suit: Physique 24.1%, Médecine 19.7%, Biologie 19.4%, Chimie 9.7%, Sciences de l'Ingénieur 8.9%, Sciences Exactes 7.3%, Sciences de la Terre 4.7%, Psychologie 0.96%, Sciences Agricoles 0.27%. Trente sept pourcent des articles sont publiés dans des journaux ayant un facteur d'impact pour 1987 ≤1, 46,1% (920) dans des journaux recevant entre 1 et 3 citations en moyenne par article et seulement 16.4% (327) dans des journaux ayant un facteur >3. Cinquante quatre pourcent (1082) des études ont été publiées dans des journaux dont le nombre total de citations au cours de l'année 1987 était ≤5000; 7,3% dans des journaux cités plus de 50,000 fois au cours de la même année. Les chercheurs de l'UNAM ont en effet tendance à publier dans des journaux dont les articles sont peu cités, limitant ainsi leur impact et leur visibilité dans la littérature scientifique internationale.

INTRODUCTION

Much attention has been focussed over the last decade on the accountability of science. Ever tightening research budgets have forced governments and other funding bodies to take a critical look at the results of the projects they sponsor and to assess the relative performances of different institutions and research groups when assigning resources (1).

Criticism aimed at the peer review process, such as partiality of peers, lack of uniformity of criteria and high administrative costs, have forced sponsoring agencies to look for supplementary ways of evaluating research (2). In the search for a quick, in-house aid to traditional assessment procedures for quantitative decision-making, the application of reliable bibliometric indicators for evaluating research output has been the subject of different studies (3, 4, 5, 6). Although the application of bibliometric and other quantitative criteria has been shown to be useful in guiding policy making decisions, it is generally agreed that these have to be applied with caution and it is unlikely that they can be considered as a possible substitute for the traditional peer review procedure. Rather the intention is for quantitative analysis to provide data for the formulation of personal judgements and sometimes even for it to challenge received wisdom (7).

It is important to bear in mind that most of the discussions and methodological developments of science indicators have been carried out within the conceptual framework of the First World countries (8). How then is their role to evaluate Third World research envisaged ? Unlike studies from countries at the centre of world scientific activity, research from the periphery is disseminated mainly through national publications, in a variety of document formats and predominantly in the native languages of the countries concerned (9,10). In consequence, only a small percentage of Third World studies reach the important international bibliographic services which makes them generally available for bibliometric monitoring or screening. This situation is especially critical with respect to the small number of documents from developing countries that are processed by the Science Citation Index, taking into consideration that this is the main and, certainly in the case of the developing world, the most commonly used tool for carrying out citation studies (11). However, reports from the peripheral countries which do reach the international literature have the advantage of publication in a widely understood language (predominantly English) and in those journals which are generally available worldwide for consultation, evaluation and subsequent citation. Perhaps more importantly, publication in core journals assures an acceptable international standard of presentation and level of science (12). Therefore, assessing what a Third World country or sector of this country publishes in the international literature will give us a clear idea of their research which is reaching a wide audience. This then represents their science which is internationally most visible. Also by evaluating production in the international literature, results at both macro (region, country) and micro (institute, research group or individual researcher) levels for Third World research are, at least in theory, capable of comparison quality-wise with their First World equivalents.

In order to get a general picture of the research published by our institution (National University of Mexico, UNAM) which reaches an wide audience, we have carried out a study of the articles published in the international literature by our researchers in different disciplines over a ten year period. We identified areas of high visibility and determined the potential impact of UNAM research based on an evaluation of the impact factors and total citation counts of the journals where the studies were published. Although the use of impact factors to measure the relative quality of scientific journals has come under scrutiny (13), analysis of the citation patterns of journals will give us a valid indication of the visibility of the articles they publish and inform us about the publication strategies of the authors in question (14). When examining the research activity of a large group of researchers, as in our case, the analysis of journal impact factors and citation counts gives a ready, if somewhat rough method of evaluating publication patterns, taking into consideration that publication in high impact and highly cited journals will give the studies the potential or maximum opportunity to achieve high citation rates. In general, quality of research from Third World countries is equated with publication in international journals, although scientists from developing countries take into consideration other factors, such as the applicability of results at local level, when deciding whether to publish research results nationally or internationally (15).

RESEARCH IN THE UNAM

The National Autonomous University of Mexico is the largest institution for higher education in the country and one of the oldest and most prestigious in Latin America - its origins go back to the sixteenth century. Research at the UNAM is currently organised into two separate areas: the humanities and the sciences. The former has more than 800 specialists working in 16 different institutes and centres. Research in science and engineering takes place in 15 institutions, eight centres and three university programmes where more than 1,700 scientists, scholars and technical staff work. Research is also carried out in the schools of Science, Engineering, Chemistry, Medicine and Veterinary Medicine, as well as in other schools located on five campuses off the main University City campus at the southern end of Mexico City. Besides the on-campus activity, scientific and technological research takes place in the University's field stations, observatories, ocean-going vessels, laboratories and national service centres located in different regions of the Mexican Republic.

Basic research is carried out which contributes both to universal scientific knowledge and to the solution of the country's diverse problems. Of high priority is research relating to health, energy and food. Figure 1 shows the number of

UNAM researchers (excluding research technicians and postgraduate scholars) working in the area of science and technology during the years comprising our study. These figures do not include researchers in the humanities nor those working in faculties or schools. However, the core of UNAM scientists is represented by these data.

METHODOLOGY

The 1978 - mid- 1987 records of the BIBLAT database produced by the Science and Humanities Information Centre (Centro de Información Científica y Humanística, CICH) were searched for documents with UNAM first author affiliation. BIBLAT covers papers published in the international literature indexed both by Science Citation Index (SCI) and Social Sciences Citation Index (SSCI). Individual journal titles used were identified and manually classified into subject categories using as far as was possible the section of Journals Ranked by Category - Ranked by Impact Factor of the 1987 (Vol. 19) SCI Journal Citation Reports. Only one subject category was assigned to each journal title. These categories were then assigned to one of the following ten major disciplines: Agrosciences, Biology, Chemistry, Engineering, Exact Sciences, Geosciences, Medicine, Physics, Psychology, Social Sciences and Humanities. Journals of a multidisciplinary nature were classified as such. Where titles did not appear in this list we assigned subject categories to them after consulting well-known periodicals directories, such as that published by Ulrich. The impact factors for 1987 and the total number of citations received by each journal title during 1987 irrespective of the years cited (all years column) were identified using the 1987 (vol. 19) SCI Journal Citation Reports (Journal Rankings Section 1 SCI Journals in Alphabetical Order). Articles were assigned the impact factors and total citation counts of the journal titles where they were published. The impact indicator we used for UNAM articles is comparable with Braun and his group's expected citation rate for articles (14).

RESULTS

A total of 2192 articles were retrieved with UNAM first author affiliation which had been introduced into the BIBLAT database from 1978 to mid-1987. These were published in 692 different journal titles. Figure 2 relates the number of UNAM articles published yearly to the total number of articles with Mexico first author affiliation in the BIBLAT database. The percentage UNAM contribution to total Mexican production in the international literature over these years is of the order of 40%. A gradual rise in both UNAM production of articles and for Mexico as a whole was noted from 1978 to 1985.

Almost one quarter of the articles authored by the UNAM were published in journals in the field of physics, followed by around 20% in both the medical and biological fields, and a further 10% in chemistry. Less than 3% of articles related to the humanities and social sciences (Figure 3). The differences in publishing patterns between disciplines is apparent in this figure. Note that in the physics field, 24% of total articles was published in just 13% of the 692 journal titles whereas in engineering a similar percentage of journal titles was used to publish only 8.9% of articles. This indicates that the physicists concentrated their articles in a reduced number of journals, whereas the engineers showed a dispersion of articles publishing fewer studies in the same number of journal titles. Figures 4 and 5 illustrate this point more clearly with the physicists publishing a large number of articles (up to 23) in certain journal titles. When examining all fields as a whole we found that half the titles identified were used only once. At the other extreme we found individual journals where up to 64 UNAM first author articles had been published during the ten year period (Figure 6).

A total of 117 (16.9%) journal titles, 39 of which were in the field of social sciences and humanities, had unknown 1987 impact factors. The corresponding figure for articles was 196 (8.9%). The impact factors for the remaining journals and their corresponding articles are shown in Figure 7. A total of 37.5% (749) of articles were published in journals with an impact factor of ≤1, 46.1% (920) with impact factors >1 and ≤3, and only 16.4% (327) in journals with a factor >3. Two articles were published in the medical journal, The Lancet, which has an impact factor of 13.25, three and eight respectively in the mutltidisciplinary journals, Science with a factor of 14.30 and Nature with a factor of 14.99, and one in Review of Modern Physics with a high impact factor of 16.28 characteristic of review journals. Fourteen articles were published in the Journal of Neuroscience Research with the highest impact factor found in this study of 22.27. Figure 8 gives a breakdown of journals and articles with impact factors of ≤1. The majority of these articles (60%) were published in journals with impact factors of >0.5.

Table 1 gives a breakdown of impact factors of journals and articles published in the areas of physics, engineering and medicine. In physics 39.8% of articles had impact factors ≤1, in engineering, 74.4% (100% had impact factors ≤2) and in medicine, 30.1%. The distribution of articles in journals with impact factors ≤1.0 showed around 55% with figures of ≤0.5 in physics and in medicine, while in engineering approximately 40% were in this range.

Figure 9 shows the distribution of the total citation counts given to each journal title during 1987. One hundred and thirteen titles (16.3%) and their corresponding 190 (8.7%) articles were eliminated from this part of the study because of absence of data. Over 76% of journals and 54% of articles had total numbers of citations of ≤5000. The breakdown of documents with total citation counts of ≤5000 is illustrated in Figure 10. Approximately 68% of articles were published in journals which received 2000 citations or less during 1987.

Table 1. Impact of journal titles in physics, engineering and medicine

	PHYSICS				ENGINEERING				MEDICINE			
IF	J.	% J.	Art.	% Art.	J.	% J.	Art.	% Art.	J.	% J.	Art.	% Art.
≤1	47	51.09	211	39.81	73	76.84	145	74.74	64	42.11	130	30.09
2	23	25.00	92	17.36	22	23.15	49	25.25	47	30.92	124	28.70
3	15	16.30	160	30.19	0	0.00	0	0.00	20	13.16	76	17.59
4	5	5.43	57	10.75	0	0.00	0	0.00	10	6.58	67	15.55
5	0	0.00	0	0.00	0	0.00	0	0.00	6	3.95	14	3.24
6	0	0.00	0	0.00	0	0.00	0	0.00	1	0.66	1	0.23
7	1	1.09	9	1.70	0	0.00	0	0.00	1	0.66	2	0.46
8	0	0.00	0	0.00	0	0.00	0	0.00	1	0.66	2	0.46
9	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
>10	1	1.09	1	1.09	0	0.00	0	0.00	2	1.32	16	3.70
Totals	92	100	530	100	95	100	194	100	152	100	432	100

Table 2. Total number of citations given to journal titles in physics, engineering and medicine

	PHYSICS				ENGINEERING				MEDICINE			
Cit.	J.	% J.	Art.	% Art.	J.	% J.	Art.	% Art.	J.	% J.	Art.	% Art.
≤5000	64	69.57	215	40.57	89	93.68	180	94.24	110	72.37	245	56.71
10000	14	15.22	100	18.87	5	5.26	10	5.23	22	14.47	69	15.97
20000	6	6.52	71	13.40	1	1.04	1	0.51	12	7.89	67	15.51
30000	3	3.26	34	6.42	0	0.00	0	0.00	3	1.97	21	4.86
40000	2	2.17	23	4.34	0	0.00	0	0.00	2	1.32	7	1.62
50000	0	0.00	0	0.00	0	0.00	0	0.00	1	0.66	19	4.40
60000	1	1.09	37	6.98	0	0.00	0	0.00	1	0.66	2	0.46
70000	1	1.09	9	1.70	0	0.00	0	0.00	1	0.66	2	0.46
80000	1	1.09	41	7.74	0	0.00	0	0.00	0	0.00	0	0.00
90000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
100000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
>100000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Totals	92	100	530	100	95	100	191	100	152	100	432	100
≤500	20	31.25	69	32.09	39	43.82	59	32.78	42	38.18	80	32.65
1000	12	18.75	39	18.14	8	8.99	18	10.00	14	12.73	29	11.84
2000	15	23.44	65	30.23	26	29.21	51	28.33	24	21.82	60	24.49
3000	10	15.63	25	11.63	7	7.87	29	16.11	9	8.18	22	8.98
4000	3	4.69	11	5.12	5	5.62	12	6.67	8	7.27	33	13.47
5000	4	6.25	6	2.79	4	4.49	11	6.11	13	11.82	21	8.57
Totals	64	100	215	100	89	100	180	100	110	100	245	100

Table 2 analyses the distribution of total citation counts in three different disciplines. The percentage of articles published in journals with total numbers of citations ≤5000 were 40.6% in physics, 92.3% in engineering and 56.7% in medicine. Over 16% of physics articles were published in journals which received between 60,000 and 90,000 citations. When examining articles published in journals with a total citation count ≤5000, percentages of articles and journals in all three disciplines were heavily biased towards citation counts of ≤2000.

DISCUSSION

According to the figure of 3335 total 1981-1985 production of papers in SCI with first author Mexican affiliation (14) and based on our total of 1459 UNAM papers in the same period, the extent of UNAM participation in Mexican research published in the international literature is around 43%. This figure is in keeping with our calculation of 40% using the BIBLAT database. However, this figure does not take into account articles in the international literature where the UNAM and other Mexican scientists appear as coauthors. Nor does it consider publications in national journals and other locally edited document formats. The institutes and centres for scientific research in the UNAM edit 12 journals which are heavily used by UNAM researchers to publish their results.

When we equate the number of articles published yearly in the international literature by UNAM first authors with the number of core UNAM scientists, we find an increase from 0.24 articles per researcher in 1979 to 0.38 in 1985. This suggests consolidation of research groups reflected in higher productivity in the international journals. Nevertheless, the research output per scientist is still low and suggests an average production of only one article every 2 or 3 years. However, with respect to other scientific communities in countries, such as Spain and Venezuela, which like Mexico have no strong tradition of scientific research, the existence has been shown of both a considerable percentage of scientists who never publish either nationally or internationally, as well as the presence of a small number of highly prolific authors (16). This suggests that it is unreasonable to think in terms of average numbers of papers per scientist in developing countries based on group totals, but rather we should examine the distribution of output within groups of researchers.

Again taking into account the distribution of the Mexican 1981-1985 SCI production of papers (14), the UNAM participation was found to be considerably lower in the life sciences than the country as a whole (40% UNAM in medicine and biology compared to 58% Mexican production in the life sciences). Little difference was seen with regard to chemistry (10% UNAM and 8.7% Mexico, respectively) and the percentage figures for physics were identical (24.1% in both cases). When we compare the latest SCI 1981-1985 figures for Mexico as a whole (14) with those presented for 1973-1975 (17), we notice a twofold increase in the percentage production of papers in physics (24.1% against 12.3%) with a corresponding drop in the medical-biological field (58% in life sciences as opposed to 77% in medicine and biology).

The small percentage of UNAM studies in social sciences and humanities reaching the international literature is probably a reflection of the publication strategy employed by Mexican researchers in this area. While researchers in the exact and empirical sciences consider publication in the international literature desirable, their counterparts in the social sciences and humanities concentrate the results of their research in nationally published books and journals. The small contribution made by UNAM researchers to the agrosciences is explained by the absence of faculties in our institution for research in this important area for development. However, this void is filled by government research facilities and a separate university dedicated to education and research in the agricultural field.

It is interesting to note the different publication strategies of scientists working in different fields. While the UNAM scientists as a whole published articles in a wide range of journals with 50% of journals publishing only one article, UNAM physicists showed a preference for publishing in a selected core of journals. UNAM engineers also seem to publish over a wide range of journal titles. However, much of the research carried out in the engineering fields is financed by industry which often implies confidentially of the results obtained. Even when not confidential, research output is channeled through documents, such as technical reports and patents, which are not indexed in SCI. Without studying in detail the publication strategies of individual scientists and groups of scientists, it is impossible to know the reasons behind these differences, although we could speculate that the physicists possibly represent a more homogenous, established research community which has defined preferences for publishing in certain journals. The majority of UNAM scientists, on the other hand, appears to lack unified criteria for the selection of journal titles in which to publish. This situation is reflected in the wide variety of titles employed for publication, the majority of which have low impact factors and total citation counts.

Arunachalam and Singh (18) in a study on Israeli scientists mention a large number of papers published in journals whose impact factors were greater than 2. They quote examples from two areas (Physics, Chemistry and Exact Sciences, and Life Sciences) where the percentage of these papers is just over 50%. In our study this figure was around 37% taking into consideration all areas of UNAM research which basically correspond to the above areas mentioned by the Indian authors.

It is important, however, to bear in mind that bibliometric indicators, such as used in this study, vary with time and with the discipline under consideration (19). According to Garfield (20), smaller fields like botany and mathematics do not generate as many articles or citations as say, biotechnology or genetics. Also, he points out, in certain fields it may take ten years or more for an article to attract a meaningful number of citations. The highest 1987 impact factors for all journals indexed in SCI corresponded to the biomedical area and especially to review publications. The non-review journal with the highest impact factor for 1987 was the biological title Cell Biology with a factor of 22.79, followed by Journal of Neuroscience Research with 22.27. Review journals in the biomedical field reached impact factors of up to 35 for 1987. Physics journals in contrast showed considerably lower impact factors for 1987 than those in the biomedical field which explains some of the differences we found with respect to the publication patterns of UNAM scientists in these two areas.

Further studies on UNAM research output need to be orientated towards defining with precision the quantitative variation in bibliometric indicators which can be attributed to the differences in publication and citation patterns between disciplines. The results could then be applied to improve the accuracy of research output analysis and evaluation by expert committees when assessing the research performance of individual scientists or, as in our case, groups of scientists, to assign research funding or to select candidates for national prizes or incentives. Not only would we expect to find global differences between disciplines with respect to bibliometric criteria but also variations between different fields within the same discipline, although these would possibly be less significant. As Garfield indicates, the number of authors and journals varies greatly between and within disciplines, as do citation levels and rates (20).

Another fact to be taken into consideration is that the evaluation of research output taking into account the ranking of articles based on journal impact factors does not tell us anything about the real citation rates of these articles. In the study carried out by Schubert and his coworkers to develop a comprehensive set of indicators for 96 countries (14), the impact of Mexican studies in certain subdisciplines, such as astronomy and astrophysics, was found to be superior to that expected from estimations based on the average citation rates per paper of the journals concerned. In general, however, the real citation rates (observed citation rate) of Mexican articles in all major disciplines was found to be below the expected citation rates. In other words, Mexican articles were cited less times on average than studies from other countries published in the same set of journal titles.

In conclusion, we can say that UNAM scientists in general publish as first authors in international journals which are not frequently cited by other scientists, thus reducing the visibility and possible impact of studies carried out in this institution. However, indications point towards the existence in the UNAM of an elite group of researchers whose publication strategies include the dissemination of articles in journals with high impact factors and citation rates. However, it is necessary to eliminate variations relating to disciplines before arriving at definite, well-fundamented conclusions concerning the publication patterns of UNAM scientists. We also need to look at publication strategies when the UNAM researcher is not the senior author but rather one of the coauthors, which indicates the existence of collaborative studies between the UNAM and other institutions both in a national and international context. It would also be interesting to analyse further the performance of UNAM scientists in different disciplines, particularly with respect to possible variations in output between UNAM researchers and their colleagues working in other national institutions.

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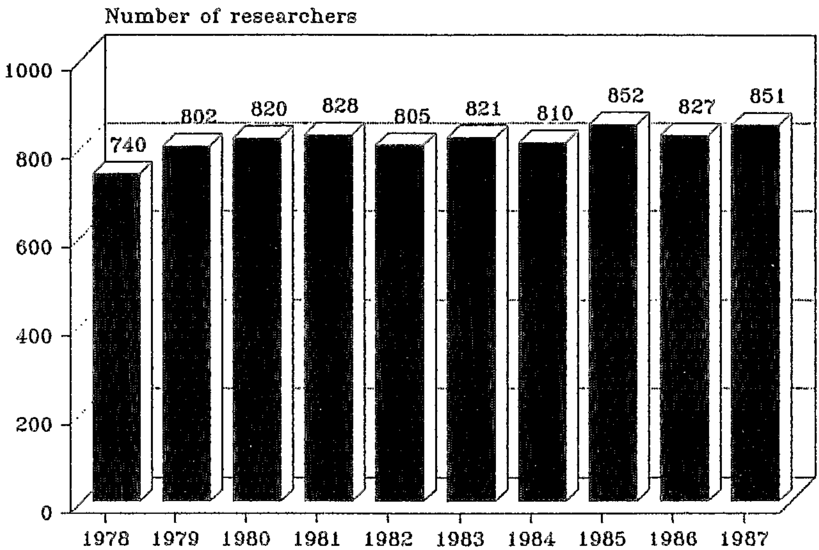
FIGURE 1

Annual distribution of UNAM research scientists



SOURCE: ANALISIS DESCRIPTIVO DEL PERSONAL ACADEMICO DEL SUBSISTEMA DE LA INVESTIGACION CIENTIFICA UNAM. CTIC REUNION FORANEA QUERETARO, QRO AGOSTO 1–4 1990

FIGURE 2

Annual production of articles

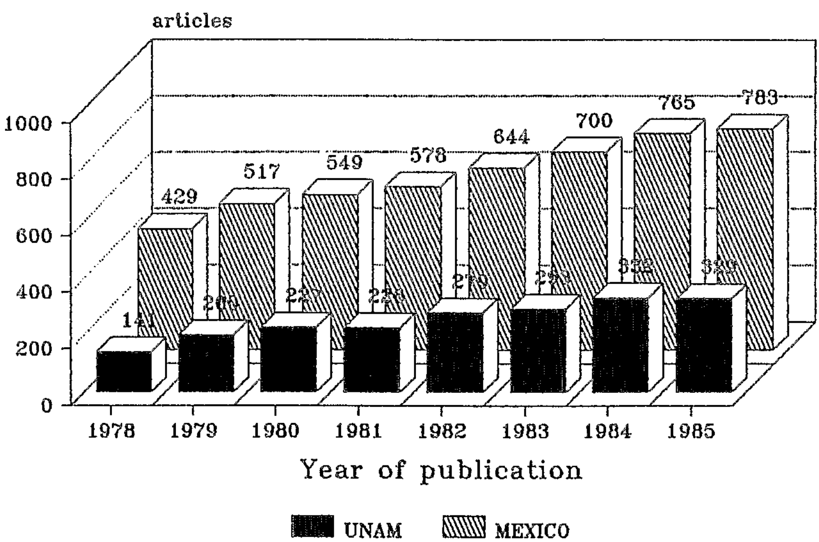
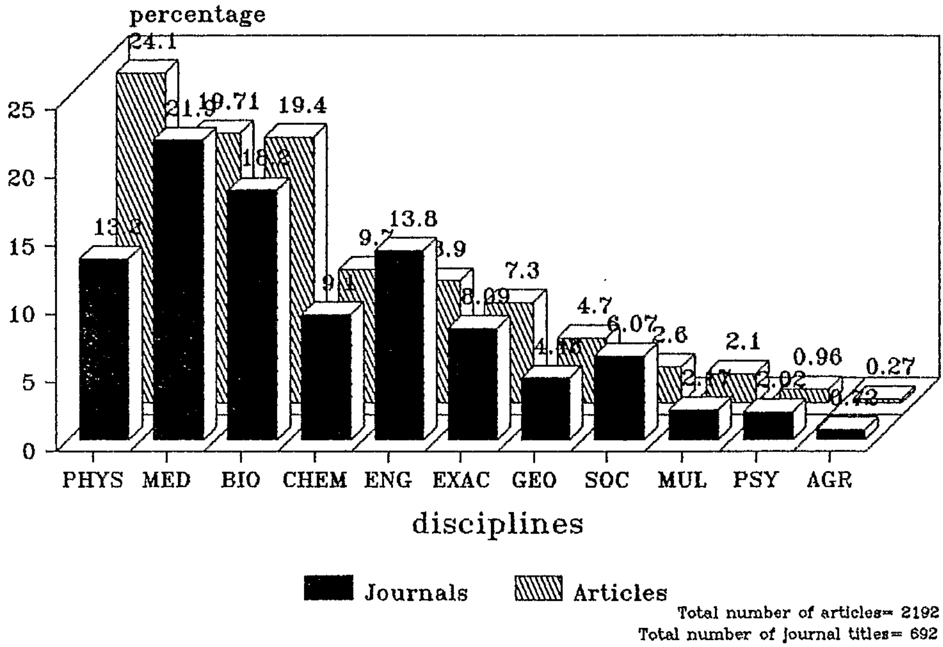


FIGURE 3

Distribution of journal titles and articles according to the major disciplines



PHYS = PHYSICS
MED = MEDICINE
BIO = BIOLOGY
CHEM = CHEMISTRY
ENG = ENGINEERING
EXAC = EXACT SCIENCES

GEO = GEOSCIENCES
SOC = SOCIAL SCIENCES AND HUMANITIES
MUL = MULTIDISCIPLINARY
PSY = PSYCHOLOGY
AGR = AGROSCIENCES

FIGURE 4

Distribution of articles in physics journals

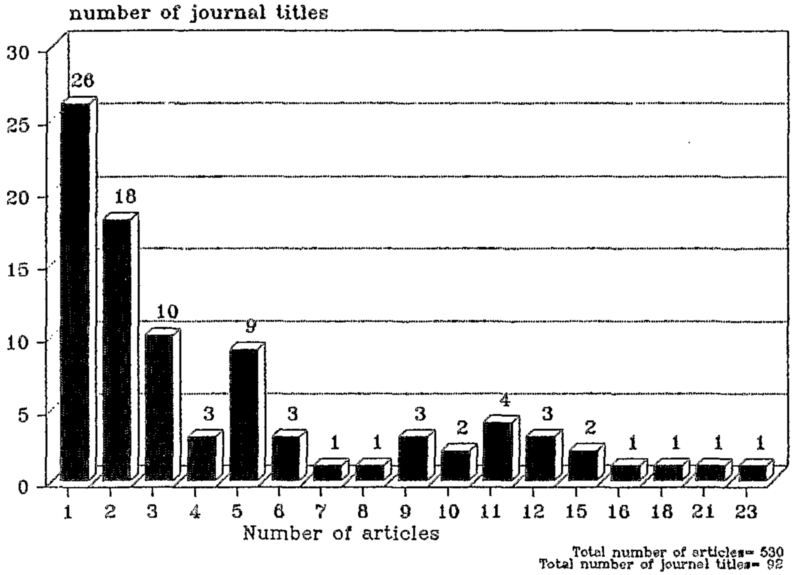


FIGURE 5

Distribution of articles in engineering journals

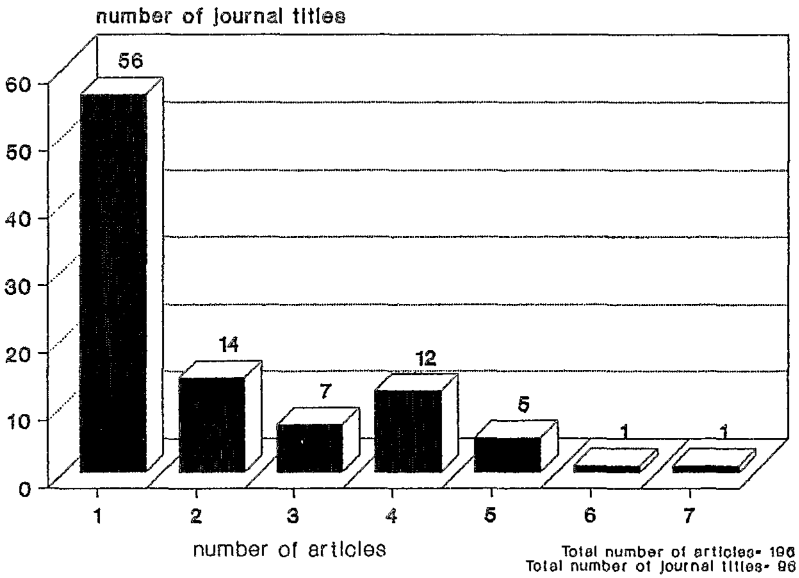


FIGURE 6
Distribution of articles in different journal titles

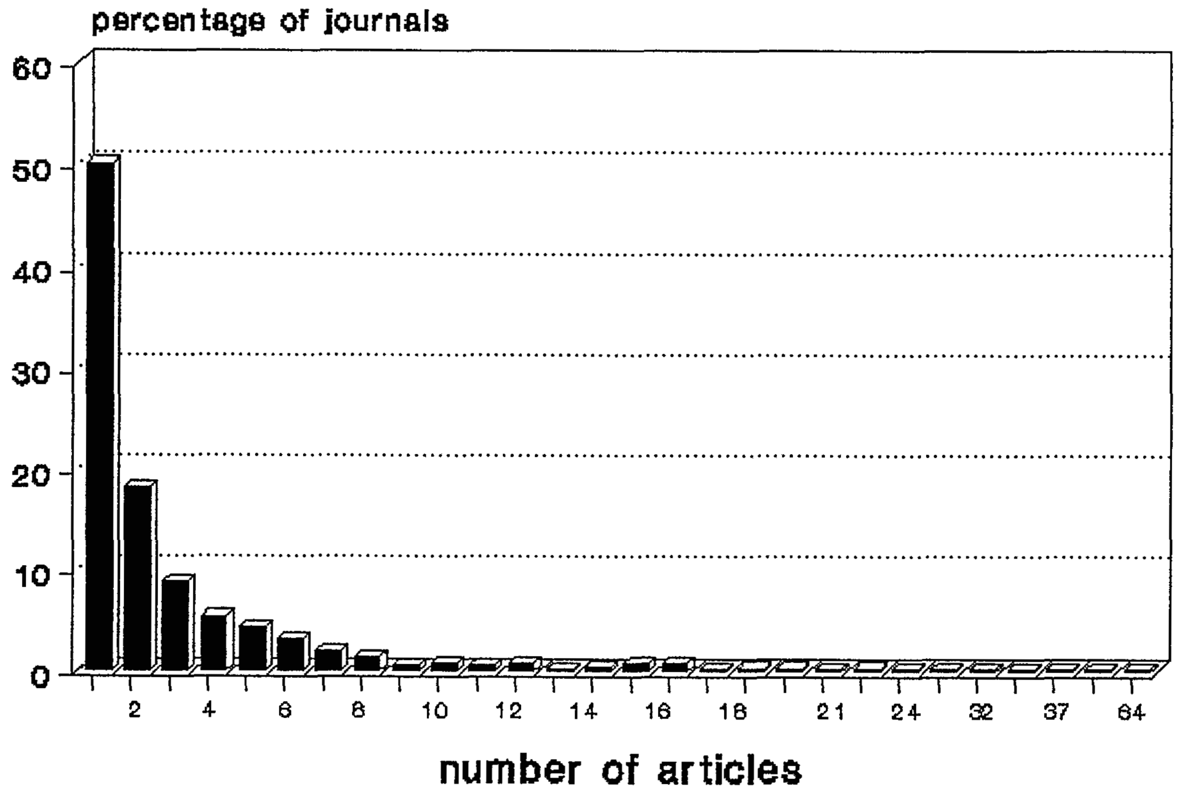


FIGURE 7
Distribution of journals and articles
according to impact factors

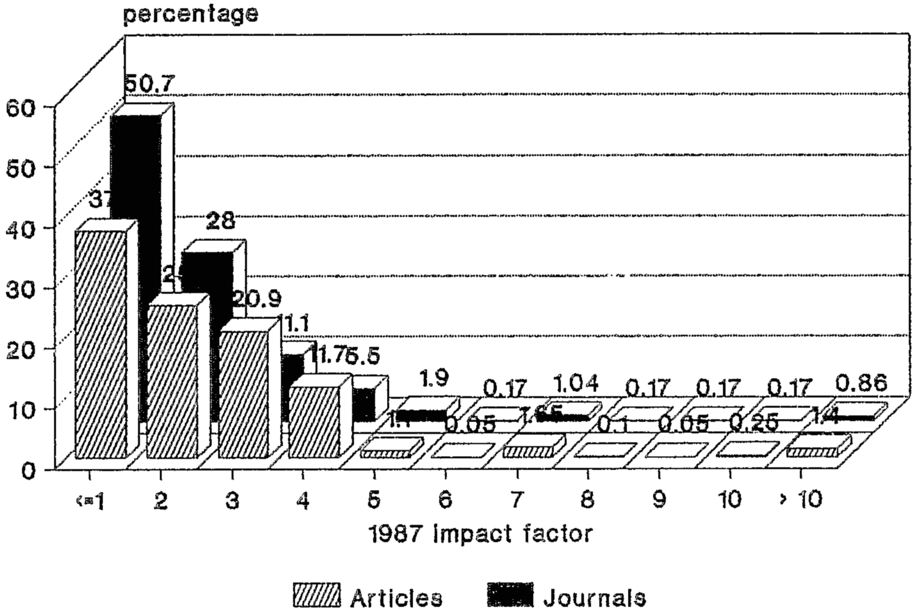


FIGURE 8
Distribution of journals and articles
with impact factors <= 1

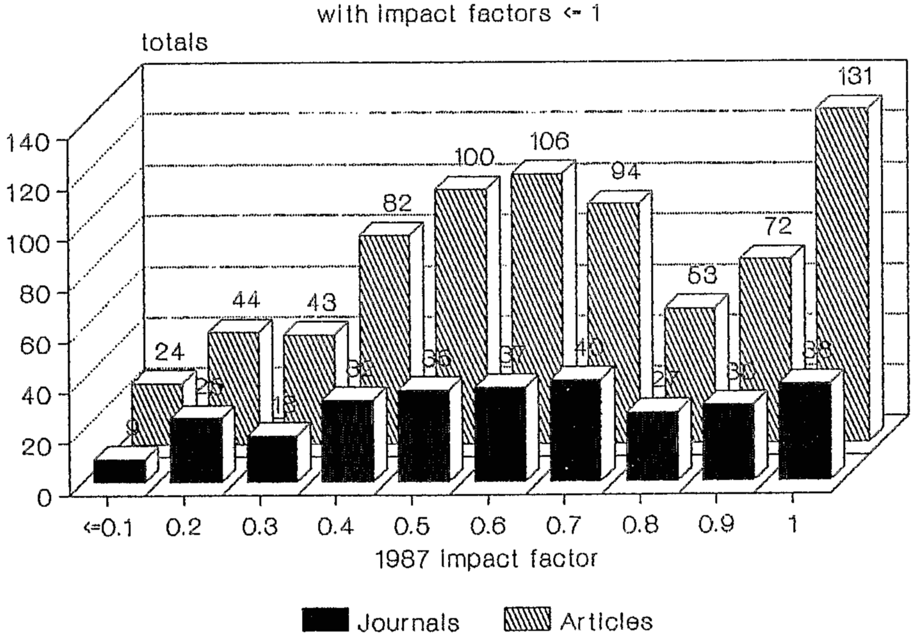


FIGURE 9

Distribution of journals and articles
according to total number of journal citations

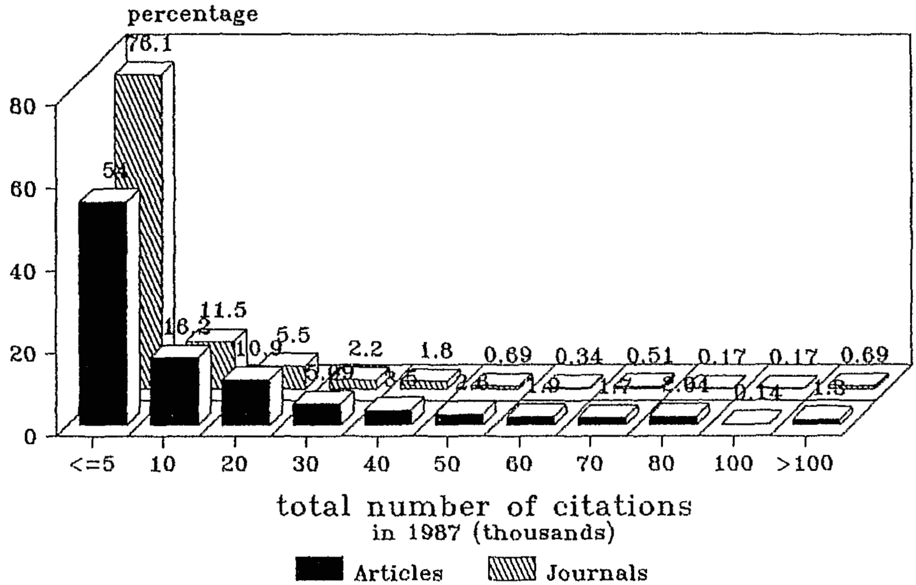
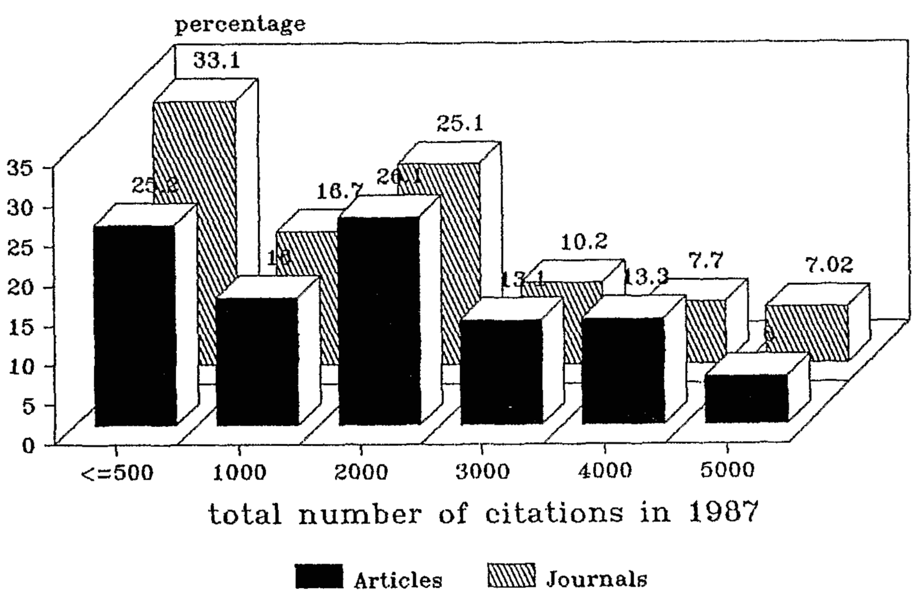


FIGURE 10

Distribution of journals and articles
with total number of journal citations <= 5000



SCIENTOMETRIC INDICATORS AS A MEANS TO ASSESS THE PERFORMANCE OF STATE SUPPORTED UNIVERSITIES IN DEVELOPING COUNTRIES: THE CHILEAN CASE

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ABSTRACT

Chilean universities are responsible for more than 80% of the science produced in the country, which in the last 20 years with some periods of great difficulties, has grown more than 600%. One of the underlying problems of the governments of developing countries to delineate suitable strategies to allocate efficiently the few funds available, has been the absence of clarity to distinguish the individuals and centers committed with competitive scientific research. As a consequence, the scarce state funds, do not always reach to the right people and to the right places, amplifying the already existing problems for the good scientists that resist to emigrate. To evaluate the corresponding situation in Chile, and to follow the results of substantial actions to support the scientific activity in the country, we have examined the performance of state financed universities.

RESUME

Les universités chiliennes fournissent plus de 80% de la production scientifique du pays, laquelle a augmenté de plus de 600% durant les 20 dernières années, et cela malgré quelques périodes de grandes difficultés. Un des problèmes que rencontrent les gouvernements des pays en développement pour déterminer une stratégie pertinente d'attribution de leurs quelques fonds disponibles, réside dans l'absence de discernement entre le soutien à apporter aux individus et aux centres qui sont engagés de façon concurrentielle dans la recherche. En conséquence, les financements publics, qui par ailleurs sont rares, n'atteignent ni les personnes ni les lieux qu'il faudrait, renforçant ainsi les problèmes des bons scientifiques qui résistent aux tentations de l'émigration. Afin d'évaluer cette situation au Chili et pour suivre les résultats des actions substantielles menées pour soutenir l'activité scientifique dans le pays, nous avons examiné les performances des universités financées par l'Etat.

INTRODUCTION

With about 8% of the population of the world, the Latin American and Caribbean region hardly contributes with 1.3% of the world's total output of mainstream publications (1,2). As in most developing countries, the region's scientific research is being performed mainly within the framework of universities. Thus, in addition to the intrinsic responsibilities which characterizes higher education and in which original scientific research plays an important role, in general, the universities in Latin America and the Caribbean, provide the main source from which local and not imported knowledge is produced to nourish the society needs and the development of the country.

The higher education scenery of the region is very heterogeneous. The same is true within each country. A peculiar feature in Latin America is that the faculty engaged in active research determine in a high degree the true possibilities of stable and competitive country progress. This is not the case in industrialized countries where universities share this obligation from a primary academic perspective. The reality is not the result of explicit policies. In a way, it has been generated as the result of the absence of adequate policies, matter that deserves further comments. However, the fact that scientific research appears as one of the most valued constituents of contemporary university life in many Latin American countries, responds to important debates and definitions which took place in the sixties.

The search for an identity involving conceptions of social mobility, democratization and capacity to answer to the requirements of the productive apparatus which slowly underwent a trend towards modernization, strengthens the needs for special efforts to train professionals with profound scientific knowledge and capacity to solve the problems of underdevelopment and dependence (3).

During the last three decades higher education in Latin America experienced an immeasurable growth regarding student population, number and kind of institutions involved, and faculty (4). While in 1960 the number of students in the region was 630,000, in 1970 it reached 1.5 million and grew to 5 million by 1980 (4). Furthermore faculty involved in higher education in Latin America comprised in 1965 about 100,000 persons and 600,000 in 1980 (4). The explosive growth of the higher educational system occurred, in general, under precarious economical and political situation which determined in part, that the universities instead of being a model for society, turned into a mirror of the current turmoils.

Chile was not an exception on this rather peculiar kind of growth. Enrollment in universities rose from 24,000 in 1960 to 39,000 in 1984 (4). In the late sixties, graduate programs at Ph.D.'s level began to be offered, but it was not until the eighties that programs towards M.Sc.and Ph.D. degrees covered many areas and reached higher standards with an increasing number of students. From 1981 to 1984 the number of graduate students doubled to 2800 (5). These programs expressed the existing research capacity and the will to proceed with a formal fourth cycle to prepare the scientists that the country needs.

As a consequence of new laws regarding higher education in Chile, the number of state supported universities grew from 8 to 20. In fact, the new universities were derived from campuses of mainly two big state universities. In addition, new truly private (without direct financing from the state) universities were founded. The latter, although to soon to judge, have shown to be teaching oriented and in general, with no interest towards competitive research.

In Chile, from 1965 to 1970, the state invested in higher education about 1% of the GNP; the fiscal support to universities increased to 2% by 1974 and then gradually diminished to 0.87% of the GNP (6). As stated by Sanfuentes (6) some signs revealed that the incidence of the state expenditure in universities would not recover the levels attained between 1971-1974, and that scantily could be maintained around 1% of the GNP. According to Lavados and Lemaitre (7), the restriction emerged when the priority criteria were changed at the time that it started to be corroborated that the expectancies associated to the development of the higher education sector were exaggerated and unrealistic.

The strengthening of scientific research in Chilean universities began almost concurrently with the rapid growth that these institutions experienced. Also with movements involving both students and faculty members who searching for clearer social commitments and in-house democracy, distracted the universities from their primary functions. Excessive ideologization ended with intervention which, --when concluded--, returned the university government to its own members. Time will tell if the identity crisis which denatured the leading role of universities, --as truly intellectual and hierarchical organizations encompassing the integral progress of the society--, will be overcome. One could say that the main current problem of universities is that they are running behind the times.

Examining the many perturbations, --whether originated in the campuses or outside them--, that lead to the present crisis of many universities in the region and in particular in Chile, is beyond the scope of this work and requires a profound study. Nevertheless, there is in Chile a consensus with respect to the preeminent role that these institutions play in the cultural, productive and social processes. Thus both, government and universities have been and are searching ways to define policies to allocate the funds within the frame of the responsibilities that the state has to undertake and, to assure an in-house autonomous and functional organization, to efficiently respond to the demands of a modern society.

As mentioned before, the scientific capacity in Chile is to a large extent embodied in the state supported universities. Thus, their functional organization affects not only their performance with respect to their undergraduate and graduate programs, but also the most important scientific endeavour that the country has. In regard to this matter, it is not irrelevant to keep in mind that because in many countries of the region, the active scientific community is small and a stringent academic hierarchy does not exist, it is frequent that people find (political) ways to anchor themselves in university positions from which they can influence on matters that require more intellectual competence than they can offer (2). According to Sagasti (8) the present situation suggests that during the next years the region will experiment a process of rapid obsolescence which will increase the gap between the productive and social needs. The lack of a sufficient highly qualified human resource seriously limits the progress of the region, especially in those countries where the university system is in crisis.

Developing countries have to deal with a variety of problems affecting the very basis of their development. When comprehension with respect to the role of science and technology exists, suitable and coherent policies to support research are established. When most of the research is performed in the state supported universities, as is the case in Chile, financing higher education becomes a matter of greater complexity. In this paper it is shown that scientometric indicators can contribute to delineate the performance of universities, and also to evaluate their efficiency and efficacy in the use of the public money they receive.

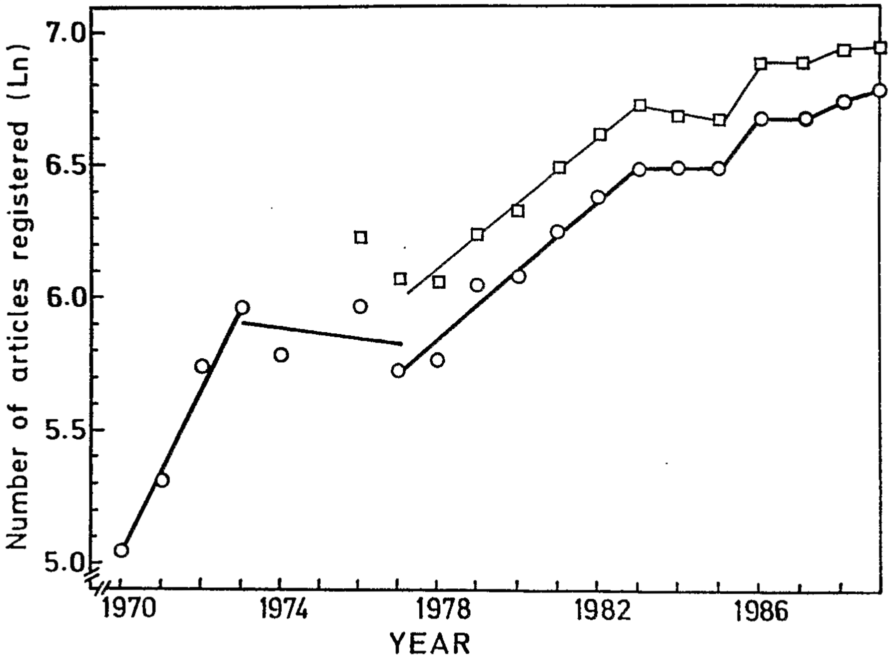
SCIENTIFIC OUTPUT IN CHILE

Scientific activity was studied quantifying the publications registered every year by the Institute for Scientific Information (ISI) and which identified Chile in their address (9-13). For the period 1970-1974 the information was obtained from the corresponding Corporate Index of the Science Citation Index. The articles registered in 1976 and 1977, were obtained through a Scisearch from ISI and the information starting in 1978 through ASCA, also from ISI. During the last few years a bank containing the full references and information regarding the field covered by the publication and the degree of collaborative work involved, is being constructed. Abstracts have not been considered as publications.

The dynamic of scientific output in Chile is shown in Figure 1. When the Ln of the number of mainstream papers registered per year is plotted, it is possible to draw linear regression lines and calculate the slopes representing average annual growth. It is also possible to obtain a plot with the changing trends through a period of time. Knowing turning points helps the analysis of a country's scientific performance specially in the Third World, where most of the time, a true political support towards scientific research does not exist. This means, that specific actions which favor scientific development rarely prevail and are subjected to changes together with government changes. Thus, the trends reveal discrete periods of time in which conditions affected positively or negatively the scientific activity.

It is difficult to ascertain the number of years that mediates between the time that research is executed and the date in which the corresponding publication is registered in the mainstream indexes. In Chile, a rough approximation is 3 to 4 years. This has to be taken into account to analyze patterns as the one of Figure 1. As seen, in spite of the unsteadiness of Chilean universities during the last

Figure n°1. Growth of the number of scientific articles in Chile



□ = total output
O = output corresponding to universities

decades, with the exception of a distinctive period of time, competitive research grew steadily. The fraction (around 85%) of mainstream papers originated in universities with respect to the total output, remains almost constant since its quantification began. Again, this feature is far for being trivial, because universities' performance determines the existing capacity of the country. The changing trends observed in Figure 1 can be correlated with well defined periods of time in contemporary Chilean history in that not only specific policies for scientific research can be clearly perceived, but also government changes and priorities, economical fluctuations and recession periods, and surely important, the government of universities and their permanent debate in search for an identity to satisfy the needs of a society in a developing country aspiring modernization.

Growth rates in numbers of publishing authors have been determined for Chile and for other Latin American countries (2) following Kowach's approach (14). The indicators comparing the decade examined by Kowach (14) and the following five years are shown in Table I. If the 1967-1976 decade is reexamined in 2 periods of five years, during 1967 to 1971 growth rate was significant while from 1972 to 1976, the increment of scientific output stopped (15). The profile is consistent with that obtained when the number of articles were measured (Figure 1).

Table n°1. Growth rates in number of publishing scientists

	1967-1976a		1978-1982	
	Growth rate b	rc	Growth rate b	rc
Argentina	0,143	0,946	0,145	0,984
Brazil	0,211	0,986	0,136	0,985
Chile	0,131	0,860	0,267	0,987
Mexico	0,184	0,983	0,118	0,894
Venezuela	0,090	0,488	-0,007	-0,030

Growth rates in number of publishing scientists in Chile (periods of five years)

1967-1971	1972-1976	1978-1982
0,257 b	-0,01 b	0,267 b

(a) Data from ref. 14; (b) Trend line slope, obtained from plots of the Ln of the number of publishing scientists per year. (c) Correlation coefficient. SOURCE. refs. 2,15.

The climate for science demands state financial investment. One of the big differences between industrialized and developing countries, is the percentage of GNP dedicated to scientific and technological research. If difficulties exist to calculate the exact percentage of the GNP utilized in each country each year, they grow when it comes to ascertain the efficiency with which the money has been used. This is particularly valid for developing countries where the exchange value of currency fluctuates notoriously.

It appears of interest to correlate the information attained with Figure and Table I and with the tendency of the investment in terms of percentage of GNP. Figure 2 shows investment of Chile in R&D according to Dellacasa & Güell (16). Despite the lack of knowledge of the many variables which determine research output, rationalizing resources is for policy makers one of the main targets in their strategies. In Chile this aspect encompasses the financial support to the state university system so as to assure the suitable resources to the faculty involved in competitive research. Thus, scientific output indicators for each university provide valuable information on the existing capacity, the efficiency with which the resources are used and the needs.

Figure n°2. Percentage of GNP invested in R&D in Chile (1965-87)

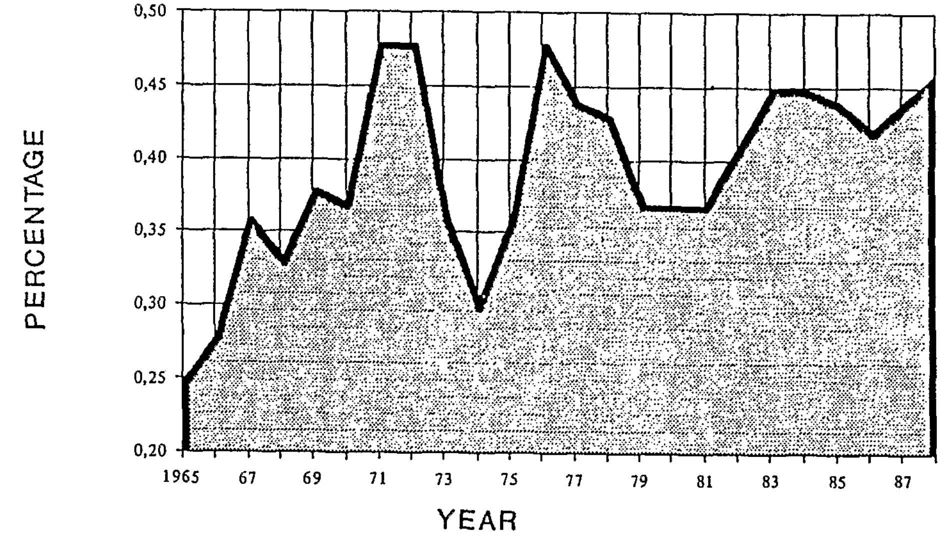


Table II shows the number of mainstream papers originated during the last 3 years in Chilean state supported universities. Clearly the scenario is highly heterogeneous. Furthermore, most of the research output corresponds to 4 of the 20 universities analized.

Because Third World countries are inadequately represented in the international databases, it is clear that the true scientific capacity of the country, and as derivative the one existing in each university, can not be inferred from the scientometric indicators used in this study. Articles from Journals not considered as mainstream, books, patents and royalties, research contracts, success in obtaining competitive grants and Ph.D.'s theses among others, have to be taken into account to delineate a more realistic picture of the available strength and productivity. In Latin America there are many good and competitive Journals which have not succeeded in their attempts to enter the mainstream literature. Needless to say, that in addition, there are also Journals which respond more to personal or institutional interests, and that do not warrant rigorous peer review and frequency of publication and also lack appropriate channels of distribution (17). This is also the case in Chile where efforts have been made to distill an editorial policy (17) to favor the publication of high quality Journals. The concern includes the scientific community and government agencies such as the Chilean Commission for Scientific and Technological Research (CONICYT) which in 1988 started to subsidize the 7 Journals indexed by ISI.

TABLE n°2. Number of mainstream papers published by chilean universities

UNIVERSITY	1987		1988		1989	
UCH	390	(49,9)	398	(45,6)	407	(46,3)
PUC	171	(21,9)	214	(24,4)	195	(22,2)
U.de C.	54	(6,9)	69	(7,9)	65	(7,4)
UCV	14	(1,8)	16	(1,8)	29	(3,3)
UTFSM	32	(4,1)	24	(2,7)	19	(2,2)
USACH	22	(2,8)	26	(3,0)	47	(5,3)
UACH	62	(7,9)	69	(7,2)	69	(7,8)
UN	3	(0,4)	8	(0,9)	3	(0,3)
UV	5	(0,6)	6	(0,7)	8	(0,9)
UA	5	(0,6)	6	(0,7)	6	(0,7)
ULS	2	(0,3)	1	(0,1)	8	(0,9)
UBB	2	(0,3)	0		2	(0,2)
UFRO	7	(0,9)	15	(1,7)	10	(1,1)
UMAG	2	(0,3)	1	(0,1)	1	(0,1)
U TALCA	1	(0,1)	3	(0,3)	4	(0,5)
UAT	0		1	(0,1)	0	
UTA	2	(0,3)	3	(0,3)	3	(0,3)
UMCE	6	(0,8)	3	(0,3)	0	
UPACE	2	(0,3)	4	(0,5)	1	(0,1)
IPO	0		7	(O,8)	2	(0,2)
U.A.IBANEZ	-		-		1	(0,1)
TOTAL U (a)	782		874		880	
OTHER	192	(20,0) (b)	183	(17,7) (b)	182	(17,6) (b)
TOTAL PAPERS	961		1032		1035	

N.B. The numbers in parenthesis indicate % with respect to the total output of universities (Total U). (a): if an article had two or more universities in the author's address it was added to each research center. The actual total number of papers can be easily deducted from the total number of papers which indicate the effective output registered every year. (b): % with respect to the total articles registered in the corresponding year.

Despite the aforementioned limitations and that it is urgent to correct the bias against competitive Journals from Third World countries, scientometric indicators arising from mainstream databases are helpful in developing countries.As stated by Cori (18) counting mainstream papers and ascertaining citation patterns can be useful to compare a country, an institution, or an individual with itself but not with other categories; in chemical languages ISI's databases are useful kinetic indicators. Towards this end the kind of bibliometric data contained in Table II contributes to examine the progress of each university with regard to their scientific activity, and in addition to detect where the most productive research centers are. The database which is been constructed allows the identification of the university departments involved. As shown in Table II there are other institutions which also contribute to the scientific and technological output in Chile. The most relevant area investigated outside de universities is Astronomy. Around 75% of the 1987-90 articles registered in this field originated in the international observatories located in the north of Chile (9). However in the period 1976-79, with a lower output, they reached 91% (13). The fraction of publications in the fields of Medical (clinical) Sciences (30%) and Social Sciences & Humanities (30%) produced outside the university system is also significant (13).

In general the nature of the scientific work performed in Latin America has been largely concentrated in the life sciences with less emphasis on disciplines which have direct influence on industries (2,19,20). Thus the changes attained during the last decade in Chile are relevant. As shown in Figure 3 concurrently with the growth of Chilean scientific output, the field pattern of the publications changed, showing a tendency towards a distribution characteristic of advanced countries (20). Figure 4 depicts the field profile of the publications produced by the universities that follow the same changes which occurred with the whole country's scientific output, except in Astronomy, where their relative contribution increased.

Recent studies have led to the conclusion that in Chile there are between 2400 and 4000 active scientists (21), which beyond any doubt are insufficient for the country's need. Upon mainstream bibliometric studies (2,22) quantitatively, Chilean science occupies the fourth place in Latin America. Scientometric indicators (13) reported by Braun et al. (23-26) reveal that among the first 100 countries, quantitatively Chile ranks 34 in Life Sciences, 38 in Physics, 38 in Chemistry, and 46 in Mathematics. However, when the qualitative impact is measured in the same period (1981-1985) Physics ranks 8, Mathematics 16, Chemistry 35 and Life Sciences 49.

To examine the performance of state financed universities, three distinctive products were measured: (a) The number of individuals which obtained their degrees in Undergraduate and Professional Schools; (b) the number of individuals which reached their Master and Ph.D. degrees, and, (c) the number of mainstream publications. It is clear that the genuine meaning of an university can be hardly reduced to mere quantities of teaching and research products. Nevertheless, their assessment provides valuable information. The problem arises when one compares universities which notorious differences in the amount of public funds they receive. In Chile, an important fraction of the total state funds correspond to what is known as historical antecedents. Thus, there are some universities which consistently receive more state funds than others.

Figure n°3. Percentage of scientific publications in each field registered during 1976-79 and 1987-88

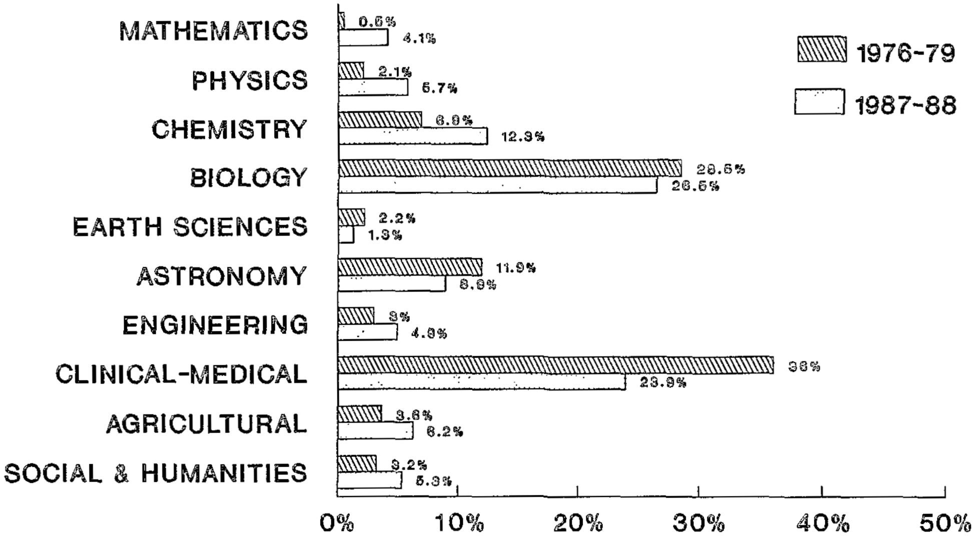
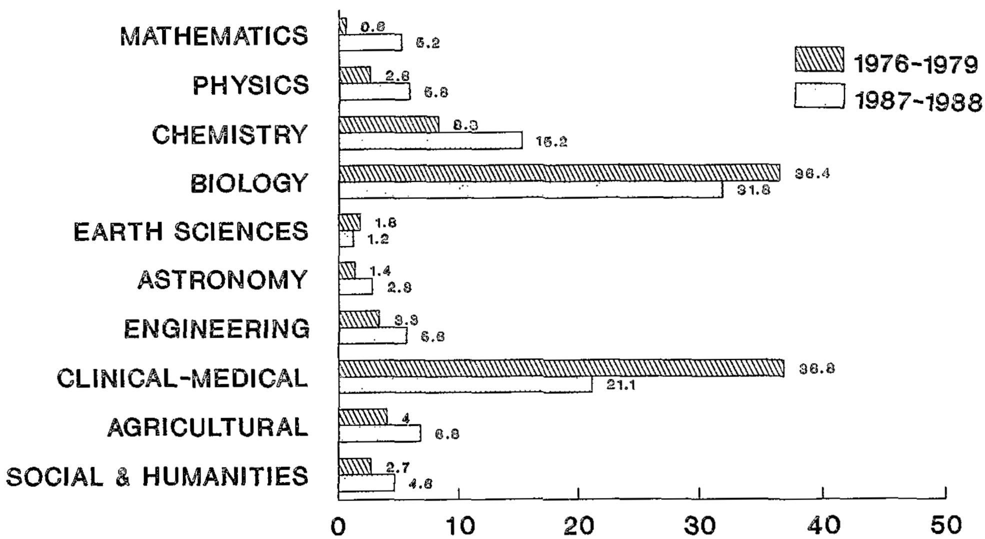


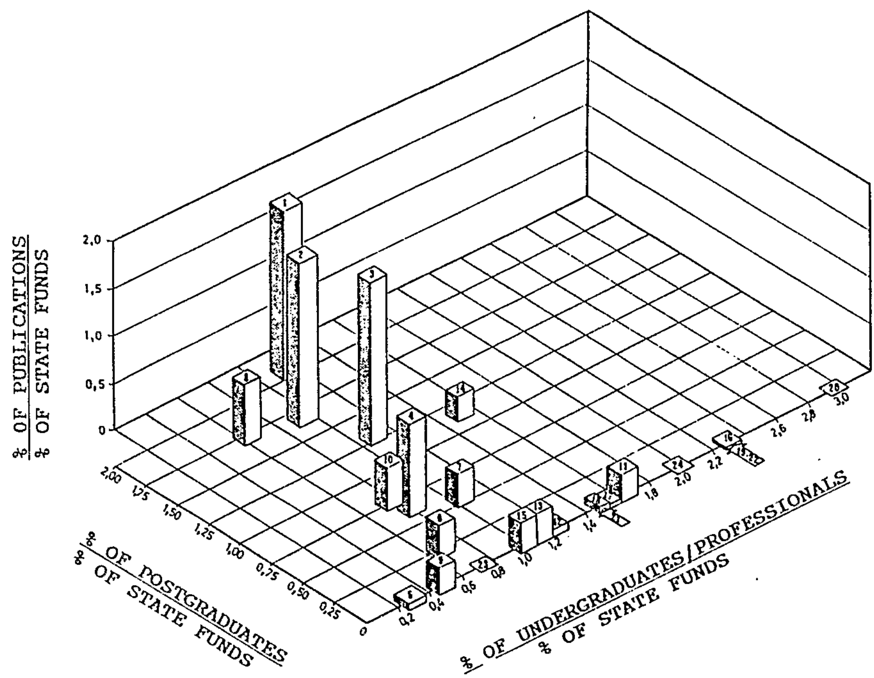
Figure n°4. Percentage of scientific publications originated in Chilean universities in each field during 1976-79 and 1987-88



Because the aim of the approach is to approximate the efficiency and efficacy with which universities use public funds within country resource constrains, it is imperative to standardize the indicators to a common denominator.

Accordingly the percentage of mainstream scientific articles of a given university with respect to the total output of the system, was divided by the percentage of money that the given university received from the total state funds which were allocated to the universities. Similar procedures were followed to compare the relative contribution of each university in regard to undergraduate/professionaldegrees or titles, and postgraduate Master and Ph.D. degrees. Thus, to evaluate the performance of public financed universities, the percentage of individuals graduated in 1985-86 in each university with respect to the total output of graduates in the corresponding category was divided by the fraction of state funds received in 1983 by the given university. This rendered two standardized indicators: undergraduate/professional and postgraduate degrees/titles yield. Scientific production was attained by dividing the percentage of mainstream articles produced by each university and registered in 1985-86, by the fraction of state funds received in 1983 by the given university. The three aforementioned indicators were plotted as depicted in Figure 5.

Figure n° 5. Academic productivity of Chilean state financed universities (Each column represents a university)



The plot represents the academic productivity of a group of Chilean universities and reveals, that indeed the scenario is highly heterogeneous. In the search for efficiency and efficacy it is difficult to asses theoretical optimums. However, the 3-D plot displays a cluster conformed by about 60% of the universities with respect to their undergraduate/professional yield. This is more difficult to distinguish when scientific performance and postgraduate activity is analyzed. Efficacy can be inferred from the correlation that results between scientific output and postgraduate activity. With few exceptions, as seen in Figure 5, the universities with higher indicators in scientific work contribute more to postgraduate training.

The results presented herein, indicate that the use of indicators related to a "unit of state financial support" can provide academic productivity maps which permit to compare the performance of the universities, and might help the design of government policies to rationalize funding and strengthen the scientific capacity so scarce in developing countries. In addition, they can provide valuable in-house information to adjust academic policies and management.

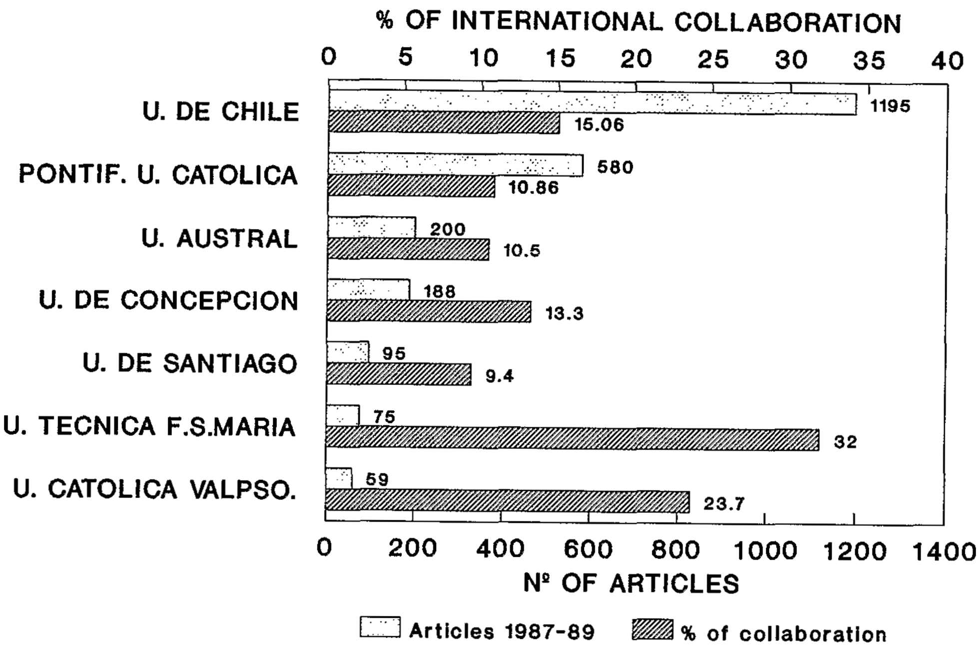
The maps can not provide insights on the quality of the graduates and scientific work performed, matter which is of enormous relevance. However, publishing in mainstream Journals is not an easy task in Third World countries. Peer review is more strict because of distrust in the capacity of developing countries to do science. Furthermore there are natural limitations regarding the English language used in the international scientific literature. Therefore, although not directly, the scientific indicators based in mainstream literature analyses reveal a degree of quality. Accordingly, the use of mainstream literature indicators in developing countries can have a meaning, despite the limitation discussed before.

Postgraduate studies underwent during the last decade a considerable development in Chile. Apart from offering advanced knowledge within a highly creative environment they raised the intellectual capacity that the universities hold. Thus, it is not irrelevant to undergraduate studies that take place in an university, the lack or presence of postgraduate programs (27). This attracts more universities to start such programs. To ensure excellence in the postgraduate programs it is deemed of importance to play public attention on them (28) and to reach as soon as possible the necessary consensus for a proper way to ascribe them public credit (5). Government authorities and faculty are aware of existing risks with respect to the generation of Master and Ph.D. programs not fulfilling the quality standards reached by the existing ones in Chile, and efforts are being made to keep the higher standards possible. It is well established that doctorates demand intensive and competitive scientific research. Scientometric indicators allow the mapping of the most competitive centers.

From the database containing the publications in which Chile is named in the address, it is possible to extract relevant information regarding collaborative work between a Chilean university and a foreign research center. Postgraduate programs require an open window to the world. Competitive scientists too.

During the last decade collaborative research has increased significantly. In fact in 1988 about 18% of all mainstream publications born in Chile shared a foreign address. As for the universities, the percentages reached between 1987 and 1989 are indicated in Figure 6. Interestingly, universities that show lower productivity in number of articles published, exhibit a higher percentage of collaboration with foreign scientists. Although clearly beneficial, it might also show that in-house research capacity is insufficient to cope with the demands of their own challenges. However, because all the universities need to back their needs and weaknesses and avoid inbreeding in their postgraduate training, international collaboration appears to be a must in developing countries. Again, scientometric indicators can contribute to the identification of those centers which fulfill suitable conditions for specific Ph.D. programs.

Figure n°6. International collaborative research.: Percentage of articles published by some Chilean universities in conjunction with foreign centers.



For developing countries which seriously think of attaining progress and international competition, science and technology is a must. In Chile, a National Plan of Science and Technology for Development was started in 1988. Conforming the Plan are actions discussed by the scientific community, the government, universities and the private sector. The Plan serves as backbone for a body of supportive means toward specific ends covering the training for young scientists, support to postgraduate students, research grants to individuals, acquisition of institutional major instrumentation, public acquaintance about the cultural and practical value of knowledge, etc. As the science and technology scenario evolves, the political will has to be expressed by strengthening and increasing mechanisms to support research by means of coherent governmental actions which have to take into account the existing reality. Once more, scientometric studies contribute to evaluate the yield that certain actions produce and the capacity which prevails.

As a recurrent motif in Chile, as in many other Third World countries, any Plan that does not take into account the conditions affecting the overall performance of their universities would be incomplete.

In his already classic essay on *The Mission of the University* (29), Ortega y Gasset stated in 1930 that universities were becoming *a tropical forest of teaching*, meaning by this that information prevailed over formative instruction. Sixty years later this condition predominates in the undergraduate and professional programs of Chilean universities. Most probably they are not an exception, yet an important obstacle for progress. "Universities generally have, as organizations, rather conservative habits of reaction. They shelter many inventive and creative minds and many people capable of reflecting in a free and bold manner on all kinds of problems. But as soon as a really profound and unexpected change is suggested in the curriculum or in the pedagogical or administrative structure of a department or faculty, the professors who see some improvement in this are few indeed". The latter are words of Rev. Alphonse-Marie Parent cited by Goma (30). University in-house conservative attitudes can be also a real problem for science. According to Brunner (31) less than 20% of the total academic staff working in Chile, is actively involved in research. Furthermore, the capacities are concentrated in a few universities. This is consistent with the maps that the scientometric indicators yield. Needless to say that this reality seriously influences in-house decisions.

The task and challenge of the present is to strengthen the scientific capacity of Chile, while preserving the legitimate and invaluable autonomy of the state financed universities which lodge most of the available research abilities of the country. Knowledge of their performance through scientometric analyses can indeed contribute to devise mechanisms for an efficient allocation of the always limited public funds.

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EVALUATION OF RECENT SCIENTIFIC RESEARCH OUTPUT BY BIBLIOMETRIC METHOD

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ABSTRACT

This paper describes a new method of evaluation of scientific output by laboratories engaged in diverse fields of research. The method used is aiming at evaluating those outputs which are quiet recent and not amenable to citation analysis. For the purpose of analysis, impact factor of journals in which papers are published are considered. A method for normalisation of impact factor of journals has been described and, normalised impact factors have also been used It is found that normalised impact factor tends to show better results compared to simple impact factor. The analysis helps us to generate numerous performance indicators such as average impact factor and normalised impact factor for each laboratory and the research complex such as the Council of Scientific and Industrial Research (CSIR) as a whole; average impact factor and normalised impact factor for each scientist of a laboratory and the research complex; spectral distribution of papers falling within various ranges of impact factors and normalised impact factors. By comparing the performances over several years the trend of research activity of each laboratory can also be obtained.

RESUME

Cet article décrit une nouvelle méthode d'évaluation de la production scientifique de laboratoires actifs dans des domaines de recherche variés. La méthode utilisée a pour but d'évaluer les produits scientifiques récents pour lesquels les analyses de citation se révèleraient inappropriées. Il s'agit d'utiliser le 'facteur d'impact' des revues dans lesquelles les travaux sont publiés. Des facteurs d'impact normalisés ont été mis au point et utilisés. Ces derniers permettent d'obtenir de meilleurs résultats que le facteur d'impact simple. Ce travail a permis de générer de nombreux indicateurs de performance tels que le facteur d'impact moyen et le facteur d'impact normalisé pour chaque laboratoire et pour l'ensemble du Conseil National de la Recherche Scientifique et Industrielle (CSIR); un facteur d'impact moyen et normalisé pour chaque chercheur; une distribution spectrale d'articles scientifiques en fonction de leurs facteurs d'impact simple et normalisé. En comparant les performances sur une période de plusieurs années, la tendance de l'activité scientifique de chaque laboratoire peut également être obtenue.

INTRODUCTION

With the appearance of Science Citation Index (SCI) in 1963, it became possible to judge by the citation scenario, the impact a paper has made in the world. The number of citations received by a paper was more or less clearly depicting its impact. In addition the total impact of the contribution of a scientist was also becoming available from the aforesaid publication purely through the citation count of his papers. It is at this time, 1968 to be precise, when SCI was in its formative stage. Dr. Eugene Garfield, the originator of the publication, drew out a list of 50 most cited scientists of the world (Table 1) using SCI database of 1967 from among about a million scientists and predicted that many a scientist appearing in the list would be crowned with Nobel Prize in future [1].

It is rather amazing that in the year 1969 itself Dr. Garfield's prediction came true through the winning of Nobel Prize by M Gell-Mann in Physics and DHR Barton in Chemistry. From 1969 to 1989, as many as 8 scientists figuring in the list won the Nobel Prize. Several scientists like L Pauling (54 Chem), R S Mullikan (66 Chem),F Jacob (65 Med), L D Landau (62 Phys), and S C Eccles (63 Med) figuring in the list won the Nobel Prize before the prediction, and maybe a few more from the list will be winning the award in future.

As can be guessed from the foregoing paragraph and Table 1, the citations received by a paper not only show its impact, but also its quality. An original contribution attracts more scientists and generates more contributions, whereby the original contribution receives more citations. .Review papers, methods papers and sometimes controversial papers also give rise to copious citations..But these papers are generally identifiable, and can be separated out, if need be.

It is now more or less proven that the quality of a paper can be judged on the basis of citations it has received. Of course, there are certain limitations which are as follows:

i) The method of citation counting does not normally apply in judging the quality of a recent paper.

ii) The method is also not very helpful in determining the quality of a paper belonging to engineering sciences.

iii) Review papers normally receive more citations than research papers, and this phenomenon does not mean that review papers are better in quality than research papers. Review papers and research papers belong to two different categories, and they need not be mixed together while judging the quality of the contributions by a scientist.

BIBLIOMETRIC ANALYSIS OF RECENT PAPERS

There is practically no bibliometric method whereby the quality of recent papers can be judged. In 1987 we encountered this problem when we were asked to bibliometrically analyse the research output of 1986 of CSIR (Council of

Scientific and Industrial Research, India) laboratories numbering about 40 to generate indicators which might be useful for decision making and other purposes.

After considering various probables, it was decided that impact factors of periodicals in which CSIR papers have been published can be used in place of citations for our analysis, since impact factor shows the standing of a periodical in the world which is available from the Journal Citation Report (JCR), an associate publication of SCI database [2]. The impact factor is a measure of the frequency with which the 'average article' in a journal has been cited in a particular year. The JCR impact factor is basically a ratio between citations and citable items published. Thus, the 1986 impact factor of journal X would be calculated by dividing the number of all the SCI, SSCI and A&HCI source journals' 1986 citations of articles journal X published in 1984 and 1985 by the total number of source items it published in 1984 and 1985. For example, Nature published 1,192 and 1,176 citable items in 1984 and 1985 respectively and these items were cited 20,173 and 15,943 times respectively in 1986. Therefore the 1986 impact factor (2) of Nature is given by :

$$If = \frac{20{,}173 + 15{,}943}{1{,}192 + 1{,}176} = 15{,}525$$

Our basic premise was that the higher the impact factor of a journal the better will be its quality. Of course, this premise may not hold good where the impact factors of journals are very close to one another. As a corollary to our premise it was assumed that a paper published in a high-impact-factor journal will be better in quality than the one published in a low-impact- factor journal. This premise again may not be always true as some good papers at times may get published in low-impact-factor journals. This type of phenomenon is rather uncommon, and as we were taking a comparatively large sample, about 2000 papers, so we thought that one or two such exceptions would not distort our results very much and our premise would work. From our premise it follows that a laboratory which publishes its papers in high- impact-factor journals, is doing good work, since the journals having high impact factors are in most cases rigorously refereed journals, and getting a paper published in those journals is creditworthy. Taking this as the basis of our work, we proceeded in the following way.

Methodology

First, all CSIR laboratories were requested to send a list of their publications of the year, i.e. 1986. Only research papers, short communications, and the like, published in journals were considered for analysis. The papers presented in conferences, seminars, etc. as well as popular and informative papers were all excluded. Papers published in monographs, patents, research reports were also not considered.

Once we have finally selected the articles for our analysis, we started assigning each paper its impact factor, i.e. the impact factor of the joural in which the paper has been published. It is to be noted that Journal Citation Report is a yearly publication, and it provides impact factors of some 4000 journals selected from all fields of science and technology.

While assigning impact factors to papers, we encountered a formidable problem. Around 50% papers published by CSIR scientists were in such journals as were not covered by JCR. Hence, their impact factors were not available. It was neither possible to ignore the huge number of papers nor any method was known to us whereby we could determine the impact factors of those periodicals. Finding no other alternative, we assigned impact factor to such a periodical arbitrarily keeping in view several factors of the journal like its age, yearly productivity, coverage by abstracting and indexing services and the impact factor of such a journal, which could act as a standard for Indian journals. For example, while assigning the impact factors of general Indian medical periodocals, we always kept in view the impact factor of Indian Journal of Medical Research, which being a SCI covered journal, acted as our standard. We compared other general Indian medical journals with it, and accordingly assigned impact factors taking, of course, other factors also into account as described earlier. Following this method, we assigned the impact factors to all journals not covered by SCI (i.e. non-SCI Journal). This method has since been mostly discarded as we have succeeded to develop a method whereby impact factor of a non-SCI journal can be accurately determined [3]. The impact factor determined by the method is consistent with JCR impact factor.

As can be seen from above, a periodical can have impact factor only when it has completed three years of its age. So, for our analysis, whenever we encountered a periodical aging below three years, 0 (zero) impact factor was assigned to the periodical.

Once assigning of impact factor to each paper was over, the score of a laboratory was determined by totalling the impact factors of all the papers. The exercise helped us to generate the following indicators.

1) Total impact factor of each laboratory (Fig.1)
2) Average impact factor of a paper of each laboratory (Fig.2)
3) Average impact factor of a scientist of each laboratory (Fig.3)
4) Total impact factor of all the laboratories i.e. CSIR impact factor.
5) Average impact factor of a paper of CSIR.

Normalised Impact Factor (NIf)

When we plotted the graph with Total Impact Factor (TIf) of each laboratory (Fig.1) it was found that the TIf of engineering laboratories was coming far below the TIf of biomedical laboratories. Two factors were found to be responsible for this: first, the engineering laboratories published less number of papers, compared to biomedical and other laboratories, and second, engineering science periodicals, by and large were having very low impact factors, compared to those of the biomedical periodicals. For example, the top research journal on aerospace engineering called AIAA Journal was having If of .520 in 1986, when the top journal on general medicine called New England Journal of Medicine was having If of 17.752. In order to resolve this anomaly we had to think of normalised impact factor (NIf).

In JCR, categorywise list of journals ranked by impact factor is available. The ranked list of journals under each category includes both review and research journals. The If of review periodicals are generally high, sometimes very high, compared to research periodicals. For example, in the subject category Biochemistry and Molecular Biology, the 1988 If of Annual Review of Biochemistry (a review journal) is 48.313, whereas the topmost research journal in the subject category is Cell, whose If 24.212 is almost half of Annual Review of Biochemistry! This particular phenomenon makes the normalisation of impact factor of research periodicals unworkable as the impact factor of the topmost periodical under each subject category is normalised to 10 using a suitable multiplier. In a subject category where there is no review periodical, the normalised impact factor of the topmost periodical is 10, but in majority of the fields where a subject category list contains review periodicals, the normalised impact factor of the topmost research periodical falls below 10, sometimes as below as 5. To avoid this type of situation, normalisation of impact factor is done only with research periodicals. Review periodicals are generally left out.

Procedure of normalisation

For determining the normalised impact factor of a periodical, the following procedure is employed.

NIf (J) = If (J) .X where

NIf (J) is the normalised impact factor of the periodical J
If (J) is the impact factor of the periodical J, and
X is the multiplier

Now, the value of X is determined by putting the value of NIf (J) as 10 as the NIf of the topmost research journal in a subject category is always considered as 10 and the value of the impact factor of the aforesaid journal.

Let us take a concrete example to determine the NIf of a periodical. The If of Indian Journal of Medical Research (IJMR) for the year 1988 is 0.204. IJMR belongs to the subject category Medicine, General and Internal, where New England Journal of Medicine (NEJM) is the topmost research journal having the If 21.148.

So, the value of X for this subject category is

$$X = \frac{10}{If(NEJM)} = \frac{10}{21.148} = 0.473$$

Hence, the NIf (IJMR) = If (IJMR) . X = 0.204 x 0.473 = 0.10

Indicators with NIf

Assigning NIf to all the papers, we get the following indicators as we got with If.

1) Total normalised impact factor of each laboratory (Fig. 4).
2) Average normalised impact factor of a paper of each laboratory (Fig. 5).
3) Average normalised impact factor of a scientist of each laboratory (Fig.6).
4) Total normalised impact factor of all the laboratories, i.e. CSIR normalised impact factor.
5) Average normalised impact factor of a paper of CSIR.

Average Impact Factor & Average Normalised Impact Factor of a Paper

The number of scientists engaged in research differs from laboratory to laboratory, and the difference at times is very significant. For example, in the Institute of Microbiological Technology, there are only a few scientists, whereas in Central Drug Research Institute, the number goes far beyond 100. The more the number of scientists, the more will be the number of research papers. Hence, with total impact factor or normalised impact factor, comparison of the performance of the laboratories is not possible. But, the same is possible with the average impact factor and average normalised impact factor. The performance of the laboratories in terms of average If and average NIf can be seen from Fig. 7. It can easily be noticed that average NIf of several laboratories have shot up, and of some others come down. On the whole, the graph of average NIf of laboratories have considerably reduced the disparity in the performances of the laboratories. It seems that normalised impact factor helps to generate better indicators when the comparison of performances of laboratories conducting research in very large number of diverse areas of science and technology is done.

Total Impact Factor (TIf) and Total Normalised Impact Factor (TNIf)

The total impact factors and total normalised impact factors of laboratories help in generating such indicators as average If and average NIf of each laboratory, as well as in determining the trend as to the performance of laboratories over the years.

Average Impact Factor and Average Normalised Impact Factor of a Scientist

This helps to generate indicators as to the productivity per scientist of a laboratory or a group of laboratories pertaining to a broad discipline like Chemical Sciences or Life Sciences, or a big research complex like CSIR.

Total Impact Factor of all laboratories and their average Impact Factor

These help us to study the trend as to the performance of the laboratories taken together over a period of years. It may be pointed out that the average impact factor and normalised impact factor of CSIR laboratories as a whole remained more or less constant at 0.6 and 2 for three years since 1986 .

Papers above CSIR average

Laboratorywise distribution of papers above CSIR average impact factor and normalised impact factor (Fig.8 & 9) provides a good deal of indicators about the papers published in good quality journals. From the graph, one can also have some idea as to the standard of work being done in various laboratories.

Spectral Distribution

Spectral distribution shows the concentration of papers at various impact factor and normalised impact factor ranges (Fig.10 & 11).

CONCLUSION

The CSIR Research Output is being analysed since 1987 following the method described above. This method of analysis has attracted the attention of many scientists of the country, including those in the top brackets, and has earned a great deal of appreciation even from scientists like the Director General of CSIR, and many directors of CSIR laboratories. However, it has attracted criticism as well mainly from the group of engineering laboratories, in as much as engineering periodicals are very sparingly covered by SCI. For some branches like highway engineering and leather science, the coverage of SCI is practically zero. This is for the first time that the method is being placed before a global audience for its proper evaluation.

Acknowledgement

We acknowledge with thanks the encouragement given by our Director, Prof. T Viswanathan, for the writing of the paper, and the permission accorded by him for the presentation of the paper at the International Conference on Science Indicators for Developing Countries, Paris, 1990.

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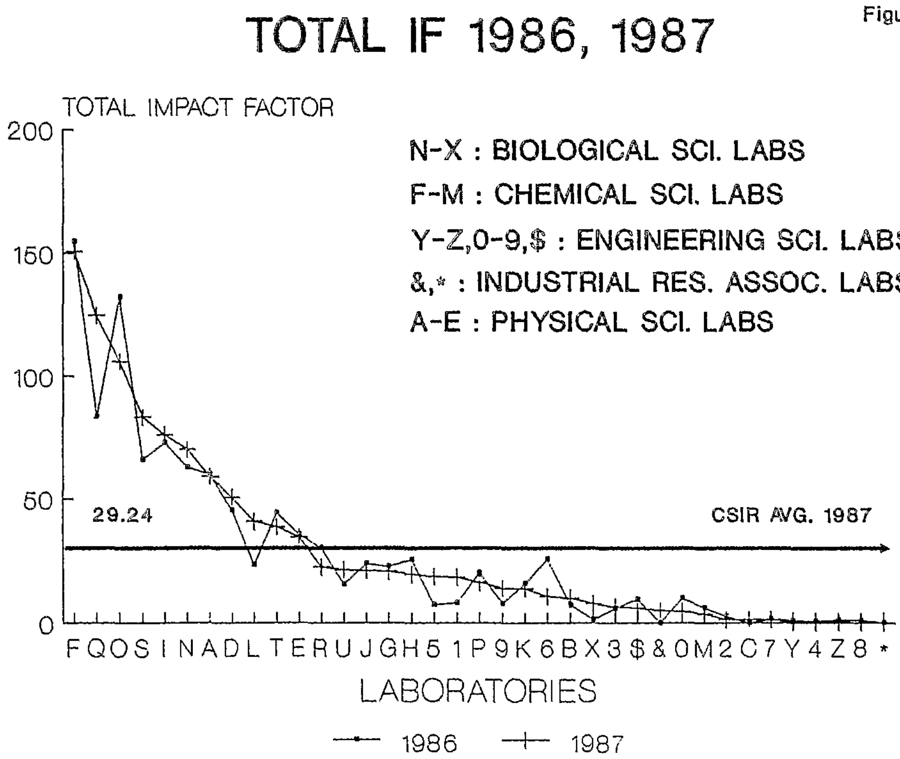
5. Council of Scientific and Industrial Research (CSIR), Research Output 1988 - a Bibliometric analysis. New Delhi: the author, 1989.

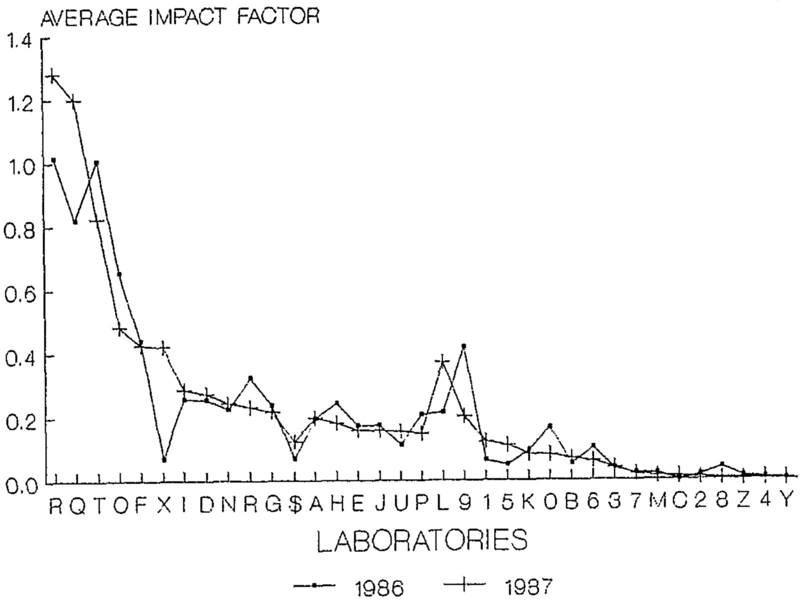
Annex

Figure-1



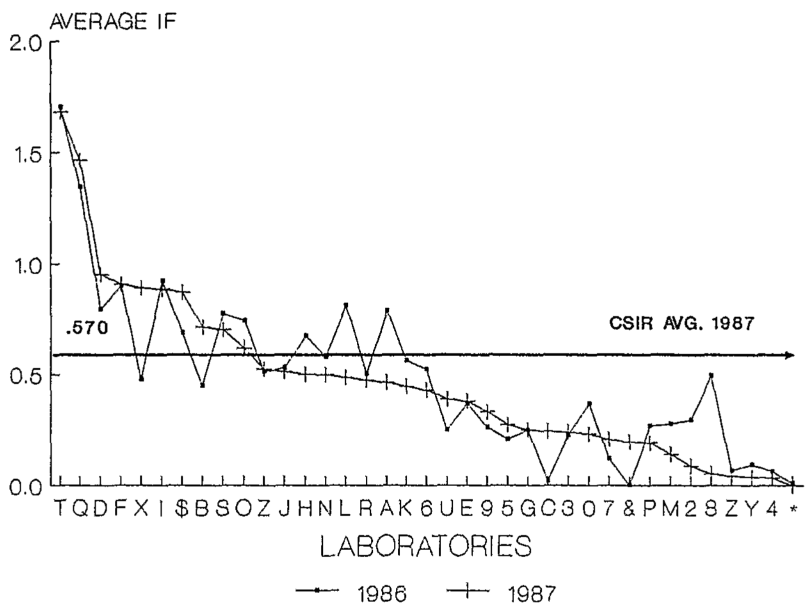
AVERAGE IF/SCIENTIST 1986, 1987

Figure-3



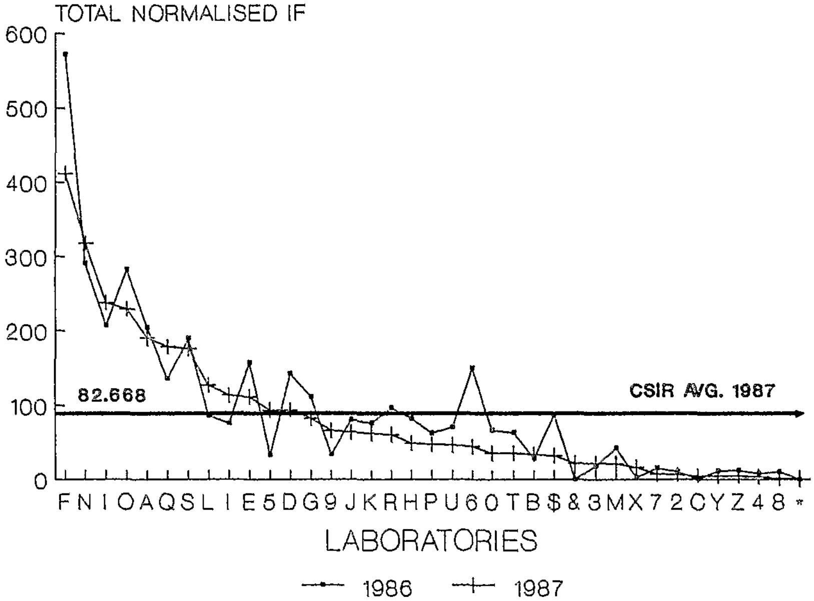
AVERAGE IF/PAPER 1986, 1987

Figure-2



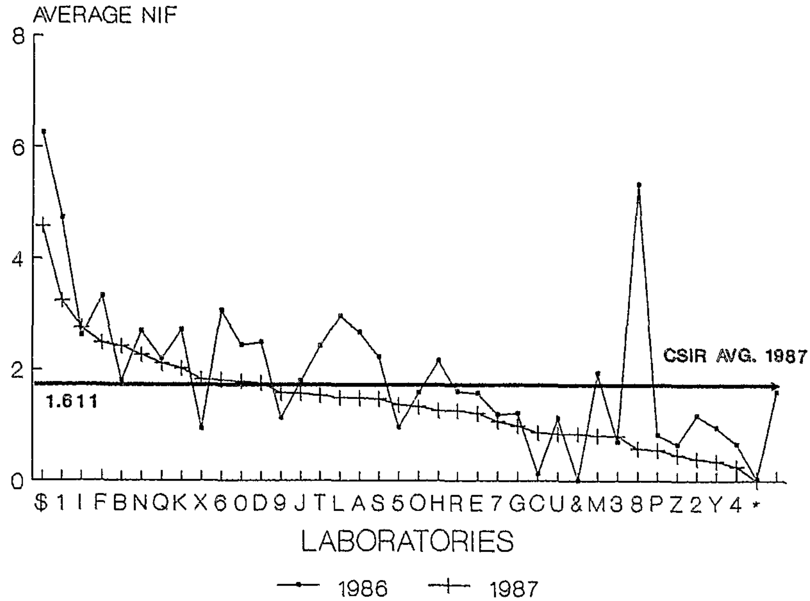
TOTAL NIF 1986, 1987

Figure-4



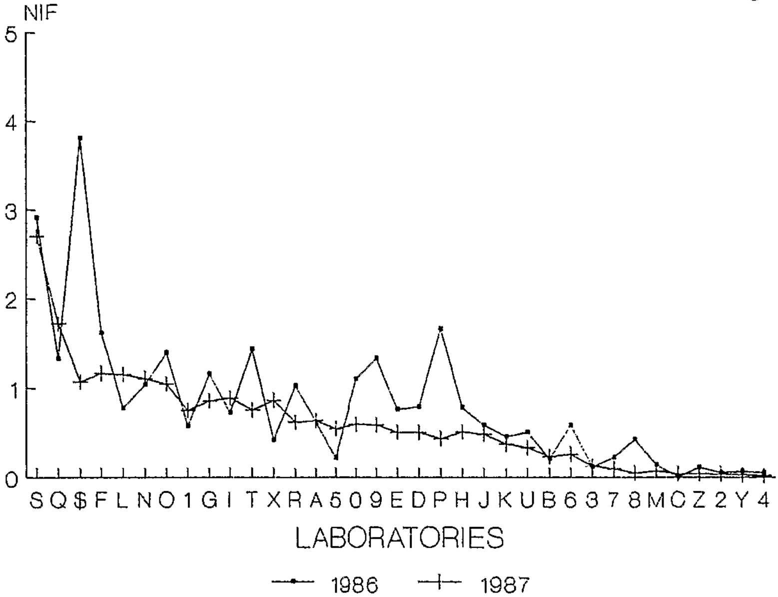
AVERAGE NIF/PAPER 1986, 1987

Figure-5



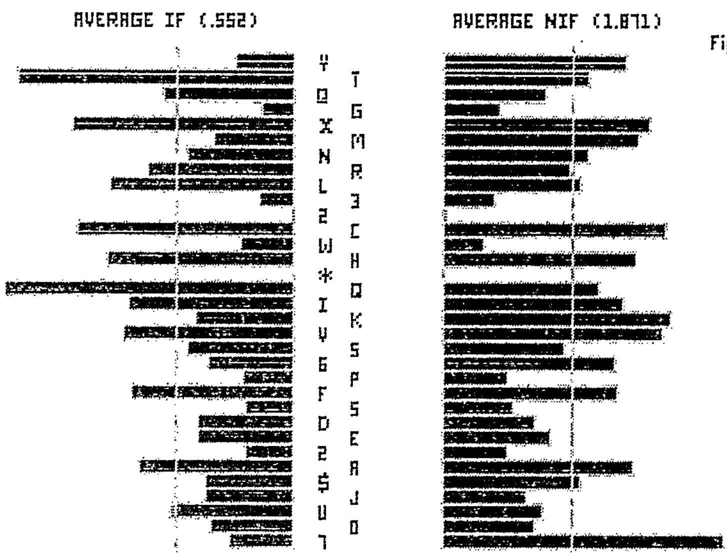
AVERAGE NIF/SCIENTIST 1986, 1987

Figure-6



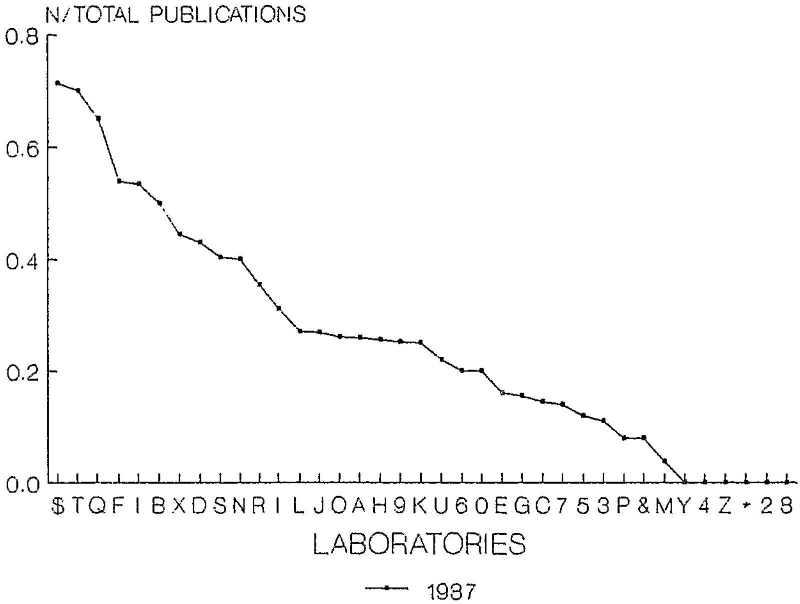
CSIR LABS - AVERAGE IF & NIF (1988)

Figure-7



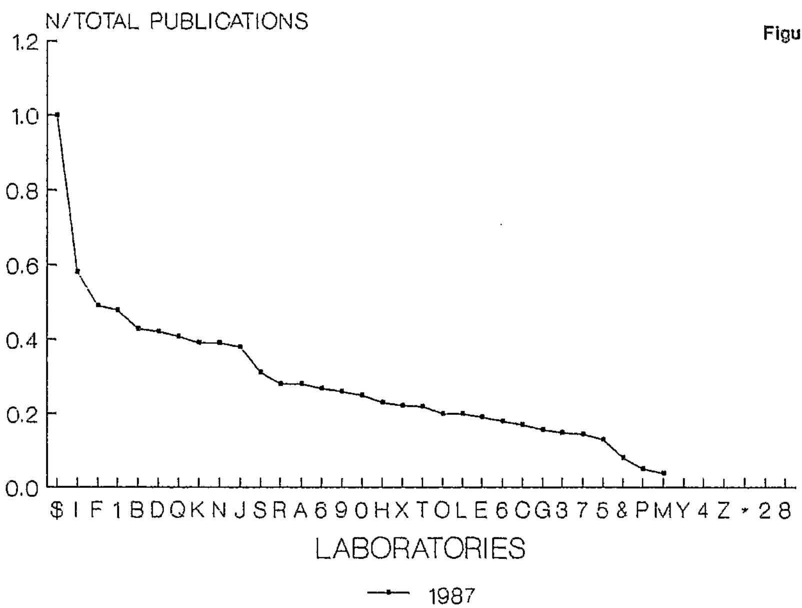
ARTICLES WITH IF >=0.6 (N) 1987

Figure-8



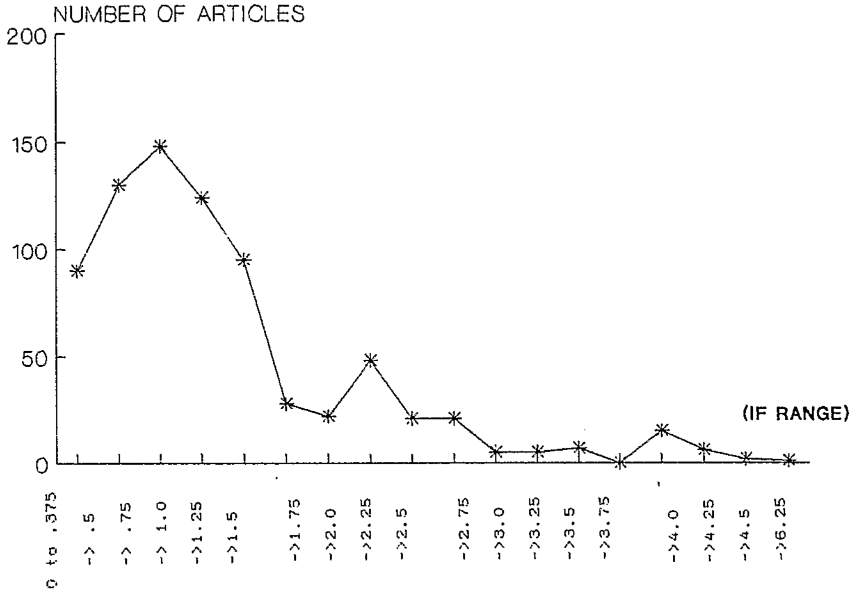
ARTICLES WITH NIF >=2.0 (N) 1987

Figure-9



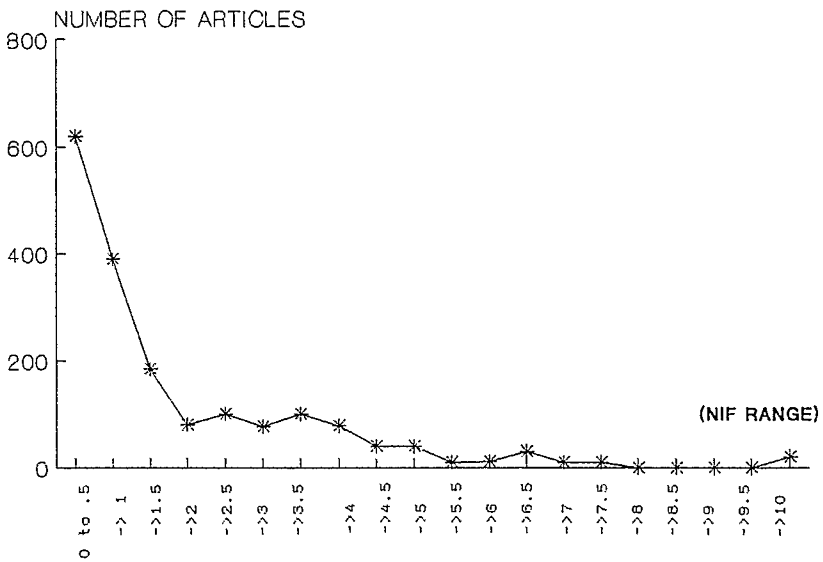
SPECTRAL DISTRIBUTION OF ARTICLES - 1987
(IF RANGE)

Figure-10



SPECTRAL DISTRIBUTION OF ARTICLES - 1987
(NIF RANGE)

Figure-11



INDICES DE STRUCTURATION DE L'ACTIVITE SCIENTIFIQUE
Exemple de cinq domaines avant 1968 en Côte d'Ivoire

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RESUME

Une information scientifique et technique (IST) aussi large que possible est nécessaire pour différencier les activités scientifiques par des indicateurs bibliométriques. Une étude de cas a été réalisée sur la Côte d'Ivoire pour la période antérieure à 1968. En considérant les proportions relatives de différents modes de publication, huit indices de structuration de l'activité scientifique ont été établis. Ce sont les indices d'associativité, de prestige scientifique, présence internationale, coopération régionale, ciblage des publications, mobilité des chercheurs, propriété scientifique, et de disponibilité de l'information. Ces indices mettent en évidence de grandes différences dans les stratégies, les relations avec les partenaires sociaux, les rapports avec la science mondiale, pour cinq domaines : sciences biologiques, sciences de la terre, sciences des milieux aquatiques, sciences agronomiques, sciences médicales. Des méthodes comparables peuvent être envisagées pour caractériser d'autres situations de la recherche scientifique dans les pays en développement. Les indicateurs à retenir devront varier selon chaque cas.

ABSTRACT

In order to have a good image on scientific activities one has to deal with multiple indicators and a scientific and technological information as rich as possible. Here a case study of scientific information on Côte d'Ivoire before 1968 is presented, using eight indicators of scientific structure. These are indicators of associativity, scientific prestige, internationality, regional cooperation, range of publications, mobility of researchers, identity of publications, and availability of publications. These indicators show a variety of scientific strategies, relations with scientific partners, relationships with world scientific activity, for five domains: biological sciences, earth sciences, aquatic sciences, agronomical sciences, medical sciences. Similar approaches could be used in order to describe the science that is done in and on Third World countries. The choice of indicators could be different in different areas of knowledge.

INTRODUCTION

L'étude présentée ici se situe au point de convergence de deux séries de préoccupations. D'une part, elle s'inscrit dans la problématique des recherches sur l'émergence des communautés scientifiques dans les pays en développement. D'autre part, elle représente une contribution aux essais de traitement et d'interprétation des données bibliométriques.

Dans cette double perspective, la Côte d'Ivoire a fourni une étude de cas intéressante. Parmi les pays africains francophones, la Côte d'Ivoire se distingue aujourd'hui par un potentiel scientifique important. Il est utile de connaître les points de départ de la recherche ivoirienne par l'examen de la période coloniale et des années pendant lesquels sont apparues, de façon significative, les premières équipes nationales. La période considérée s'étend depuis les origines de la recherche scientifique sur le sol ivoirien jusqu'à l'année 1968 inclue. Le corpus bibliométrique qui correspond à cette période se prête bien à un essai méthodologique. C'est pratiquement la totalité de la production écrite, publiée, et communiquée qui est disponible, dans les conditions qui vont être décrites maintenant.

DONNEES BIBLIOMETRIQUES

Les listes bibliographiques ayant servi de base à l'étude ont été publiées par Geneviève JANVIER et Guy PERON en 1972 et 1975, après avoir été établies avec le concours de nombreux chercheurs, bibliothécaires et documentalistes. Les travaux scientifiques produits sur le sol ivoirien sont évidemment les premiers retenus, mais G. JANVIER et G. PERON ont accepté aussi dans leurs listes des documents qui concernent la Côte d'Ivoire mais ont été réalisés à l'extérieur. Un cas fréquent est celui de la publication d'un auteur qui ne connaît pas personnellement le pays mais qui a travaillé dans son laboratoire sur des échantillons envoyés depuis la Côte d'Ivoire. Un autre cas fréquent est celui d'une étude réalisée dans un cadre régional et concernant non seulement la Côte d'Ivoire mais des pays limitrophes. G. JANVIER ET G. PERON ont retenu au cours de leur enquête tout ce qui trouve dans les bibliothèques des laboratoires de Côte d'Ivoire et que les chercheurs concernés leur ont présenté comme spécifiquement nécessaire à la connaissance des milieux ivoiriens.

Un tel corpus est d'une qualité exceptionnelle. Il correspond à la manière dont les scientifiques comprennent leur travail et à la notion de science disponible pour un pays, ou une région donnée. Il offre également l'immense avantage de saisir un ensemble scientifiquement cohérent et dont on peut analyser les connexions internationales. Ajoutons que ce corpus est en bonne adéquation avec la notion d'information scientifique et technique (IST). Il n'est pas limité à la stricte production scientifique (publication apportant des connaissances nouvelles) mais inclut aussi des travaux d'application, de recherche-développement, des textes d'information et à la limite de vulgarisation.

C'est le fait de disposer d'une IST suffisamment large qui va permettre, au cours de notre étude, de préciser différents types d'insertion sociale des domaines scientifiques, et de définir des styles de science.

Nous avons retenu plus de 6.000 références (après élimination de celles, trop peu nombreuses, concernant des domaines scientifiques marginaux pour la Côte d'Ivoire de l'époque, comme physique et chimie). A partir de ces références, nous avons constitué une base de données contenant 6.005 enregistrements (1 enregistrement pour 1 référence), chaque enregistrement étant formé de 13 champs, ce qui au total représentait 78.065 entrées.

Liste des champs et la nature des variables :

- numéro d'enregistrement (permet de retrouver la référence complète),
- rubrique (nous avons distingué 27 rubriques scientifiques),
- date de la publication,
- nombre d'auteurs (valeur nulle pour les références anonymes),
- type de publication (nous avons retenu un très grand nombre de variables : rapports, livres, chapitres de livre, notices, comptes-rendus à congrès, et près de 400 revues différentes),
- langue de publication,
- localisation de l'étude,
- 4 champs pour indexation par mots-clés,
- 2 champs supplémentaires ont été retenus pour des variables libres (noms d'auteurs, nationalité, etc.).

LES DOMAINES SCIENTIFIQUES

Toutes les références (IST en totalité) sont considérées pour définir les "domaines scientifiques (cf.tableaux ci-dessous).

L'examen de ces tableaux montre qu'une bibliométrie simple, à condition de porter sur un corpus suffisamment complet, fait immédiatement apparaître les grands traits de l'activité scientifique d'un pays. Il est évidemment possible d'aller beaucoup plus loin que ce qui est présenté ici, dans l'analyse du contenu scientifique d'un corpus bibliométrique, si l'on veut faire l'analyse des titres, des mots-clés, des résumés (sans même envisager les techniques plus compliquées nécessaires à l'établissement des leximappes et à l'analyse des citations).

	CLIMATS ET MIL. AQUATIQUES		
		Nbre de Réf.	%
Rubr. 1	Climatologie	106	22,32
Rubr. 2	Océanographie Physique	62	13,05
Rubr. 3	Hydrologie de surface, Hydraulique	161	33,89
Rubr. 4	Hydrogéologie	88	18,53
	TOTAL	475	100 %

	SCIENCES DE LA TERRE		
		Nbre de Réf.	%
Rubr. 5	Géophysique, Géochronologie	205	10,80
Rubr. 6	Gîtologie, Géol. de l'Ingénieur	795	41,89
Rubr. 7	Géologie Générale	220	11,59
Rubr. 8	Géologie Régionale	318	16,75
Rubr. 9	Pédologie, Formations Superficielles	360	18,97
	TOTAL	1898	100 %

	SCIENCES MEDICALES		
		Nbre de Réf.	%
Rubr. 10	Généralités, Techn. de Laboratoire	77	11,76
Rubr. 11	Médecine Traditionnelle	10	1,53
Rubr. 12	Anatomie	54	8,24
Rubr. 13	Nutrition, Epidémio., Vaccination	49	7,48
Rubr. 14	Etudes Cliniques	388	59,24
Rubr. 15	Entomologie Médicale	77	11,76
	TOTAL	655	100 %

	SCIENCES BIOLOGIQUES		
		Nbre de Réf.	%
Rubr. 16	Généralités, Physio, Ecol. Animales	107	6,12
Rubr. 17	Espèces Animales Aquatiques	189	10,81
Rubr. 18	Espèces Animales Terrestres	824	47,14
Rubr. 19	Botanique Générale, Taxonomie	308	17,62
Rubr. 20	Ecologie Végétale	209	11,96
Rubr. 21	Ethnobotanique	111	6,35
	TOTAL	1748	100 %

	SCIENCES AGRONOMIQUES		
		Nbre de Réf.	%
Rubr. 22	Généralités, Vulgarisation	107	8,71
Rubr. 23	Agro Générale, Techn. Culturales	483	39,30
Rubr. 24	Génétique, Amélioration des Plantes	128	10,41
Rubr. 25	Phytopathologie	247	20,10
Rubr. 26	Foresterie, Sylviculture	180	14,65
Rubr. 27	Zootechnie, Médecine Vétérinaire	84	6,83
	TOTAL	1229	100 %

Une analyse bibliométrique se contentant de comptages dans les plans de classement de bases documentaires suffisamment larges (et non limitées au soi-disant mainstream) suffirait à montrer les grandes stratégies nationales des pays en développement. Il n'y a pas grand risque à affirmer que la Côte d'Ivoire, l'Algérie, le Nigéria, pour ne prendre en exemple que quelques pays africains, montreraient de grandes différences, d'ordre qualitatif et non seulement quantitatif, à la suite d'une telle analyse.

INDICES DE STRUCTURATION DE L'ACTIVITE SCIENTIFIQUE

Nous avons établi une série de huit indices de structuration de l'activité scientifiques. Notre base de données comportait, comme cela a été dit plus haut, 13 champs représentant 78.065 données élémentaires. Les indices dont il est question maintenant sont constitués à partir de 5 champs seulement, totalisant 30.025 données. Il faut remarquer que nous parlons d'indices de "structuration de l'activité scientifique," et non par exemple d'indices de "structuration de l'IST." La raison de cette nuance vient de la sélection des 5 champs et du fait que, dans beaucoup de cas, les indices ne tiennent pas compte des références anonymes. Nous avons focalisé les indices plus sur la production scientifique proprement dite, sur ses modalités, que sur la production technique et de vulgarisation.

Les 8 indices s'établissent ainsi :

- indice d'associativité (I.A.): c'est tout simplement le nombre moyen d'auteurs, par publication, dans un domaine donné. Une étude antérieure a montré qu'il se distribue, sur le plan international, de façon hautement significative : 1,4 pour les pays européens, 1,8 pour les USA, 2,2 et plus pour les pays en développement comme Inde et Brésil.
- indice de prestige scientifique (I.P.) : certaines types de publication ont un haut prestige, ou sont une marque de notoriété. Nous avons retenu ici comme indice le rapport de la somme des comptes-rendus à l'Académie des Sciences, livres, chapitres de livre, au nombre total de publications (à l'exclusion des rapports inédits, notices, communications à colloques).
- indice de présence internationale (I.I.): c'est le rapport du nombre de références en langues autres que le français (la Côte d'Ivoire est un pays francophone), au nombre de l'ensemble des références (anonymes exclus).
- indice de coopération régionale (I.R.): c'est le rapport du nombre de références concernant un ensemble régional qui inclut la Côte d'Ivoire, au nombre de l'ensemble des références ayant une localisation (anonymes exclus). Plus cet indice est élevé, plus la Côte d'Ivoire paraît insérée dans un dispositif scientifique inter-régional ou inter-état.
- indice de mobilité des chercheurs (I.M.) : c'est le rapport du nombre de communications aux congrès, au nombre de références publiées (anonymes exclus).

- indice de propriété scientifique (I.S.): c'est le seul à tenir compte des références anonymes; il est défini par le rapport du nombre de références signées au nombre total de références de l'IST.
- indice de disponibilité de l'information (I.D.) : c'est le rapport du nombre de références régulièrement éditées (communications aux congrès comprises), au nombre total de références (notices inédites et rapports inclus), les anonymes étant toujours exclus.

	Domaine 1		Domaine 2		Domaine 3		Domaine 4		Domaine 5	
	Mil. Aqua.		Sci. Terre		Sci. Médica.		Sci. Biolog.		Sci. Agron.	
Indice	Brut	Pond.	Brut	Pond.	Brut	Pond.	Brut	Pond.	Brut	Pond.
I.A.	1,19	0,66	1,16	0,64	2,81	1,56	1,19	0,66	1,22	0,67
I.P.	0,20	0,89	0,23	1,00	0,01	0,04	0,06	0,29	0,04	0,18
I.I.	1,32	0,10	7,53	0,61	0,79	0,06	12,26	1,00	1,55	0,12
I.R.	0,31	0,57	0,23	0,42	0,28	0,51	0,55	1,00	0,23	0,42
I.C.	2,35	0,31	2,88	0,39	7,39	1,00	8,07	1,09	7,63	1,03
I.M.	0,18	0,85	0,21	1,00	0,10	0,48	0,04	0,19	0,15	0,74
I.S.	0,79	0,94	0,86	1,02	0,95	1,13	0,98	1,17	0,83	1,00
I.D.	0,31	O,39	0,34	0,42	0,92	1,15	0,87	1,08	0,80	1,00

Les basses valeurs d'indice sont censées traduire une situation peu satisfaisante, mais les très hautes valeurs ne sont pas bonnes non plus. Il est raisonnable de chercher un seuil d'équilibre. Pour une communauté scientifique, il est normal d'ambitionner une certaine notoriété; mais la communauté d'un pays en développement qui axerait sa stratégie vers la poursuite forcenée de la notoriété manquerait certainement la plus importante de ses missions, celle de soutenir le développement. Autre exemple, celui de l'indice de coopération régionale : trop bas, c'est l'isolement, trop haut, c'est la dépendance.

En examinant la situation des 5 grands domaines scientifiques que nous avons définis, nous avons adopté pour références, de façon conventionnelle ou arbitraire, comme l'on voudra, certaines valeurs d'indices. Pour l'associativité, c'est la valeur 1,8 (celle des publications nord-américaines, intermédiaire entre celle des pays européens et celle de pays comme Inde et Brésil). Pour les autres indices, c'est la valeur trouvée dans l'un ou l'autre de nos 5 domaines scientifiques. Ce sont donc des valeurs réalistes, en ce sens qu'elles sont (sauf une) effectivement trouvées dans l'un ou l'autre des 5 domaines scientifiques ivoiriens, et non des valeurs idéales.

L'adoption d'une valeur de référence permet de pondérer les indices; la valeur 1 est conventionnellement adoptée pour la valeur de référence.

Ceci permet d'établir des graphes représentatifs de la structuration de l'activité scientifique dans les 5 domaines étudiés. Le cercle noir du graphe représente, pour les 8 indices, la valeur 1. Chaque domaine scientifique se trouve représenté par un graphe, et l'on peut remarquer que les 5 domaines scientifiques présentent des graphes différents qui traduisent des contraintes différentes, et des stratégies scientifiques différentes, ainsi qu'on l'expliquera plus loin.

Insistons encore sur le fait que cette méthode a une valeur comparative et ne prétend pas du tout à une valeur absolue.

STYLES DE SCIENCE

Il existe des styles de science différents, ainsi que le montrent des études antérieures, qui correspondent à des constructions théoriques particulières, ou à des stratégies nationales, ou à des contextes sociaux, etc. Les styles de sciences particuliers à chacun des 5 domaines scientifiques et dont nous allons parler sont mis en évidence par les graphes établis avec les indices de structuration de l'activité scientifique et présentés en annexe.

1.- Le style de science le plus classique, celui qui répond le mieux à l'image que l'on se fait habituellement du fonctionnement de la science, c'est celui donné par les disciplines biologiques. Manifestement, les chercheurs y travaillent pour une communauté scientifique; ils sont plus associatifs que les autres, ils publient davantage et produisent beaucoup moins de documents inédits ou anonymes, ils disposent pour cela d'un grand nombre de revues souvent hautement spécialisées, ce sont eux qui ont la plus forte présence internationale et même régionale, qui publient le plus en langue anglaise.

Il faut remarquer aussi que les biologistes ont été les premiers, historiquement, à s'intéresser à la Côte d'Ivoire (et autres pays africains francophones) et à publier régulièrement.

La plus grande déficience des sciences biologiques est marquée par l'indice de mobilité des chercheurs. Cette faible mobilité n'est sûrement pas attribuable à la mentalité des chercheurs. Elle est la conséquence d'une faible liaison avec les problèmes de développement. Congrès et voyages coûtent cher. Taxonomie des plantes ou entomologie trouvaient difficilement des sponsors à l'époque coloniale. Le prestige scientifique est, par contre, artificiellement faible. Il est dû au fait que les biologistes publiaient peu à l'Académie des Sciences parce qu'ils disposaient par ailleurs de revues de haut niveau.

2.- Les sciences de la terre ont un style différent, marqué à l'inverse du cas précédent par la lourdeur des opérations liées au développement : tout ce qui concerne les ressources minières, et même en pédologie, toutes les prospections liées au développement rural. Cela correspond indiscutablement à un style de science propre, et à un type d'IST. D'autres caractères peuvent correspondre à des raisons plus circonstancielles.

Le graphe correspondant traduit l'inflation par les rapports et documents inédits, le faible taux de publication. Le manque de revues scientifiques est flagrant, désastreux même pour une discipline comme la pédologie. Les articles, en nombre insuffisant, se dispersent par manque de revues adaptées, donnant un mauvais indice de ciblage.

Il y a deux contreparties favorables à cette situation. Le taux de mobilité est fort parce qu'il y a des sponsors, des budgets importants, des problèmes scientifiques mondiaux; tous les grands congrès internationaux de géologie ont reçues des communications concernant la Côte d'Ivoire. L'indice de prestige scientifique est fort lui aussi, parce que les auteurs ne dispersant pas leur littérature pouvaient se concentrer sur le plus important. Indice de ciblage et indice de prestige sont liés par une relation inverse.

3.- On ne peut plus en dire autant du domaine de l'agronomie. Présence internationale et prestige scientifique sont vraiment trop bas pour des disciplines "scientifiques."

Le ciblage des publications est bon : il existe un certain nombre de revues françaises (à prétentions scientifiques plus ou moins élevées) pour accueillir tout ce que produisent de publiable les chercheurs. Les agronomes ont aussi eu la bonne idée de créer des périodiques locaux en Côte d'Ivoire. La mobilité est assez bonne : il y a des sponsors pour organiser des conférences sur la protection des cultures, le conditionnement des produits tropicaux, etc.

Nous avons pris pour référence les indices fournis par les sciences agronomiques en ce qui concerne disponibilité de l'information et propriété scientifique. Ces deux indices correspondent à une adaptation à un pays en développement auquel il faut fournir une IST spécifique, évidemment différente de l'information du mainstream scientifique.

4.- Le domaine climats et milieux aquatiques est un domaine plus hétérogène, d'une part, et trop marqué par deux disciplines qui sont souvent des activités de service, la météorologie et l'hydrologie de surface.

Les indices sont faibles, parfois très faibles : présence internationale des plus réduite, ciblage très insuffisant, peu d'associativité, inflation des documents anonymes et inédits.

Dans ce mauvais contexte, prestige et mobilité scientifique paraissent meilleurs. C'est le même effet de compensation que l'on a noté plus haut pour les sciences de la terre. En raison d'une faible politique éditoriale, quelques livres et communications à l'Académie des Sciences font remonter l'indice de prestige.

5.- Les sciences médicales sont complètement atypiques. En réalité l'IST qui compose ce domaine n'est pas porté par une véritable activité de recherche, certains secteurs (comme l'entomologie médicale, très analogue aux sciences biologiques) mis à part. Il n'y a pas d'équivalent de l'INSERM, et pas d'Institut Pasteur en Côte d'Ivoire à l'époque considérée. Par contre il y a un Institut Pasteur à Dakar et l'O.C.C.G.E. (lutte contre les grandes endémies) à Bobo-Dioulasso. D'où les caractères particuliers du domaine médical ivoirien

Il faut remarquer aussi que c'est historiquement, le dernier de nos 5 domaines à s'être développé. Il faut attendre 1958 pour constater un accroissement significatif des références. A noter aussi que nous avons compté les articles de la

Revue Médicale de Côte d'Ivoire comme des articles normaux, ainsi que nous l'avons à juste titre fait pour toutes les revues domiciliées en Afrique. Cependant, c'est beaucoup plus un bulletin professionnel de liaison qu'une revue scientifique. Il s'agit donc d'un signe d'activité intéressant à considérer, mais qui gonfle articiellement le corpus bibliographique des disciplines médicales.

A l'encontre des sciences biologiques, mais de même que les sciences agronomiques et de la terre, les disciplines médicales sont fortement liées à des buts pratiques. La présence internationale est hors de portée pendant la période considérée, et le prestige "scientifique" n'a pas le même sens que dans les 4 autres domaines de notre étude.

CONCLUSION

En conclusion, nous ferons quelques remarques générales sur la recherche d'indicateurs bibliométriques pour les pays en développement.

La première remarque est que la bibliométrie ne s'applique bien qu'à des ensembles assez grands. Il serait risqué de prétendre détecter ou suivre, quasi instantanément, la recherche de pointe, ou d'excellence. Par contre, la bibliométrie est une très bonne technique de suivi global de l'activité scientifique, sur des périodes de quelques années.

La deuxième remarque est que l'analyse bibliométrique a surtout une valeur comparative. Elle peut difficilement fournir des critères absolus, mais peut comparer de manière utile des pays, des disciplines, des groupes, des communautés scientifiques, des laboratoires ou des institutions.

En dernière remarque, nous soulignerons la nécessité d'élargir, dans les bases documentaires, l'IST concernant les pays en développement. Il n'y a pas de difficulté à établir des indicateurs dans la mesure où l'on dispose d'une masse de données suffisamment importante et diversifiée.

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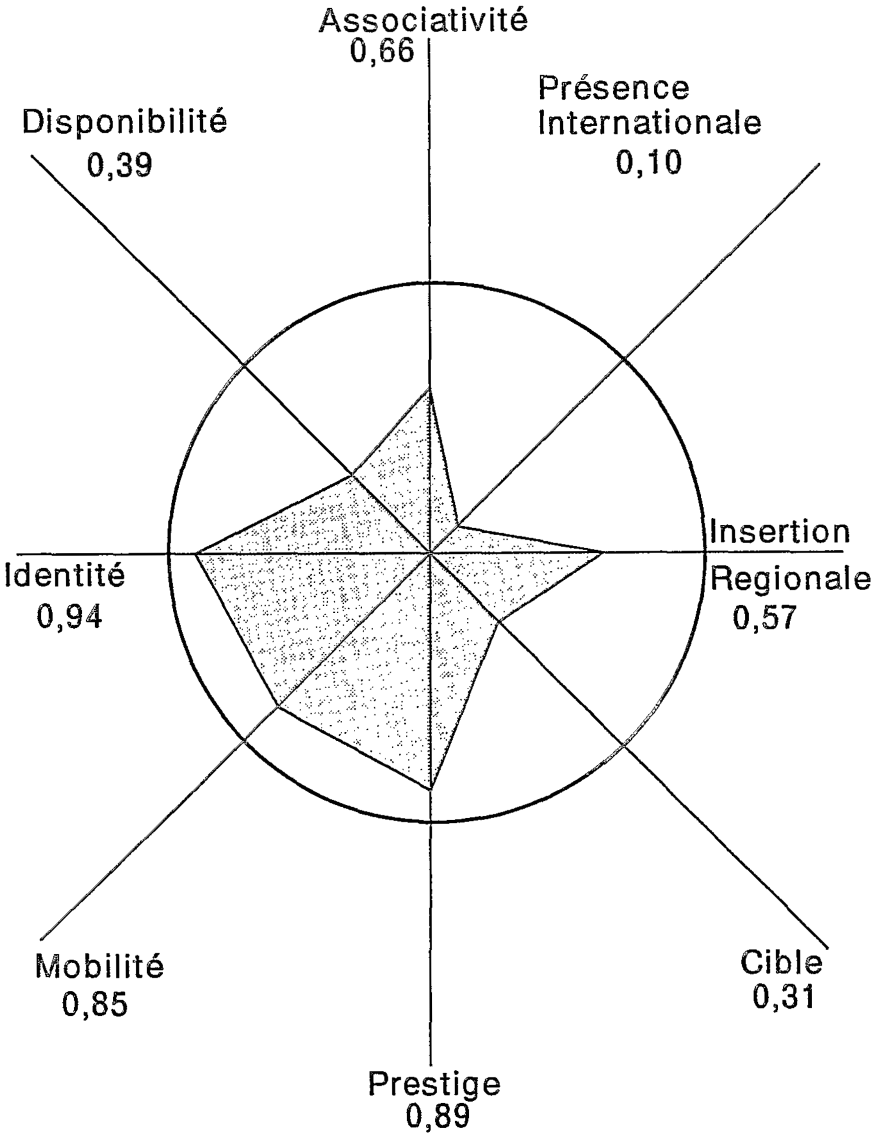
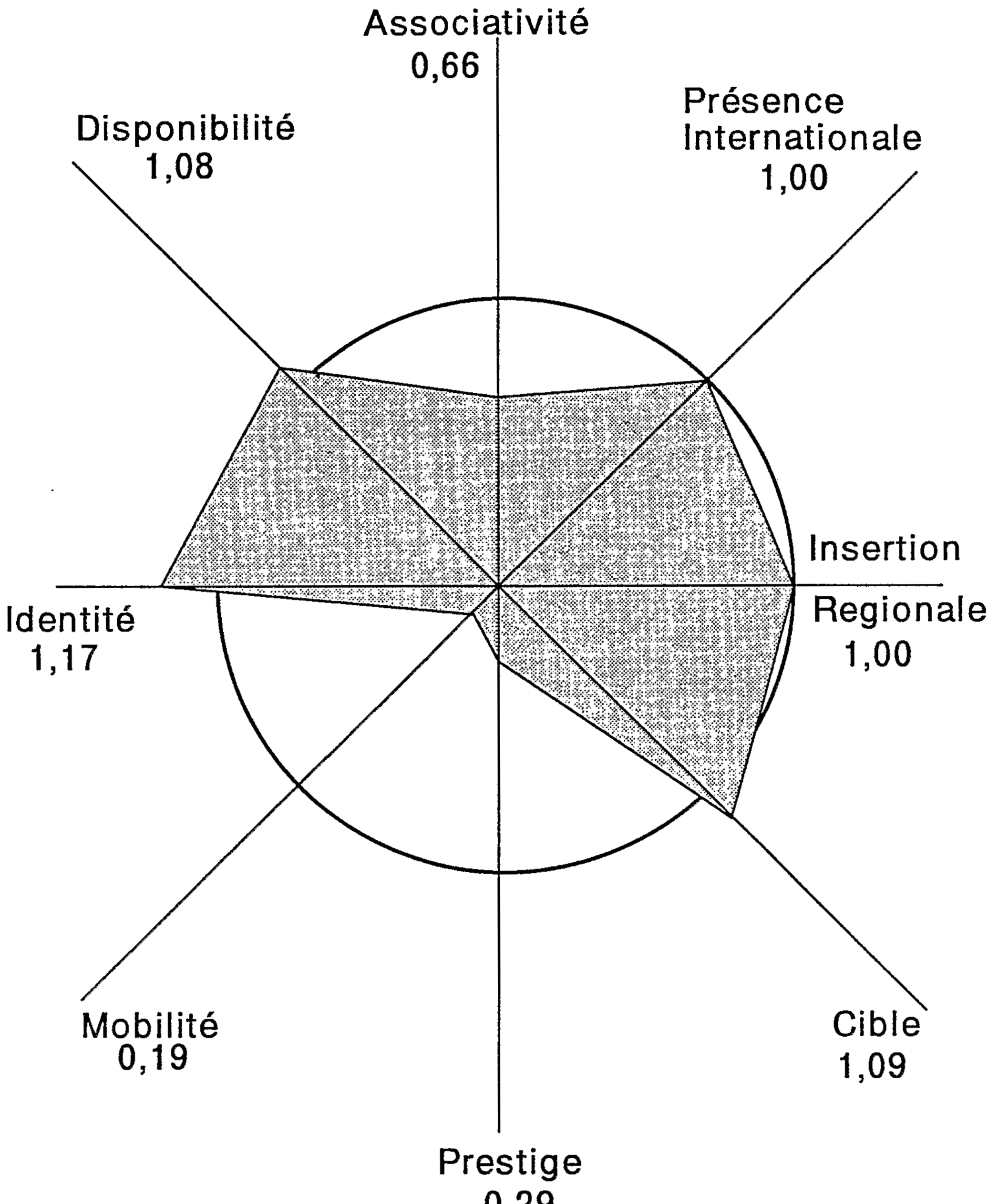
Annexe



CLIMAT ET SCIENCES AQUATIQUES



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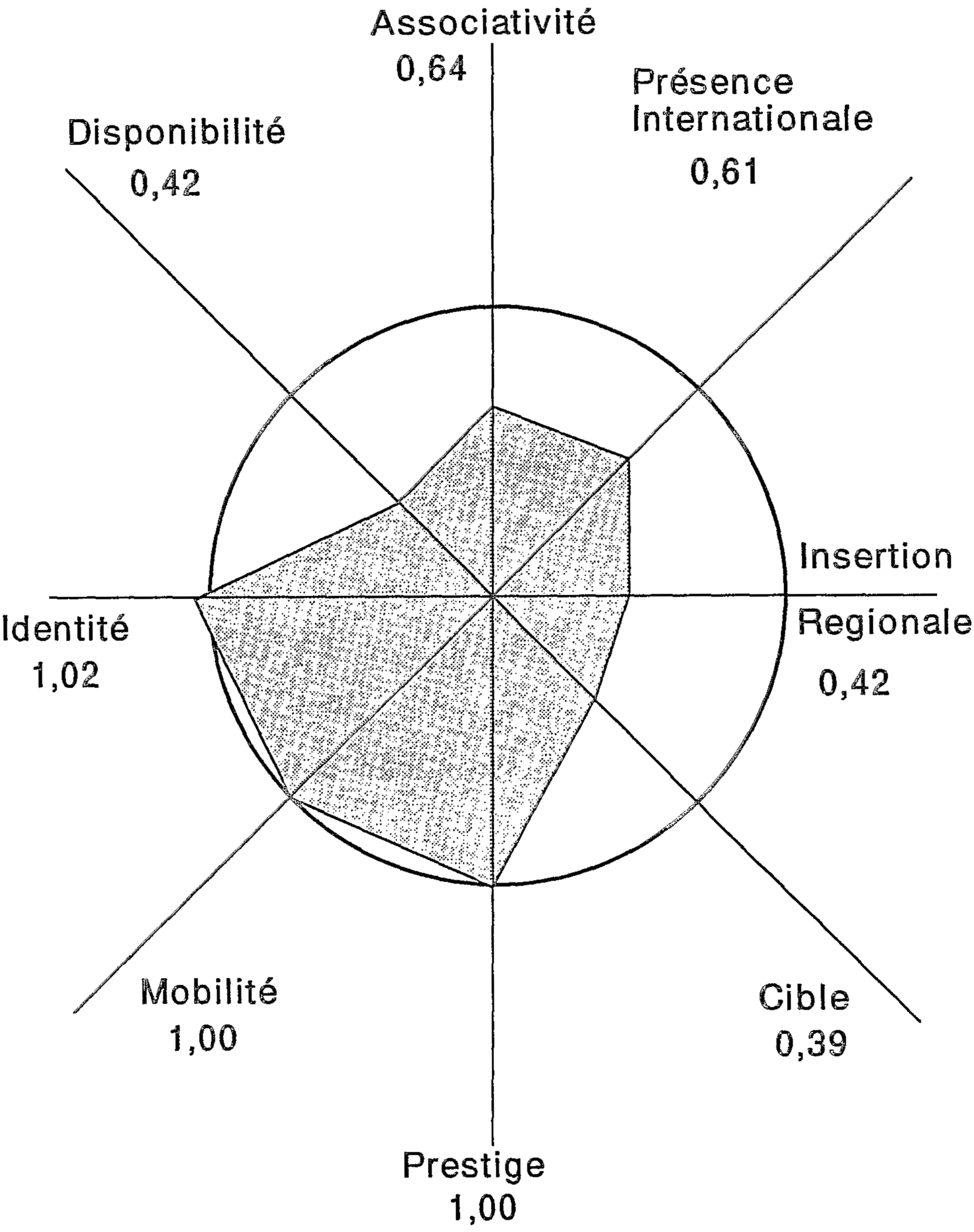
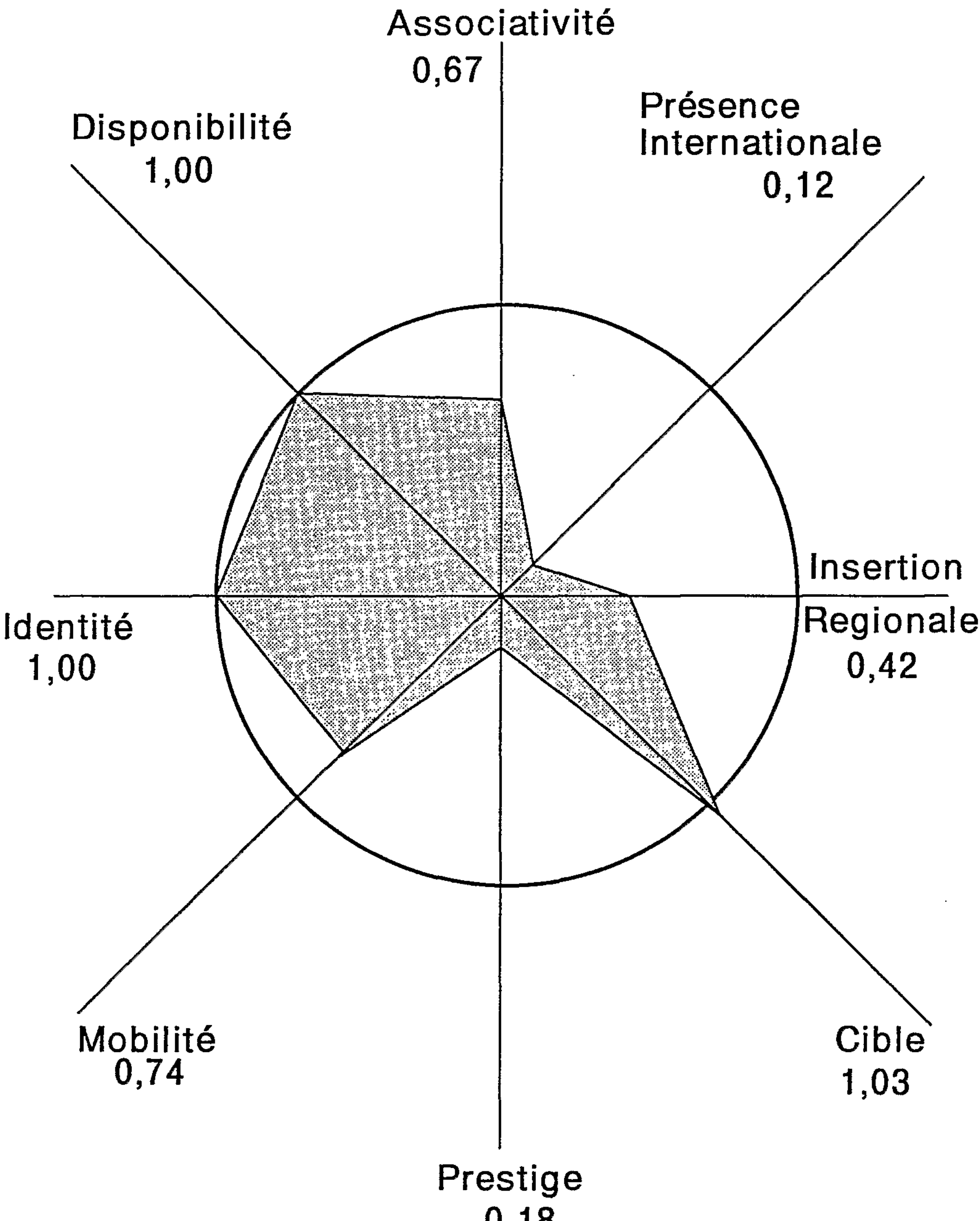


SCIENCES DE LA TERRE



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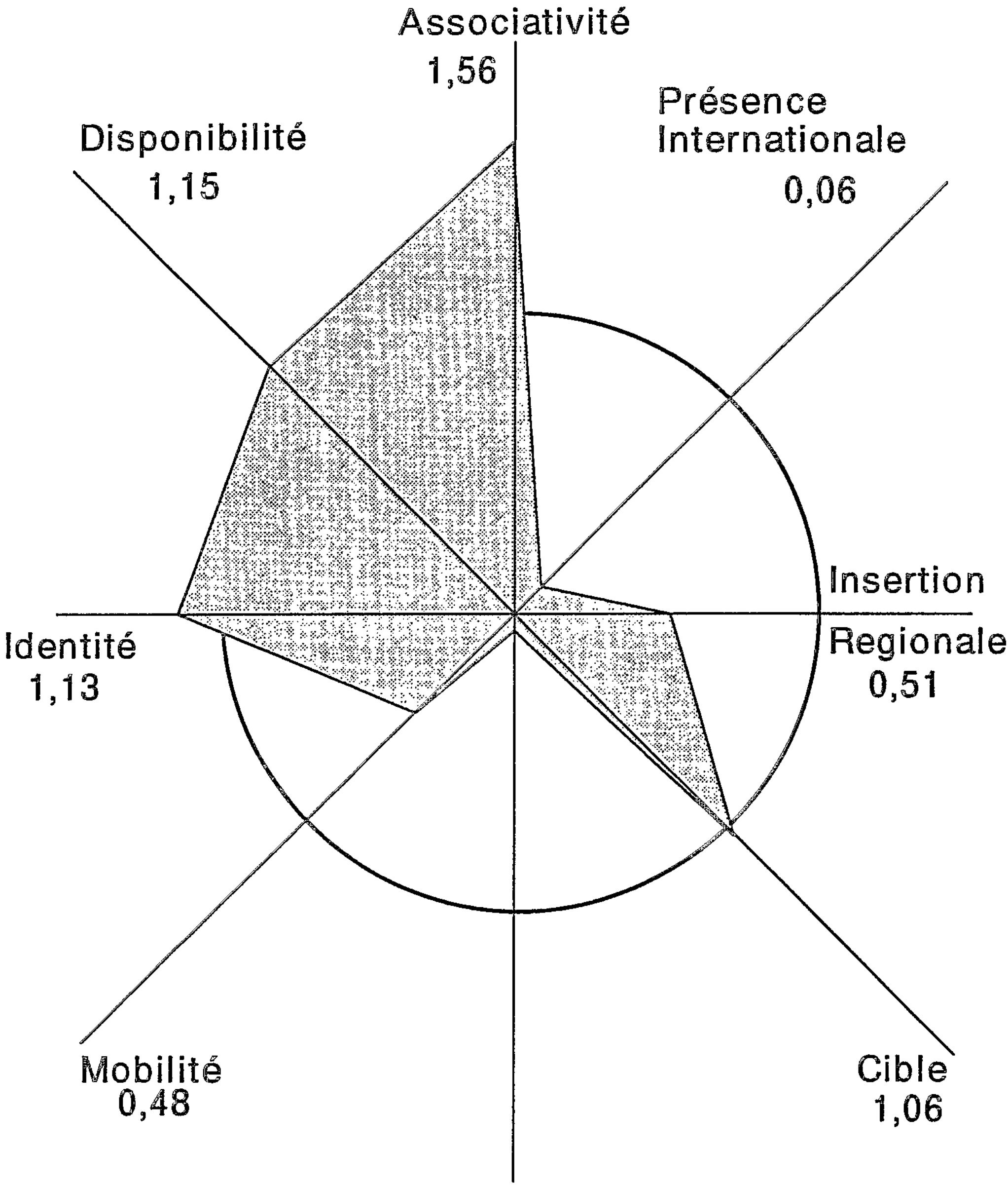

SCIENCES MEDICALES

LA STRUCTURE D'UN GROUPE DE RECHERCHE: COMPARAISON DE DEUX METHODES D'ANALYSE DE RESEAUX

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RESUME

Deux méthodes de description de la structure d'un groupe de recherche sont utilisées. La première est une analyse des co-auteurs de résumés de recherche, l'autre est une analyse sociométrique en réseau. Les deux méthodes offrent une image similaire du groupe de recherche étudié. La portée et limites des deux méthodes sont discutées. Les différences essentielles portent sur le type et l'ampleur des données qu'il faut traiter.

ABSTRACT

Two methods are used in order to describe the structure of a scientific group. The first one is a co-author analysis based on research abstracts, the second one is a network analysis of sociometric data. Both methods offer a similar image of the research group. Scope and limits of both methods are discussed. The essential differences are due to the representativity and type of data that need to be treated.

INTRODUCTION

Un des aspects essentiels de la scientométrie devrait être l'analyse du fonctionnement des groupes de recherche. En effet, il faut trouver des outils qui permettent de rendre compte de la structure des groupes de recherche, et, partant, obtenir une description fiable des stratégies poursuivies par les chercheurs et les autres acteurs impliqués. Notre article cherchera a montrer l'intérêt de deux méthodes qui permettent d'identifier la structure d'un groupe de recherche, l'analyse des co-auteurs et une analyse sociométrique des réseaux, et tentera d'établir leurs avantages respectifs.

Le groupe de recherche vénézuélien sur Canavalia ensiformis

Le groupe de chercheurs que nous allons examiner est un groupe multidisciplinaire qui travaille sur une légumineuse tropicale, Canavalia ensiformis. Cette légumineuse peut être utilisée dans l'alimentation animale et par sa richesse en protéines en fait une alternative possible à l'importation massive de protéines étrangères (soja principalement). Ces importations constituent une des principales faiblesses de l'agriculture vénézuélienne à l'heure actuelle, comme dans bon nombre de pays tropicaux. Il existe plusieurs groupes de chercheurs qui travaillent sur Canavalia (Mexique, Colombie, France, Vénézuéla) mais nous avons décidé de nous intéresser particulièrement au plus actif et plus ancien de ceux-là, qui est vénézuélien, situé aux Facultés Agronomiques et Vétérinaires de l'Université Centrale du Vénézuéla.

Par ailleurs, nous avons étudié en profondeur son histoire, les facteurs principaux qui en expliquent la permanence et les difficultés survenues, ainsi que son devenir (Arvanitis et Bardini, 1989; Arvanitis, 1990). Notre connaissance des recherches sur Canavalia nous permet donc de mesurer la qualité des résultats obtenus par les méthodes quantitatives.

La recherche au sujet de Canavalia peut être qualifiée de typique pour un PED en ce sens qu'elle pose des questions essentielles au développement économique du pays et cherche à y répondre au moyen de travaux de recherche appliqués. Plusieurs filières de production sont envisagées (utilisation de la graine dans la composition des rations alimentaires pour l'aviculture, système d'élevage bovin, production fourragère, utilisations comme engrais vert et culture de protection ou barrière anti-érosion). A terme, Canavalia peut être envisagée comme une culture parfaitement adaptée aux écosystèmes tropicaux (Afrique, Amérique du Sud tropicale, Asie du Sud-Est).

L'utilisation de Canavalia cependant ne sera possible que si sont levées de nombreux obstacles: toxicité de la graine, pour laquelle aucun traitement définitif n'a encore été élaboré, difficultés de la mécanisation de la culture, difficultés agronomiques quant à la culture de la plante. La principale orientation de recherche à ce jour a été celle de l'utilisation de Canavalia dans l'alimentation des volailles, pour lesquels la toxicité de la plante est rédhibitoire. L'ensemble des thèmes développés présentent tous une situation de dépendance vis à vis de ce problème. L'exemple le plus frappant concerne la recherche à proprement parler agronomique (conduite de la culture, mécanisation, physiologie végétale,...) qui reste finalement un point faible du programme. La partie agronomique, qui fut initialement prise en charge par pratiquement tous les chercheurs quelle que soit leur orientation, a pris du retard dans les dernières années.[1]

Le groupe de recherche sur Canavalia du Vénézuéla se distingue par une position tropicaliste dominante qui, si elle assure la cohésion du groupe, repose sur une vision de l'agriculture qui ne fait pas nécessairement l'unanimité, et cela malgré le fait que la situation économique actuelle lui soit favorable (triplication du prix des aliments importés).

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[1] Le détail des orientations de recherche a été présenté dans le chapitre huit de Arvanitis (1990).

Le réseau de co-auteurs

Nous avons réuni tous les résumés de recherche présentés dans les journées internes de l'Institut de Production Animale, principal lieu où se déroulent les recherches. Ces journées annuelles permettent aux chercheurs de présenter les résultats de leurs travaux et d'engager une plus grande interaction entre membres de l'Institut. C'est une pratique liée à la recherche. Peu de Facultés ou d'Ecoles organisent ce genre de journées. Les résumés présentés sont tous "édités" dans le rapport annuel de l'Institut. Les résumés ne donnent pas toujours lieu à des articles publiés dans des revues. Mais ils sont utilisés comme tels dans les travaux publiés en bonne et due forme. Ainsi, aux yeux des chercheurs ces résumés de recherche ont la même valeur (informative) qu'un article. Leur défaut évident est de ne pas être visibles hors de l'IPA. De plus, il semble que nombre de chercheurs considèrent que la présentation orale des recherches, accompagnée d'un résumé assez détaillé et précis, "publié" dans la revue de l'IPA est une activité suffisante de production scientifique. Rares sont les articles publiés hors du Vénézuéla ou dans des revues arbitrées. Ce comportement implique une visibilité extrêmement faible en termes d'articles publiés. Nos chercheurs tombent sous le coup de la critique de "in-breeding" et de basse productivité, usuellement adressée aux chercheurs du Tiers Monde (Velho et Krige, 1984). Il n'en reste pas moins qu'il existe une véritable recherche dont les résumés sont un excellent indicateur. [2]

Nous avons cherché à identifier les collaborations scientifiques à travers l'analyse des co-auteurs en partant du principe que les collaborations scientifiques se traduisent par des résumés signés conjointement (Edge & Mulkay, 1976; Stockes & Hartley, 1979). Il s'agit d'une méthode assez robuste, qui ne dépend pas de la taille de l'échantillon. De plus, dans notre cas, les auteurs signent conjointement les résumés avec plus de facilité que les articles, de sorte que nous pouvons affirmer que l'analyse des co-auteurs est plus à même de fournir une bonne base d'information pour décrire la structure des collaborations scientifique.

Les données de base

De 1980 à 1987, 70 résumés ont été présentés sur Canavalia, parmi lesquels 33 traitaient des aspects agronomiques et 37 des utilisations de la plante dans l'alimentation ou son traitement en vue de l'alimentation. Nous n'avons retenu que les résumés co-signés (évidemment), ce qui élimine un auteur (un nom). De plus, les co-auteurs qui n'apparaissent qu'une seule fois sont également éliminés (3 noms). Au total, nous avons donc réuni 68 résumés, ce qui représente 29 co-

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[2] D'autres traitements plus complexes auraient pu être effectués (traitement des mots par Candide et Leximappe, par exemple, ou analyse des thématiques). De tels traitements auraient été justifiés sur un corpus documentaire plus important.

auteurs, pour un total 197 occurrences, soit une moyenne de 2,9 auteurs par résumé, pour une moyenne de 6,8 occurrences de chaque auteur dans l'échantillon, avec un maximum de 30 occurrences et un minimum de 2.

Pour chaque paire d'auteurs (x,y) nous avons calculé un indice de dépendance (ou indice d'inclusion dans la terminologie de Callon, Courtial, Turner et Bauin, 1983): dépendance de x par rapport à y: D = N(x,y)/N(y).

Cet indice mesure la fréquence de l'apparition d'une paire de noms N(x,y) par rapport à la fréquence de l'un des deux noms, N(x). La matrice des résultats de ce calcul fait apparaître de nombreuses fois l'indice 1 qui marque la "dépendance" d'un auteur par rapport à un autre, c'est-à-dire que cet auteur n'apparaît que comme co-auteur de son compagnon. Le tableau 1 indique ces auteurs en situation de dépendance statistique.

Tableau 1. Co-auteurs en situation de dépendance statistique

Dépendants de	En situation de dépendance
Escobar	Paredes, Dixon, López, González, Fernández,
	Vásquez, Troccoli, Miranda, Medina.
Viera	Ramis, Díaz, Marín, Pérez.
Mora	O.de Parra.
R. Parra	O.de Parra, Dixon, Miranda, Medina.
Montilla	León, Reina, Vasquez.
Ramis	Díaz.
Horesok	Pérez.
León	Reina, Vargas.
Combellas	Silva, Vasquez.
Paredes	Fernández.
Silva	Vasquez.

Les groupes de recherche

Etant donné la structure particulière de la matrice, nous pouvons regrouper les auteurs, pour tous les noms dont l'ensemble des affiliés ou dépendants n'est pas vide. Nous obtenons ainsi trois groupes de noms.

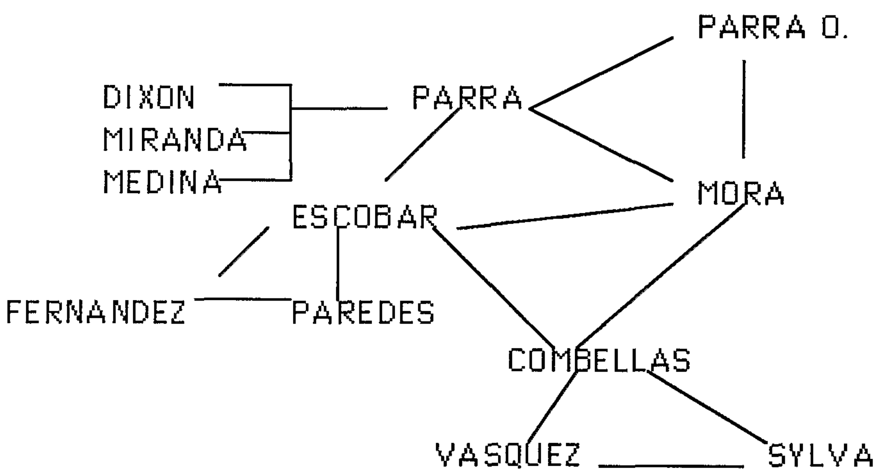
GROUPES DE CHERCHEURS[3]

Groupe I : Escobar, Mora, R.Parra, Paredes, Dixon, López, González, Fernández, Vasquez, Troccoli, Miranda, Medina, O.de Parra, Silva, Combellas.
Groupe II : Viera, Ramis, Díaz, Marín, Pérez, Horesok.
Groupe III : Montilla, León. Reina, Vargas.

Quatre auteurs n'apparaissent jamais dans nos regroupements, soit parce qu'ils n'ont aucun affilié, soit parce que eux-mêmes ne sont pas dépendants. Le graphique 1 nous montre la forme des réseaux de co-auteurs. Il hiérarchise ces relations, c'est-à-dire que les auteurs sont positionnés auteurs par rapport à un "centre". Ces centres[4] sont composés des noms qui ne sont dépendants d'aucun autre nom composant le groupe (noms soulignés dans la liste de groupe de recherche ci-dessus).

Graphique 1. Groupes de recherche sur Canavalia identifiés par la méthode des co-auteurs

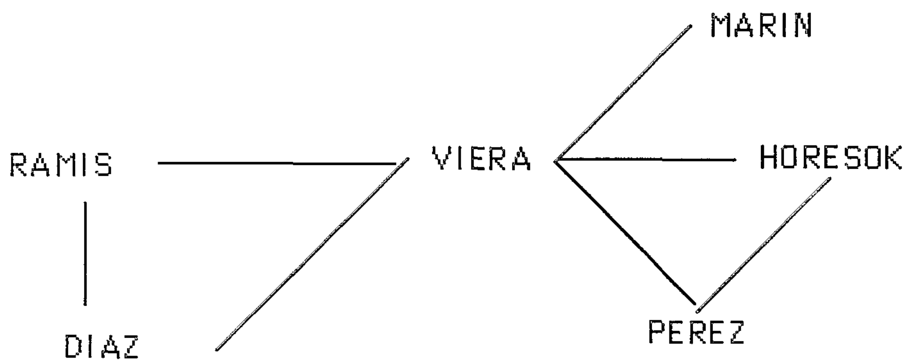
Groupe 1:



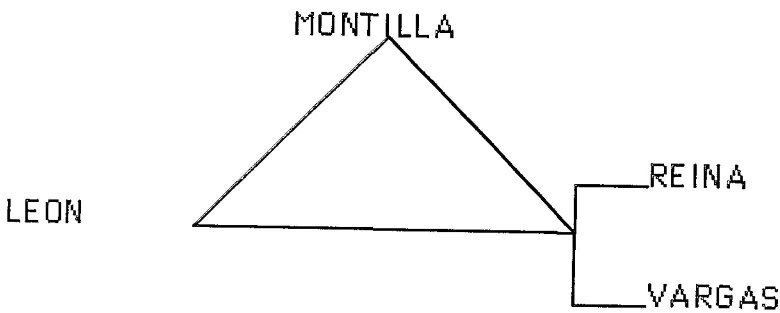
[3]Les individus centraux sont soulignés.

[4] Le nombre de centres dépend évidemment du nombre de noms dans le groupe. Mais c'est là une règle empirique, car statistiquement on pourrait imaginer des groupes assez grands formés autour d'un seul nom (ce qui signifierait que ce nom apparaît dans tous les articles).

Groupe 2:



Groupe 3:



Ces trois groupes correspondent aux pôles d'intérêts principaux. Le groupe I inclut des chercheurs qui travaillent sur l'alimentation des ruminants. Le groupe II inclut les chercheurs qui travaillent sur la génétique végétale et d'un chercheur en écologie végétale. C'est donc le groupe "production végétale". Le troisième groupe est celui des chercheurs sur l'alimentation des volailles. Il faut ici donner deux précisions. Depuis 1986, les chercheurs de la Faculté des sciences vétérinaires ont travaillé de manière plus autonome, avec moins de présentations de résumés à l'IPA. De plus, le groupe sur les volailles s'est consolidé durant les quatre dernières années, en particulier par le retour au Vénézuéla de Vargas, qui est actuellement le principal représentant de ce groupe.

Notre procédure d'identification des groupes ne nous a pas permis de classer 4 auteurs. Sans entrer dans les détails ces cas atypiques[5] sont dus soit à un abandon de la recherche sur Canavalia, soit au fait que ces individus représentent des lignes de recherche relativement peu développées mais différentes de celles

[5] Pour les détails sur ces cas atypiques voir Arvanitis (1990), op. cit.

citées ci-dessus (fourrages, alimentation des porcins), soit parce que les auteurs mentionnés n'ont été que de passage au sein du groupe de recherche vénézuélien sur Canavalia, soit, enfin, par une insertion non encore définitivement définie. Les cas atypiques ne sont donc pas des artefacts de calcul mais traduisent bien des situations marginales au sein du groupe de travail sur Canavalia.

Les relations entre les groupes

Afin d'étudier les relations entre les groupes nous utilisons un indice symétrique (ou d'équivalence dans la terminologie de Callon et alii, 1989):

$$I = N(x,y)^2/N(x).N(y)$$

Cet indice permet de donner une image plus fidèle de la proximité relative des auteurs. En effet, il tient compte de la fréquence des deux auteurs qui forment une paire. Un indice égal à zéro signifie que les deux auteurs n'ont rien co-signé. Un indice égal à 100 (ou 1) signifie que les auteurs n'ont écrit de résumés qu'en co-signature (paire jumelle). Un indice est faible si les co-signatures entre deux noms sont rares par rapport à la fréquence de l'un ou de l'autre des auteurs. Il sera élevé si les co-signatures sont très nombreuses par rapport à la fréquence de l'un ou de l'autre des deux membres de la paire (celui ayant la plus faible fréquence).

Nous pouvons observer qu'en dehors du couple Horesok-Combellas et Viera-Montilla, les indices de centre à centre sont assez faibles, alors que les indices de centre à individus affiliés aux autres groupes sont plus fortes. Ceci nous amène à penser que le groupe de génétique végétale (II) et celui d'alimentation des monogastriques (III) sont très étroitement liés, plus que ne le sont les groupes d'alimentation (I et III) entre eux (voir tableau 2).

Commentaires sur le réseau des co-auteurs

En conclusion, nous devons souligner que ce réseau est celui des chercheurs du groupe Canavalia au sein de l'UCV à Maracay, c'est-à-dire des Facultés d'Agronomie et de Sciences Vétérinaires.

Le groupe qui comprend les auteurs en matière d'alimentation des ruminants est le plus important numériquement. Mais il faut aussi noter que ce groupe a produit durant les premières années de nombreux travaux sur l'agronomie de la plante. En effet, il s'agissait de couvrir une série d'interrogations qui étaient absentes de la littérature et d'examiner la possibilité de la culture de Canavalia en vraie grandeur au Vénézuéla.

Le groupe II correspond aux auteurs en matière de génétique et phénologie de la plante. Sa position intermédiaire se justifie par le fait qu'un des chercheurs a travaillé aussi bien avec les chercheurs d'alimentation des ruminants que ceux d'alimentation des monogastriques (volailles notamment), entre autres parce que c'est lui qui, dans un premier temps, pouvait fournir l'information utile sur les graines, et fournir ces graines aux chercheurs explorant les possibilités d'utilisation de Canavalia.

Tableau 2. Indice de relation symétrique pour certains membres du réseau de co-auteurs

Auteur en relation	avec un auteur Central		avec un auteur Dépendant	
	Nom	Valeur	Nom	Valeur
Escobar (I)	Viera (II)	0,58		
Viera (II)	Mora (I)	0,91		
	Parra R. (I)	0,91		
			Dixon (I)	8,69
	Montilla (III)	6,27		
			León (III)	7,68
			Reina (III)	9,7
			Vargas (III)	5,7
Mora (I)	Horesok (II)	0,57		
Parra (I)	Montilla (III)	0,48		
			León (III)	1,05
			Vargas (III)	1,75
	Horesok (II)	0,57		
Montilla (III)			Ramis	1,01
Horesok (II)	Combellas (I)	2,75		
Vierma (II-III)	Viera (II)	23,6		
	Montilla (III)	2,5		
Preston (I-III)	Escobar (I)	1,1		
	Parra R. (I)	1,7		
	Combellas (I)	33,3		
	Montilla (III)	12,0		

(groupe entre parenthèse)

Le groupe III correspond aux chercheurs travaillant sur l'alimentation des volailles, mais il est faiblement représenté dans le corpus que nous avons examiné et pour la période étudiée. C'est en effet, après 1987 que ce groupe donnera l'essentiel de ses résultats, notamment ceux effectués en collaboration avec les chercheurs français.

De plus nous avons pu signaler la dépendance des travaux de génétique par rapport aux demandes en matière de détoxification de la plante. Ce biais est particulièrement sensible dans la position du groupe II par rapport au groupe III.

Enfin, il faut souligner la position des individus intermédiaires qui sont soit des étrangers de passage à l'IPA, soit des chercheurs extérieurs aux Facultés de science vétérinaire et d'agronomie.

Le réseau Canavalia

Le groupe de travail Canavalia est plus un réseau de recherche qu'un groupe. Il faut tenter maintenant de l'examiner plus précisément. Nous avons effectué une enquête auprès des principaux responsables du GTC. L'enquête à proprement parler a duré cinq mois. Elle a été réalisée auprès de 13 personnes parmi les 16 personnes que nous avions sélectionnées à la suite d'une première série d'interviews en profondeur.[6] La réalisation de l'enquête s'est limitée aux Facultés de Maracay. Cette restriction est importante, car le réseau dans son ensemble devrait être plus étendu du côté des Facultés des sciences et de quelques autres institutions. Seule exception à la règle: nous avons inclus Michel Picard, car il est le seul étranger aux Facultés de Maracay qui nous a été systématiquement mentionné par les chercheurs vénézuéliens. Etant donné l'importance de sa contribution, il semblait impossible de faire l'impasse étant donné surtout son rôle de "désenclavement" des travaux vénézuéliens.

Nous n'avons pas non plus cherché à contacter les agriculteurs ou les producteurs mentionnés. En effet, l'objectif n'est pas une description fidèle de ce que font tous ceux qui travaillent sur Canavalia, mais une description de la vision des chercheurs.

Nous avons élaboré un questionnaire dont la partie principale, permet de saisir le réseau de noms demandés aux personnes interrogées. Nous leur demandions de nous mentionner les noms des personnes avec lesquelles ils avaient entretenu des relations de travail sur Canavalia. La formulation est volontairement vague afin que chacun interprète la participation au réseau Canavalia de la manière la plus ouverte possible.

Les personnes interrogées sont toutes mentionnées dans le tableau 4 (une seule a été éliminée pour n'avoir pas fourni de liste de noms) avec un astérisque. Au total les treize personnes ont donné 110 noms différents, pour un total de 225 citations (soit 18,75 noms par enquête en moyenne).

Les membres du réseau

La distribution institutionnelle des noms cités correspond très exactement à l'image qui ressort des interviews. La majorité des recherches est menée au sein

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[6] Deux chercheurs seulement ne nous ont pas répondu et une personne n'a pu être contactée.

de la Faculté de d'Agronomie et Vétérinaire. L'autre faculté importante est la Faculté des Sciences de l'UCV à Caracas. En dehors de l'UCV ont est frappé par le grand nombre d'Universités mentionnées (LUZ, UNELLEZ, UDO, URG, USR) et institutions de recherche (FONAIAP, IVIC). En vérité toute la recherche vénézuélienne est ici présente. A l'étranger, la prédominance de la France est due essentiellement au grand nombre de noms mentionnés par Picard, de même que le poids du Mexique s'explique par la présence du groupe de recherche de l'Université de Mérida dans le Yucatán. Un grand nombre d'entreprises, de producteurs agricoles ou avicoles ou d'associations de producteurs ont été mentionnés, mais rarement plus d'une fois.

Tableau 3. Description du réseau selon les appartenances institutionnelles

Institutions scientifiques vénézuéliennes		45
Université Centrale	33	
Faculté d'agronomie UCV	17	
Faculté vétérinaire UCV	6	
Autres Facultés UCV	10	
Autres institutions vénézuéliennes.	12	
Institutions de recherche étrangères		37
Entreprises, Fondations privées		11
Producteurs et associations de producteurs		17
TOTAL		110

En effet, si le nombre de noms est important, il ne faut pas perdre de vue l'irrégularité qui intervient dans la fréquence des mentions. Nous avons établi le compte détaillé des mentions que reçoivent les noms cités en fonction de leur fréquence.[7] La fréquence du nombre de citations que reçoit un nom diminue considérablement après deux mentions. Les 90 individus ou organismes cités une ou deux fois seulement, ont une position périphérique dans le réseau.

Le grand nombre de mentions données à des noms qui ne sont cités que par un seule personne est généralement dû à trois causes distinctes. Soit les noms mentionnés correspondent à des personnes à l'étranger (34 cas); soit il s'agit de noms d'associations de producteurs avec lesquels les chercheurs enquêtés ont eu

[7] Par manque de place, nous ne reproduirons pas ici le détail des nom cités par affiliation institutionnelle, ni les graphiques de fréquence des citations.

un ou deux contacts, personnes qui sont effectivement inconnues des autres chercheurs; soit, il s'agit de noms de chercheurs ou professeurs dans d'autres facultés de l'UCV (deux noms à la faculté d'ingénierie, cinq noms à la faculté des sciences) ou d'autres universités ou centres de recherche (10 noms). Enfin, seuls 10 noms de professeurs de la Faculté d'agronomie ou de sciences vétérinaire n'ont été mentionnés qu'une seule fois. Les mentions de faible fréquence sont aussi, dans la plupart des cas le fait de chercheurs qui nous ont donné une plus grande liste de noms.

La structure du réseau

Les étrangers et les producteurs ou associations de producteurs sont donc le plus probablement périphériques. De même sont plus probablement périphériques les individus hors de l'UCV. Cependant il ne faut pas tirer comme conclusion que tous ceux qui n'appartiennent pas aux deux facultés d'Agronomie et de Sciences Vétérinaires sont nécessairement périphériques. Pour pouvoir dire cela il faut pouvoir mesurer la centralité des individus. La méthode que nous utilisons est assez empirique. Elle repose sur le calcul des indices suivants:
- soit F la fréquence, c'est-à-dire le nombre de citations obtenues par un individu;
- la fréquence relative Fr de cet individu est calculée par la formule Fr=(100*F)/Ft, où Ft est la fréquence totale soit 225 occurrences;
- le poids P d'un individu est défini comme la somme des fréquences F(i) des i individus le citant;
- le poids relatif Pr d'un individu est défini par la formule : Pr=(100*P)/Ft;
- enfin, la centralité C et la centralité relative Cr sont définies par les formules suivantes: C=P+F, et Cr=((P+F)*100)/Ft.

Le tableau 4 récapitule les données pour les individus de poids relatif supérieur à 10, c'est-à-dire ceux dont la somme des fréquences des individus le citant est supérieure à 10% de la fréquence totale. En réalité cette liste de noms recouvre presque totalement (avec une exception) celle des individus ayant reçu trois mentions ou plus. L'ensemble de ces individus peuvent donc être qualifiés de centraux. On remarquera que les deux individus les plus centraux se suivent de très près. Il y a inversion de leur ordre selon que l'on considère le poids (absolu ou relatif) et la centralité. Si on additionne la fréquence et le poids d'un individu, Montilla est plus central que Vargas. Cela vient du fait que Montilla a été mentionné par tous les chercheurs interrogés, alors que ce n'est pas le cas de Vargas qui a été mentionné surtout par les chercheurs les plus centraux du réseau. Les interviews nous ont permis de déterminer la cause de cette différence. Vargas est un individu qui ne fait pas l'unanimité car il défend un point de vue particulier sur le rôle de la recherche par rapport aux applications pratiques, d'une part, et sur le type de travaux qu'il convient d'effectuer, d'autre part. Montilla est un personnage plus militant, plus respecté, plus agé aussi, à qui ses collègues reconnaissent un rôle de leader politique.

Tableau 4. Caractéristiques des individus centraux

Individu	P	Pr	F	Fr	C	Cr
51 JARAMILLO	23	10,22	2	0,89	25	11,10
76 PARRA,O*	23	10,22	3	1,33	26	11,56
38 F.POLAR	27	12,00	4	1,78	31	13,78
19 CARABAÑO*	31	13,78	4	1,78	35	15,56
92 SEIDL	32	14,22	4	1,78	36	16,00
74 PARRA+	35	15,56	4	1,78	39	17,33
83 PRESTON	37	16,44	4	1,78	41	18,22
24 CENTENO*	37	16,44	6	2,67	43	19,11
2 ANGULO	39	17,33	6	2,67	45	20,00
20 CARMONA	40	17,78	4	1,78	44	19,56
57 LEON*	44	19,56	5	2,22	49	21,78
81 PICARD*	44	19,56	5	2,22	49	21,78
87 RISSO	48	21,33	7	3,11	55	24,44
60 MARIN*	51	22,67	6	2,67	57	25,33
101 VIERMA*	60	26,67	8	3,56	68	30,22
67 MORA*	62	27,56	8	3,56	70	31,11
35 ESCOBAR*	63	28,00	10	4,44	73	32,44
100 VIERA*	65	28,89	11	4,89	76	33,78
65 MONTILLA*	69	30,67	12	5,33	81	36,00
98 VARGAS*	71	31,56	9	4,00	80	35,56

* personne ayant répondu à l'enquête.
\+ décédé

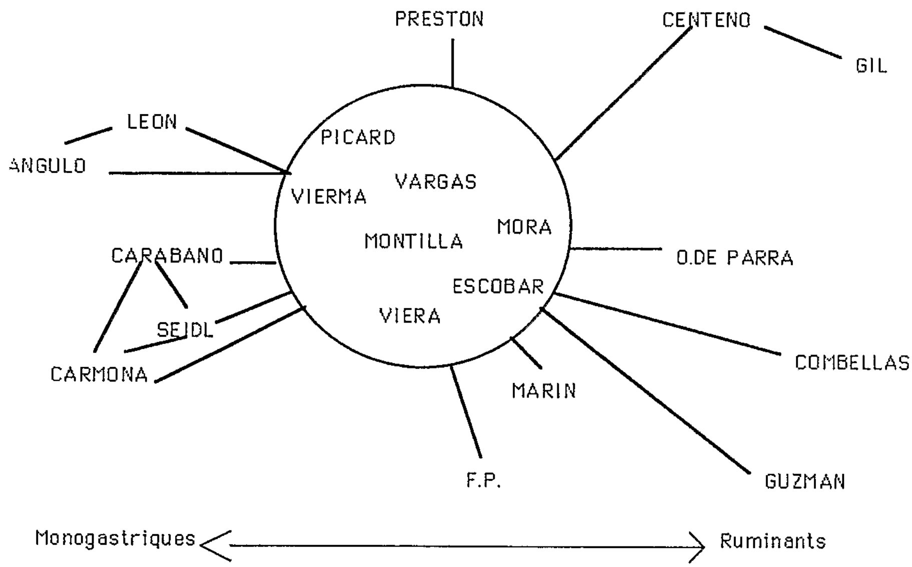
Sur la base de ces indicateurs, nous sommes donc en mesure de dessiner la forme du réseau Canavalia. Le graphique 2 est une schématisation possible de ce réseau. Il ne représente que les individus centraux, sans tenir compte des noms cités une seule ou deux fois. Nous avons donc là une représentation du noyau du réseau et de ce que l'on peut appeler la "première périphérie". En réalité, ce noyau se décompose en groupements élémentaires.

La distance entre les individus représente leur position respective les uns par rapport aux autres. Plus centrale la position plus fréquente est leur occurrence. Les individus dans le cadre central, sont le noyau.

Ce graphe appelle aussitôt quelques commentaires. 6 parmi les 7 individus qui composent le centre du réseau ont un indice de centralité entre 30 et 35,5. Seul celui de Picard est moins élevé, ce qui se justifie par le fait que c'est un étranger. Eut-il été vénézuélien il aurait eu une position plus centrale. Les quatre autres noms du noyau sont ceux des chercheurs de la première heure du groupe Canavalia. Leur situation actuelle est d'ailleurs différente pour chacun d'eux.

Aujourd'hui en effet, seuls 5 parmi les 7 chercheurs du noyau central, travaillent à temps plein sur Canavalia.

graphique 2. représentation simplifiée du réseau canavalia



Aucun producteur (aviculteur, agriculteur ou éleveur) n'est finalement retenu par l'indice de centralité. Par contre, Jaramillo, ingénieur de production dans une entreprise colombienne d'aliments pour animaux (mentionné par des chercheurs des centraux), et la Fondation Polar, qui finance une très importante partie de la recherche, ont été retenus. Cette fondation a été le principal organisme de financement de la recherche sur Canavalia (en dehors du financement propre de l'Université Centrale et des budgets de fonctionnement des autres chercheurs). Quant aux relations avec les producteurs nous devons souligner que cette relation est loin d'être directe. Les chercheurs tissent des liens de manière relativement isolée avec quelques agriculteurs, mais qui ne portent pas semble-t-il de conséquences sur les autres membres du réseau.

Les individus centraux ne sont pas tous reliés entre eux. Il existe deux grands ensembles au sein du noyau. Un ensemble avec une orientation "alimentation des volailles et biochimie", et un ensemble avec une orientation "alimentation des bovins". Contrairement à l'analyse des co-auteurs la génétique végétale n'apparaît pas autonome, sinon reliée très étroitement à l'alimentation des volailles et biochimie.

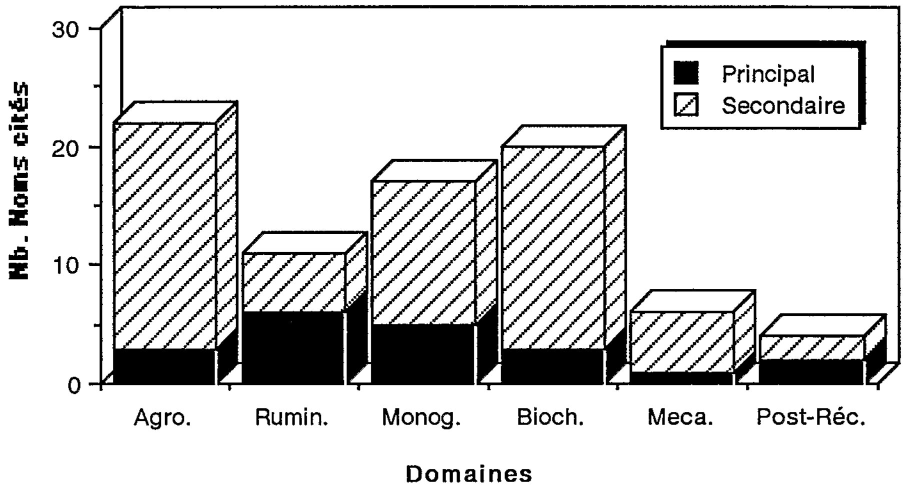
Conclusion sur le réseau

C'est donc un réseau avant tout de recherche où les contacts avec le secteur productif sont faibles bien que la volonté explicite des chercheurs soit de se rapprocher des producteurs. De plus il semble se profiler une certaines différentiation entre ceux qui travaillent sur la détoxification ou identification des toxines et l'alimentation des volailles et ceux qui travaillent sur les autres sujets. La biochimie semble révéler une structuration plus grande que les autres domaines. Celle-ci est évidemment liée à un plus grand nombre de personnes qui travaillent dans de domaine. Mais ce n'est probablement pas la seule raison. La raison principale doit découler aussi des choix, souvent implicites, qu'effectuent les chercheurs.

Du point de vue de la méthode d'observation, nous devons constater que l'enquête socio-métrique donne des résultats fiables mais en soi insuffisants. En l'absence d'informations supplémentaires, l'observateur extérieur ne saurait pas comprendre la structuration du réseau. Par contre, il dispose d'un outil très efficace pour mesurer le poids et la centralité des acteurs, plus que pour évaluer la forme du réseau. En effet, les indicateurs synthétiques sont particulièrement fiables pour restituer le poids qu'ont ou devrait avoir certains acteurs aux yeux des autres. Ce sont les acteurs de la première périphérie qui sont alors les plus intéressants. On y compte des chercheurs qu'une enquête qualitative n'aurait pas nécessairement identifié. La force de l'enquête sociométrique réside donc dans l'objectivation de l'observation. Sa faiblesse est principalement le fait de la fluidité du réseau: les liens changent de dimension et de nature dans le temps.

Mais surtout la méthode pèche par le fait qu'elle ne mesure pas l'implication des chercheurs. Or, tous les pôles ne sont pas d'égale signification dans la mesure où l'intérêt que portent certains chercheurs pour Canavalia est plus importante que pour d'autres. C'est pour cette raison que nous tenté d'identifier les acteurs du réseau qui ont un intérêt plus marqué et soutenu pour Canavalia (graphique 3). Cette identification de l'importance de l'intérêt porté par les chercheurs à l'objet de la recherche (ici Canavalia) est essentielle dans l'analyse sociométrique en termes de réseaux. A cette précision près, on peut considérer que le résultat de l'enquête socio-métrique est fiable et robuste.

Graphique 3. Réseau Canavalia: Intérêt principal et secondaire



Comparaison des deux méthodes d'identification du réseau

Tout d'abord, nous devons remarquer que s'agissant d'un réseau de recherche avec une production écrite, même non-conventionnelle (ce ne sont que des résumés de recherche pas des articles) mais à laquelle nous avons accès avec une relative facilité, les informations sur la structuration du réseau de recherche semblent être plus fines quand on s'appuie sur les co-auteurs qu'en utilisant les informations obtenues à travers les questionnaires. Ce symptôme pourrait s'appeler "la mémoire du papier": en effet, la mémoire des interviewés est soit sélective, soit tout simplement ne fournit pas tous les noms demandés au moment demandé. Par contre, les noms des co-signataires sont bien répertoriés par écrit. De plus, le réseau des co-auteurs, dans la mesure où nous connaissons les règles de fonctionnement de cette relation au sein de l'institution, permet de mettre à jour la structure de travail réelle, par opposition à la structure nominale, celle qui ressort des nominations des personnes interrogées. Ainsi, par exemple,nous voyons apparaître dans ce réseau des étudiants de haut niveau (mais pas exclusivement), alors qu'ils étaient totalement absents des enquêtes. D'un autre côté, la structure nominale fournit probablement des éléments supplémentaires, comme c'est le cas des techniciens de recherche, qui apparaissaient dans les enquêtes mais sont absents de l'analyse des co-auteurs. Cependant, il faut reconnaître que l'analyse des co-auteurs a été très efficace dans le cas présent.

L'analyse de la structure du réseau de recherche par les co-auteurs n'est donc possible que s'il existe un corpus documentaire dont on connaît la norme de fonctionnement. Elle deviendrait plus problématique dans le cas d'un corpus plus disparate (publications dans des revues dont le mode de fonctionnement échappe au groupe, ce qui est le cas habituel).

L'analyse sociométrique, dont nous avons souligné plus haut les avantages et inconvénients, est donc un complément, notamment en ce qu'il saisit des relations qui ne se matérialisent pas par des publications conjointes. Cependant, nous notons que dans les deux cas nous avons obtenu la même structure d'ensemble.

CONCLUSION

Le réseau de chercheurs impliqués dans le programme se caractérise comme un réseau universitaire développé au Vénézuéla autour de l'Université Centrale (UCV); les contacts avec d'autres institutions non-universitaires restent relativement rares en dehors des bailleurs de fonds (Fondation Polar, FIS, Fondation Mendoza, entreprises agro-industrielles).

Le programme de recherches sur Canavalia a pu être utilement décrit par les deux méthodes exposées. Ce programme constitue à nos yeux un exemple particulièrement intéressant de recherches pluridisciplinaires. Ces réussites résultent d'une structuration réelle du réseau de chercheurs aussi bien au sein des institutions qu'au niveau international, comme en témoigne le dynamisme des contacts, tant nationaux qu'internationaux.

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PATTERNS OF SCIENTIFIC COMMUNICATION AMONG LATIN AMERICAN JOURNALS IN THE FIELD OF MEDICAL EDUCATION

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ABSTRACT

This work reports on the medical subject headings that build-up the medical education field in Latin America, through the content and citation analysis of "Educacion Medica y Salud" (EMS). An attempt was made to establish the articulations between the citing and cited countries in the region. It was generally found that EMS was built-up by subjects of Medical Education, Health Manpower, Water Supply, and Health Policy. Although strongly citing/ cited countries, Brazil, Mexico, and Colombia have not established significant information flows among them. Further research lines are proposed.

RESUME

Ce travail étudie la structuration du domaine de l'éducation médicale en Amérique Latine, à travers l'analyse des contenus et des citations des travaux publiés dans "Educacion Medica y Salud" (EMS). Les relations entre pays citant et cités sont analysées. Parmi les résultats on a trouvé que EMS s'est principalemnt développé autour des thèmes de l'éducation médicale, des ressources humaines dans le domaine de la santé, de l'approvisionnement en eau et des politiques de la santé. Le Brésil et le Mexique, bienque faisant partie des pays citant et cités de façon importante, n'ont pas significativement établi d'échanges d'informations entre eux. Des pistes de recherche sont proposées.

INTRODUCTION

Referencing behaviour constitutes the primary source of data in citation studies and needs to be understood in a comprehensive way as part of the total picture of scholarly communication (1). This paper presents the results of a research in progress related to the content and citation analysis of the Pan

American Health Organization's (PAHO) journal of medical education, "Educacion Medica y Salud" (EMS). Preliminary results have shown that (1) multiple authorship were quite frequent; (2) the use of books and grey literature are more frequent than journal articles; and (3) that Spanish predominated, rather than portuguese and English as language of communication.

Different disciplines have different rates of citation (3-5). The same specialties in different countries often have different citation rates. Lange (6) for example, studied nationally-produced citation habits and found that preferred language of the cited publication and absolute citation frequencies were dependent on discipline and country of publication. Indeed, there is considerable variation among disciplines, subdisciplines, and countries in citation patterns, and as more studies are undertaken, problems proliferate (7). Referring to Third World countries, Garfield (8) reported in 1983 the mapping of science. Data from journals not covered by ISI's databases however, is more difficult to obtain. This is the case of "Educacion Medica y Salud".

PURPOSE OF THIS WORK

The purpose of this work is to present the medical subject terms that participate in the building-up of EMS, and the specific articulations between citing and cited countries, with the aim of detecting the main information flow patterns among descriptors and among countries in the Latin American region.

METHODOLOGY

A retrospective, automated search on MEDLINE was performed to obtain the Medical Subject Headings (MeSH) of 257 documents, as indexed in EMS for the period 1979-1988. Each reference was numbered, accordingly. 13 x 21 cms. cards were used to capture data on each indexed MeSH term regarding (1) the reference number of each indexed article under that term; (2) the subheadings, as applied to each term and to each article; and (3) a unique identifier number for each MeSH term.

Following MEDLINE parameters, a difference between " ordinary " and "asterisked" terms also applied to this study. According to the U.S. National Library of Medicine (9) in the indexing process, the indexer assigns as many headings as necessary to characterize accurately the content of a journal article. Those that represent the most significant points are identified with an asterisk in the online citation. The remaining " ordinary " headings are used to identify concepts which have also been discussed, but are not the primary topics.

In this study, when a term applied to both, "ordinary" and "asterisked" descriptors, two cards were created with the same unique identifier number, differentiating the "asterisked" descriptor with an "A". Check tags such as "human", "child", or "male", were excluded from the study.

A manual, alpha-numeric inverted file was thus created with all MeSH terms. The file was used to obtain information regarding (1) the total number of MeSH terms used throughout the period of study; (2) the number of "asterisked" terms; (3) the highly indexed terms; both, "ordinary" and "asterisked"; and (4) the geographical descriptors by country, and by region. Data was then manually processed and tabulated. Information regarding the subheadings was not processed at this time.

In order to obtain the information flows among the medical subject headings, the Annotated (9), and Tree Structured (10) MeSH were used. On the other hand, the geographical terms as indexed and captured in the inverted file, and the corpprate sources of the citing-cited documents were used to obtain the information flow among the participating regional countries.

RESULTS

Excluding check tags, 1745 medical subject headings were used once or more to index all 257 original documents in EMS, during the period 1979-1988. An average of 6.8 descriptors per document were used to index all documents.

Table 1. Distribution of MeSH terms per indexed document, as published in "Educacion Medica y Salud", 1979-1988.

No. of MeSH terms (A)	No. of documents (B)	A x B	%
2	6	12	02.34
3	12	36	04.67
4	24	96	09.34
5	36	180	14.00
6	54	324	21.01
7	37	259	14.40
8	24	192	09.34
9	28	252	10. 89
10	19	190	07.39
11	10	110	03.89
12	3	36	01.17
13	1	13	00.39
14	1	14	00.39
15	1	15	00.39
16	1	16	00.39
TOTAL	257	1745	100. 00

Table 1, provides the distribution of MeSH terms per indexed document. The total amount of original MeSH terms used was 376 (100%). 138 (36.70%) were asterisked terms. A Bradford-like distribution of MeSH terms was found thus creating a core of "ordinary" and " asterisked" descriptors. Tables 2 and 3, show the overlaps and rank distributions, accordingly.

Table 2. Rank distribution of "ordinary" MeSH terms, as used to index original articles published in "Educacion Medica y Salud", 1979-1988.

RANK	MeSH Terms (ordinary)	Frequency	%
1	Latin America	65	04.71
2	Curriculum	44	03 19
3	Brazil	35	02.53
4	Education, Medical	32	02.32
4	Health Occupations	32	02.32
5	Public Health	27	01.96
6	Pan American Health Organization	23	01.67
7	Health, Manpower	22	01.59
7	Mexico	22	01.59
8	Health Services	21	01.52
8	Colombia	21	01.52
8	Socioeconomic Factors	21	01.52
8	Health Policy	21	01.52
9	Education, Nursing	19	01.38
10	History	18	01.30
10	History of Medicine, 20th. Cent.	13	01.30
11	Allied Health Personnel	17	01.23
11	Evaluation Studies	17	01.23
11	Health Resources	17	01.23
11	Sanitary Engineering	17	01.23
11	Teaching	17	01.23
12	Health Planning	16	01.16
12	Primary Health Care	16	01.16
12	United States	16	01.16
13	International Cooperation	15	01.09
14-27	Others (302)	792	42.66
1-27	327 MeSH Terms	1381	100.00

In general, it was found that EMS comprehends the following disciplines (in descending order): (1) Education, (2) Health Care, (3) Biological Sciences, (4) Information Sciencs, (5) Physical Sciences, (6) Social Sciences; (7) Humanities, and (8) Analytical, Diagnostic and Therapeutic Technics and Equipment. More specifically, EMS is built-up by subjects of (1) Education; mainly medical, nursing, continuing, curriculum, inservice training, and teaching. (2) Facilities, Manpower, and Services; mainly health manpower, allied health personnel, health services, and health education (3). Environment and Public Health; mainly public health, sanitation, sanitary engineering, and water supply. (4) Economics, Organizations, Control; mainly health planning, health services research, health resources, health policy, and PAHO. (5) Health Occupations. (6) Social Sciences; mainly international cooperation, and socioeconomic factors. (7) Humanities; mainly history, and history of medicine, 20th cent. (8) Information Science; mainly information services. (9) Physical Sciences; mainly reaearch. (10) Miscellaneous technics; mainly evaluation studies; and (11) Health Services Administration; mainly primary health care.

Table 3. Rank distribution of "asterisked" MeSH terms, as used to index documents published in "Educacion Medica y Salud", 1979-1988.

Rank	MeSH terms (a) (asterisked)	Frequency	%
1	Education, Medical (4)	22	06.29
2	Health, Manpower (7)	16	04.57
3	Water Supply	13	03.72
4	Health Policy (8)	12	03.43
5	Health Services Research	11	03.14
5	Curriculum (2)	11	03.14
6	Health Ressources (11)	10	02.86
7	Health Planning (12)	9	02.57
7	Education, Continuing	9	02.57
8	Sanitation	8	02.30
9	Education, Nursing (9)	7	02.00
10	Public Health (5)	6	01.71
10	Health Education	6	01.71
10	Information Services	6	01.71
11	Inservice Training	5	01.43
11	Internahip and Residency	5	01.43
11	Research	5	01 .43
12	Others (121)	189	53.99
1	138 MeSH TERMS	350	100.00

(a) MeSH Terms with a parenthesis and a number indicate that the same term was used as an "ordinary' term. The number indicates the rank, as given in Table 2.

In descending order, Brazil, Mexico, Colombia, U.S.A, Chile, Cuba, and Peru, were the most indexed countries in EMS, representing 74.39% of the 25 indexed countries. Table 4, provides a rank distribution of these results. As for the geographical regions, it was found that although there were nine regions in

Table 4. Rank distribution of indexed countries in "Educacion Medica y Salud", 1979-1988.

RANK	COUNTRY (as a MeSH term)	Frequency	%
1	Brazil	35	22.44
2	Mexico	22	14.10
3	Colombia	21	13.46
4	U.S.A.	16	10.26
5	Chile	9	05.77
6	Cuba	8	05.14
7	Peru	5	03.22
8	Venezuela	4	02.56
8	Panama	4	02.56
8	Costa Rica	4	02.56
9	Honduras	3	01.92
9	Guatemala	3	01.92
9	Dominican Republic	3	01.92
9	Canada	3	01.92
9	Argentina	3	01.92
10	Nicaragua	2	01.28
10	Jamaica	2	01.28
10	Bolivia	2	01.28
11	Others (7)	7	04.49
1-11	25 MeSH terms	156	100.00

Table 5. Rank distribution of indexed geographical regions in "Educacion Medica y Salud", 1979-1988.

RANK	REGION (as a MeSH term)*	Frequency	%
1	Latin America	65	63.11
2	Developing Countries	16	15.53
3	West Indies	9	08.74
4	Central America	6	05.83
5	North America	2	01.94
5	South America	2	01.94
6	Africa	1	00.97
6	Asia	1	00.97
6	Europe	1	00.97
1-6	Nine MeSH terms	103	100.00

*Both, "ordinary" and "asterisked" MeSH terms.

total, EMS is mainly focused to Latin America and Developing Countries. Table 5 shows these results.

An analysis of the relationships among citing/cited and indexed countries shows a similar ranking distribution. Table 6 illustrates such relation. A further specific analysis however, showed that, excluding WHO/PAHO citations : (1) Brazil was highly self-cited (87.84%), as compared to U.S.A (10.87%). (2) While Brazil was not significantly cited by any country (six or more citations), Mexico was cited by Venezuela, and Cuba. Argentina was cited by Venezuela, and Colombia. U.S.A. was cited by the top ten countries. Thus, (3) appart from Argentina and Mexico, all Latin American countries are mainly self-cited. Figure 1 illustrates the information flows among the top ten leading countries in the region.

Table 6. Comparison among citing, cited and indexed countries, as found in "Educacion Medica y Salud", 1979-1988. Order by rank of citing countries. (R=Rank; F= Frequency).

Country	Citing country			Cited country			indexed country		
	R	F	%	R	F	%	R	F	%
Brazil	1	45	17.50	2	255	11.27	1	35	22.40
Mexico	2	35	13.61	3	188	08.31	2	22	14.10
Colombia	3	24	09.34	5	91	04.02	3	21	13.46
U.S.A.	4	15	05.84	1	1002	44.26	4	16	10.26
Chile	5	10	03.89	8	64	02.83	5	9	05.77
Argentina	6	9	03.50	6	80	03.53	9	3	01.92
Cuba	6	9	03.50	10	55	02.43	6	8	05.14
Venezuela	7	7	02.72	7	71	03.14	8	4	02.56
Costa Rica	8	6	02.33	13	23	01.02	8	4	02.56
Peru	8	6	02.33	12	29	01.28	7	5	03.22

DISCUSSION AND CONCLUSION

No parameter was found to indicate whether 376 descriptors were adequate to cover the field of medical education and its related disciplines. As it was mentioned previously, MeSH assigned 95 descriptors under its "Education" category; however, both isolated indicators are not sufficient to evaluate, i.e. conclude on these findings.

According to Brooks (11) to some degree all bibliographic phenomena tend to cluster. In our study, a core of most indexed headings helped to identify the main subjects that constructed EMS. The outlying zones however, remained uncovered and need to be fully analyzed in order to comprehend its relationship with the core zone. This is also true for the subheadings, as applied to both, "ordinary" and " asterisked " MesH terms.

The highly indexed countries as found in the content analysis of this study, corroborate our previous findings of the highly citing-cited countries in the field. This helped to select Brazil, Mexico, Colombia, and U.S.A, as the top four leading countries in EMS. Appart from the U.S.A., only Mexico and Argentina showed "some" information transfer in the region. Brazil and Colombia, although highly citing countries, were found to be mainly self-cited. Whether this is due to the language barrier (Portuguese in the case of Brazil), the accessibility of information sources, or to other factora, is not known. Further research needs to be conducted to fully understand this pattern.

This research has contributed to understand the structure of EMS, and to some extent, the information flows among subjects and among countries in the field.

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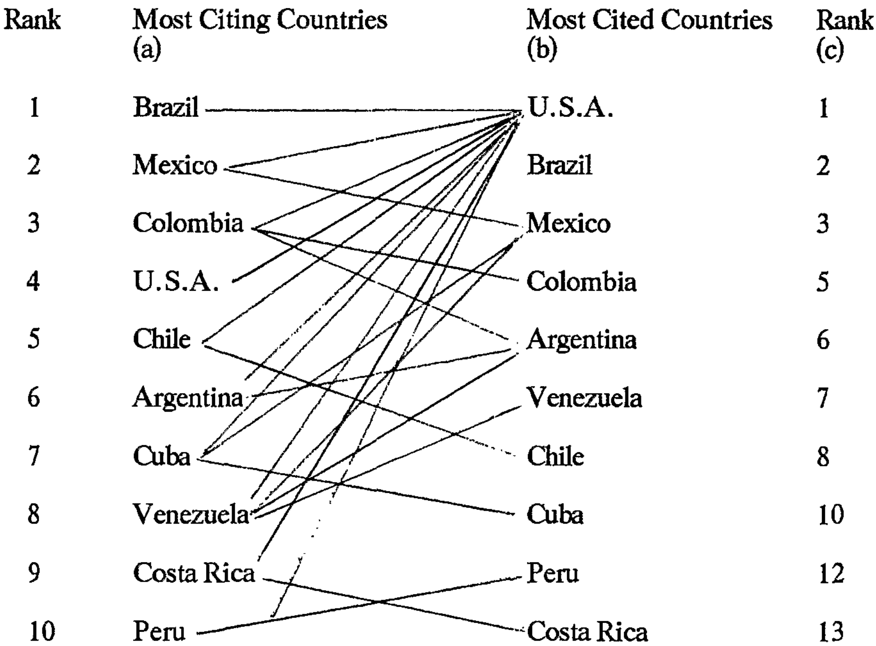
Figure 6. Information flows among the top ten leading countries in "Educacion Medica y Salud", 1979-1988. Order by rank of citing countries.



THE CONDITIONS OF SCIENTIFIC RESEARCH IN CHEMISTRY: A VIEW FROM THE BRAZILIAN COMMUNITY

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ABSTRACT

The aim of this paper is to analyse the environment in which scientific research in Chemistry is carried out in Brazil. This task is accomplished by the analysis of a questionnaire which was distributed among academic scientists by the Brazilian Chemistry Society. This survey examined the attitudes of scientists towards their activities at the different institutions, at the national level, and by region, and also according to their research fields within Chemistry. The researchers' evaluation of the positive and negative factors facing the scientific development of Chemistry were examined in the light of peer review trials which focus on the distribution of fellowships and grants, and on the assessment of post-graduate programmes in Chemistry. By examining the linkages that emerged from the researchers' views and expert judgements of research and post-graduate activities, as well as the input-output indicators connected with them, it was possible to draw up strategies and recommendations to be considered by the government, national enterprises, and the academic community itself, with regard to the improvement of an endogenous progress in Chemistry. Presently, this is of keen importance due to the relationship between chemical knowledge and intensive knowledge technologies such as fine chemicals, biotechnology, new materials, among others.

RESUME

L'objectif de cet article est d'analyser le contexte dans lequel se déroule la recherche scientifique en chimie au Brésil. Ceci est fait en examinant les réponses à un questionnaire qui a été distribué parmi les chercheurs essentiellement universitaires par la Société Brésilienne de Chimie. Ce questionnaire examine les attitudes des chercheurs face à leurs conditions de travail au sein des institutions de recherche au niveau national et régional ainsi que par disciplines. L'évaluation par les chercheurs des facteurs négatifs *et positifs du développement scientifique sont examinés et sont mis en relation avec les processus de jugements par les pairs qui permettent d'établir les distributions de bourses de recherche et d'effectuer l'évaluation des programmes d'enseignement et de recherche de "post-graduation". En examinant conjointement les opinions des chercheurs et les jugements des experts sur la recherche et les programmes de "post-graduation", ainsi que les indicateurs d'input et output qui leur sont liés, il a été possible d'effectuer une série de recommandations au gouvernement, aux entreprises nationales et à la communauté scientifique elle-même pour l'amélioration et le progrès endogène de la recherche en Chimie. Ceci est aujourd'hui très important notamment dans le cas du développement de technologies nouvelles, comme le sont par exemple la chimie fine, les biotechnologies, les nouveaux matériaux.*

INTRODUCTION

The present study is related to a future programme to be established by the brazilian governement jointly with the Brazilian Chemistry Society (SBQ)-which assembles the majority of researchers and post-graduate students working in universities and isolated institutes-, the"Chemistry Programme for the Next Decade". The study focuses only on the academic research environment with the purpose of evaluating its fragility as well as its potentialities, through the use of scientific indicators.

METHODOLOGY

Three basic topics on the research environement are analysed in this survey. This first topic consists of 19 items, listed in Table 1, and organized under three categories: Intellectual Capital, Infrastructure, and Investments. Answers were evaluations based on grades ranging from 1 to 5.

Topics 2 and 3, respectively, present the opinion of researchers on the three most serious problems and the three main factors which contribute to the efficiency of the research and post-graduate activities (RPG), all ranged from the most important to the least relevant. The analysis of these three factors, when confronted with the results of the first topic, allow us to match the information and to grasp, in a more consistent manner, the circumstances under which academic research in Chemistry is carried out in Brazil. This is done by putting together the "problems" and "factors" under the same categories as in the first topic, and by using a point scale (3 points for a factor considered of greater importance; 2 points for the second most important; and 1 point for the third most important factor) it was possible to classify the related factors in each answer. The point values attributed to different opinions and attitudes reflected in the study were correlated by region and by university.

Table 1 Classification of the first items of the first topic by category

CATEGORY	ITEM	CONTENTS
Intellectual Capital	01	Research quality performed in your State in chemistry
	02	Research quality performed in your field
	03	Quality of post graduate students in the universities of your State in your field
	04	Quality of post graduate students in the universities of your State in chemistry
	05	Number of researchers in your State in your field
Infrastructure	06	Infrastructure in your Department for research and post graduate activities (RPG)
	07	Infrastructure in your State for RPG in chemistry
	08	Infrastructure in your State for RPG in your field
	09	Accessible equipment for RPG
	10	Equipment in your State for RPG in chemistry
	11	Equipment in your State for RPG in your field
	12	Availability of solvents, reagents, and other imported items of consumption
	13	Availability and quality of the services for the maintenance of equipments
Investments	14	Availability of resources for research in your laboratory
	15	Availability of resources for research in chemistry in your State
	16	Availability of resources for research in your field
	17	Suitability of grants and scholarships offered by CNPq to the needs of RPG in chemistry in your State in relation to their monetary values
	18	Suitability of grants and scholarships offered by CNPq to the needs of RPG in chemistry in your State in relation to their types
	19	Suitability of FINEP's grants to the needs of RPG in your state

The sample (Table 2) consisted of 168 responses and enabled us to trace a profile which reflects a cross section of the opinions of the researchers. 115 (or 68.4%) of the respondents held Doctorate degrees, and thus were best placed to judge the conditions of academic research; 32 (or 19%) were Masters degree holders; and 17 (or 10.2 %) were post-graduate students, or graduates. In this manner the points of view of all the main participants in the social aspects of the scientific process were taken into account, but the predominance of Doctorate degree holders in the sample ensures that the weight of their opinions prevails[1] .

[1] It is significant that the 115 Doctors in the sample account for more than half (or 51.3%) of the 224 currently receiving research fellowships in Chemistry from CNPq (the National Council for Scientific and Technological Development) at the time of this study , and that

Table 2A- Number of answers to the questionnaire by chemistry field, geo-economic region and the researcher's level

CHEMISTRY FIELD	NORTH						NORTHEAST						CENTRAL WEST					
	D	M	G	U	WI	TT	D	M	G	U	WI	TT	D	M	G	U	WI	TT
ORGANIC	2	3	5	1	1	12	3	2	-	-	-	5	4	2	-	1	1	8
PHYSICAL	-	-	-	-	-	-	5	1	-	1	-	7	1	-	-	-	-	1
ORGANIC	-	-	-	-	-	-	9	2	-	-	1	12	1	-	-	-	-	1
ANALYTICAL	-	-	-	-	-	-	3	-	-	-	-	3	-	-	-	-	-	-
EDUCATION	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
BIOCHEM.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2	3	5	1	1	12	20	6	-	1	1	28	6	2	-	1	1	10

Table 2B- Number of answers to the questionnaire by chemistry field, geo-economic region and the researcher's level.

CHEMISTRY FIELD	SOUTHEAST						SOUTH						BRAZIL	
	D	M	G	U	WI	TT	D	M	G	U	WI	TT	TT	%
ORGANIC	26	2	-	-	1	29	7	4	-	1	-	12	66	39.3
PHYSICAL	25	2	-	1 *	-	28	3	3	1	-	-	7	43	25.6
INORGANIC	3	1	1	-	-	5	5	2	-	-	-	7	25	14.9
ANALYTICAL	10	2	-	-	-	12	4	3	-	2	-	9	24	14.3
EDUCATION	-	1	1	1 *	-	3	-	1	-	1*	-	2	6	3.6
BIOCHEM.	3	-	-	-	-	3	1	-	-	-	-	1	4	2.4
TOTAL	67	8	2	2	1	80	20	13	1	4	-	38	168	100.0

*with specialization course

D= Doctoral Scientist; M= Master; G= Post Graduate Student; U= Graduate; WI= Without Information.

It should also be stressed that the sample gives us a representative national cross section, as the regional distribution of responses from doctor-researchers is compatible with the geographical distribution of Chemistry researchers around

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they also represent more than a quarter (or 27%) of the total Doctors/faculty-members engaged in post-graduate programmes in Chemistry in the whole country according to CAPES (Coordinating Agency for Advanced Training of High Level Personnel).

the country[2].The sample also remains valid when it is seen from the point of view of the traditional fields of Chemistry[3].

RESULTS

Table 3. Regional distribution of the answers for the first topic by category

		NORTH		CENTRAL -WEST		NORTH- EAST		SOUTH- EAST		SOUTH		BRAZIL	
CATEGORY	DEG REE	#	%	#	%	#	%	#	%	#	%	#	%
Intellectual Capital	very bad	0	0.0	0	0.0	1	3.6	0	0.0	0	0.0	1	0.6
	bad	1	8.3	2	20.0	4	14.3	4	5.0	7	18.4	18	10.7
	fair	10	83.3	7	70.0	10	35.7	33	41.3	23	60.5	83	49.4
	good	1	8.3	1	10.0	12	42.9	38	45.7	6	15.8	58	34.5
	very good	0	0.0	0	0.0	1	3.6	5	6.3	2	5.3	8	4.8
Infra structure	very bad	0	0.0	0	0.0	1	3.6	0	0.0	3	7.9	4	2.4
	bad	2	16.7	3	30.0	17	60.7	24	30.0	18	47.4	64	38.1
	fair	10	83.3	4	40.0	6	21.4	32	40.0	12	31.6	64	38.1
	good	0	0.0	3	30.0	4	14.3	24	30.0	5	13.2	36	21.4
	very good	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Investments	very bad	1	8.3	0	0.0	4	14.3	1	1.3	3	7.9	9	5.4
	bad	1	8.3	6	60.0	13	46.4	7	8.8	8	21.1	35	20.8
	fair	9	75.0	4	40.0	10	35.7	53	66.3	20	52.6	96	57.1
	good	1	8.3	0	0.0	0	0.0	18	22.5	5	13.2	24	14.3
	very good	0	0.0	0	0.0	1	3.6	1	1.3	1	2.6	3	1.8
# of individuals		12	100	10	100	28	100	80	100	38	100	168	100

2 If the regional distribution of research fellowships in Chemistry by CNPq is taken as basis. The relative importance of the five geo-economic regions of the country, in terms of their contribution to Chemistry, is also adequately reflected in the number of institutions and research centres surveyed: 3 in the North, 2 in the Central-West, 8 in the Northeast, 13 in the South, and 17 in the Southeast.

3 By comparison between Doctors' research field who responded to the survey with the list of those receiving research fellowships from CNPq at the time when the survey was being carried out (1987).

Table 3 shows that in the general view of the Chemistry researchers, research activities in Brazil could, on average, count on Intellectual Capital which they rated as Fair to Good, and an Infrastructure that they rated as being Bad to Fair, and investments that they rated as being Fair.

Intellectual Capital

Although the grade Fair is the most common feature of the survey, higher values are attributed to this category -especially by groups working in the Southeast, the Northeast, and to a lesser extent, in the Central-West.

Table 4A and 4B show that the groups which awarded the highest ratings to their activities were those engaged in research in the fields of Physical Chemistry (in São Paulo, Pernambuco, and Santa Catarina); Organic Chemistry (in São Paulo, Rio de Janeiro, Ceará, and Santa Catarina); and Analytical Chemistry (in Rio de Janeiro).

Table 4A. Distribution of the regional and national answers of the first topic by category and chemistry field (inorganic and analytical chemistry) .

		Inorganic Chemistry						Analytical Chemistry			
CATEGORY	DEGREE	NO	CW	NE	SE	SU	BR	NO	SE	SU	BR
Intellectual Capital	very bad	0	0	1	0	0	1	0	0	0	1
	bad	0	0	1	0	0	1	0	0	1	1
	fair	0	1	6	1	6	14	2	5	7	14
	good	0	0	4	4	0	8	1	7	1	9
	very good	0	0	0	0	1	1	0	0	0	0
Infra structure	very bad	0	0	0	0	0	0	0	0	1	1
	bad	0	0	8	0	6	14	2	2	0	4
	fair	0	1	3	3	1	8	0	8	5	13
	good	0	0	1	2	0	3	1	2	3	6
	very good	0	0	0	0	0	0	0	0	0	0
Investments	v.bad	0	0	2	0	1	3	1	0	0	1
	bad	0	1	6	0	1	8	1	1	2	4
	fair	0	0	3	4	4	11	1	9	6	16
	good	0	0	0	1	1	2	0	2	1	3
	very good	0	0	1	0	0	1	0	0	0	0
# of individuals		0	1	12	5	7	25	3	12	9	24

Table 4B. Distribution of the regional and national answers of the first topic by category and chemistry field (organic and physical chemistry).

		Org. Chemistry						Physical Chemistry					
CATEGORY	DEGREE	NO	CW	NE	SE	SU	BR	NO	CW	NE	SE	SU	BR
Intellectual Capital	very bad	0	0	0	0	0	0	0	0	0	0	0	0
	bad	1	1	1	1	3	7	0	1	2	1	2	6
	fair	10	6	0	14	6	36	0	0	1	11	2	14
	good	1	1	4	9	3	18	0	0	3	16	2	21
	very good	0	0	0	5	0	5	0	0	1	0	1	2
Infra structure	very bad	0	0	1	0	1	2	0	0	0	0	1	1
	bad	2	3	2	12	8	27	0	0	5	6	2	13
	fair	10	2	1	12	3	28	0	1	1	7	2	11
	good	0	3	1	5	0	9	0	0	1	15	2	18
	very good	0	0	0	0	0	0	0	0	0	0	0	0
Investments	very bad	1	0	0	0	1	2	0	0	1	1	1	3
	bad	1	4	3	3	3	14	0	1	3	1	1	6
	fair	9	4	2	22	6	43	0	0	3	15	3	21
	good	1	0	0	4	2	7	0	0	0	10	1	11
	very good	0	0	0	0	0	0	0	0	0	1	1	2
# of individuals		12	8	5	29	12	66	0	1	7	28	7	43

The relative density of researchers in the Northern Region is considered to be very low (grades varying between Very Bad and Bad). Table 5 also shows that the limited number of researchers in the Northern Region is still the greatest obstacle to assessing the RPG values presented for this region[4].

[4] The Chemistry research being carried out in the North is linked directly to the region's main features: the Amazon Rain Forest- Organic Chemistry, specifically Chemistry of Natural Products. It is well known that several parts of the Brazilian Amazon are being subject to a rapid process of human and economic occupation, and that this process is destroying certain environmental niches that will undoubtedly result in the extinction of species of flora that have therapeutic potential. It is necessary to give priority to its scientific progress, with a view to promoting a social/scientific process by which knowledge intensive products required for the most advanced technologies should find their supplies from natural sources. Thus special emphasis on fine chemicals and biotechnology research could transform the Amazon region into a centre for scientific research which could even alter the model of occupation and development prevalent in the region. Therefore, the starting point will be to design a plan to attract highly experienced human capital.

Table 5. Principal barriers to efficiency in the research and post graduate activities in chemistry by region.

Category	North		C. West		Northeast		Southeast		South	
Factor	#pts	%	#pts	%	#pts	%	#pts	%	#pts	%
Intellectual Capital										
Low density of qualified researchers	14	25.0	4	6.7	5	2.9	13	2.7	6	2.7
Lack of techn. support	4	7.1	3	5.0	5	2.9	14	3.0	17	7.5
Teaching hours	-	-	5	8.3	6	3.5	23	4.8	7	3.1
Administrative tasks	-	-	-	-	7	4.1	22	4.6	19	8.4
Lack of students	-	-	11	18.3	-	-	4	0.8	-	-
Poor Research env.	3	5.4	-	-	7	4.1	7	1.5	3	1.3
lack of motivation	-	-	6	10.0	-	-	-	-	-	-
Lack of courses for specific needs	-	-	-	-	-	-	-	-	8	3.5
Infrastructure										
Imports of reagents and equipments	-	-	2	3.3	3	1.8	70	14.7	10	4.4
Maintainance of equip.	3	5.4	3	5.0	18	10.5	54	11.4	17	7.5
Availability of equip	6	10.7	6	10.0	22	12.9	45	9.5	39	17.3
Access to special. library	12	21.4	5	8.3	20	11.7	48	10.1	14	6.2
Lab. and techn. infrastruct.	1	1.8	-	-	15	8.8	30	6.3	20	9.0
Comput Resources	-	-	1	1.7	-	-	6	1.3	-	-
Physical space	-	-	2	3.3	5	3.0	2	0.4	5	2.2
Univ bureaucracy	7	12.5	1	1.7	15	8.8	34	7.2	11	4.9
Investment										
ins. univ. budget	-	-	-	-	1	0.6	15	3.2	-	-
ins. extramural budget	3	5.4	3	5.0	22	12.9	16	3.4	33	14.6
The financing research systematic	-	-	2	3.3	9	5.3	28	5.9	7	3.0
Lack of a policy for S&T	-	-	-	-	5	2.9	10	2.1	1	0.4
Others	3	5.4	6	10.0	6	3.5	34	7.1	9	4.0
TOTAL	56	100.0	60	100.0	171	100.0	475	100.0	226	100.0

Therefore, the starting point will be to design a plan to attract highly experienced human capital.

At the national level it can be seen that only a very small number of people are involved in RPG in Chemistry, and that 39.3% of those surveyed rated this as Bad and 33.3% as Very Bad. The only group that did not conform to this pattern were the Physical Chemistry researchers centered on the Federal University of Pernambuco (UFPe)[5], located at the Northeastern Region.

In the Central-West the greatest obstacle to the efficiency of RPG is not the number of researchers working at the University of Brasilia (UnB), but rather the lack of post-graduate students[6] (Table 5) and this should be changed since it is clear that the presence of students[7] is a factor that enhances scientific research (Table 6).

Table 6 shows that in all regions of the country those items listed under Intellectual Capital are considered to be the most important for the efficiency of RPG[8]. The same table also shows that the North, Northeast, Southeast, and South share a factor that promotes RPG, namely the cooperative networks that have been established for scientific activities (the collaboration/exchange programmes that have been set up, and the support activities offered to other groups of researchers were frequently cited, and integrated work group of researchers were also favourably mentioned). Only the Central-Western region, where there is less integration, appears to be the exception to the rule.

Thus it is possible, from the evaluations and observations of the Chemistry researchers, to identify those factors which were most important for carrying out research. These are: the establishment and consolidation of integrated working groups in research activities; and the nurturing of collaboration and exchange systems, which seem to be the best strategies for stimulating and increasing Intellectual Capital at the post-graduate level.

There are currently in the country 32 post-graduate programmes in chemistry at the Masters level (12 were evaluated as excellent or A rating, 9 assessed as

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5 The group of Theoretical Physical Chemistry at UFPe attributes the best grades of the Northeastern region to the items of Intellectual Capital (Good for the research quality in Chemistry; almost Very Good in relation to its field as well as for the density of its researchers, excepting the post-graduate programme, left without any grade because it was only formalized in March 1988). This group and the Organic Chemistry group of the University of São Paulo (USP) presented the highest ratio of publication per faculty member- respectively 2.9 and 3.2 in the 1985/1986 period.

6 Even though the Chemistry department at UnB possesses one of the best libraries in the country and well-equipped laboratories, and although it considers itself the best centre for Organic Synthesis, it has the drawback of the second lowest ratio between the total number of post-graduate students, and the size of the faculty staff (1.0/2.12).

7 As one of the researchers emphasized: "-When I have them".

8 In all regions, for the own qualities of the researchers set up by themselves were appointed as the main positive factor for the efficiency of RG. By intrinsic qualities it is meant: dedication, intensive work even in adverse conditions, love for the job, disposition, persistence, patience, scientific curiosity, idealism, fighting spirit, among others.

appraised due to their recent implantation) and 11 at the Doctoral level (8 rated A, 2 rated B, and 1 rated C)[9].

These programmes are located in 22 universities and 1 research institute and are heavily concentrated on the Southeastern Region (18 Masters and 7 Doctoral), namely at the State of São Paulo (55% and 64%, respectively)[10]. In general, they are characterized by a low multiplying effect -the national average advisor/students ratio was 1.0/2.83 (413 faculties to 1171 students)[11] in 1987, and by providing very low rates of training -4.5 years to complete a Masters programme and further 6.5 years to get a Doctoral degree[12].

One proposal could be to abolish the requirement that demands that, in order to participate in a PhD programme, a candidate must first have his/her Masters degree, as this would make it possible, after a careful selection process, to choose the most brilliant of the graduates and engage them directly in Doctoral programmes. This is the usual procedure in Chemistry in other countries, where the Masters degree is seen as a final stage in studies, rather than as an intermediate step before the Doctorate[13]. Such measure would help to increase, in medium run. Another piece of information that reinforces this recommendation and confirms the researchers' evaluation is that the number of Doctors/faculty-members in Chemistry only started to increase after the second half of the 1980's.

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9 In relation to the evaluation process, N.B. Rancich, Notas sobre a avaliação da pós-graduação, CAPES/Coordenação de Avaliação, Brasília, August, 1982, points out that the concept of a post-graduate course allows is to be situated in a given scale, as a result of a comparative analysis of one course with the others in a given field of knowledge. It is graded in a value scale from A to E, where A represents the best evaluation and E a situation where the course does not fulfill the necessary criteria. The concept is derived from an analysis of multiple indicators and considers not only the evolution, in time, of the course, but also its evolutionary stage. CAPES evaluation process is done by prominent researchers in a given field, through the peer review system.

10 It implies that the greatest number of researchers on CNPq fellowships are concentrated in the Southeast (73% or 169), mainly at São Paulo (63.4% or 104). Concerning the scientific production, M.A.H. Cagnin, O Desenvolvimento Regional a e Participação do Pesquisador Químico no Progresso Científico da Química Brasileira, *Química Nova* 10 (1987), 223, has shown that, of the 73.3% of scientific publications in Organic Chemistry and 83% of scientific publications in Physical Chemistry, Inorganic Chemistry and Analytical Chemistry, that were produced in the Southeastern Region during the 70's, the production of USP alone represented 40.5% of the former group, and 41.6% of the latter.

11 An advisor/student ratio considered as fair is 1.0/5.0, see N. B. Rancich, op. cit. note 8.

12 This seems to be a general tendency of the Brazilian post-graduate programmes, as stressed the study of the Commission of the Scientific Societies, Documento sobre Ciência e Tecnologia na Nova República, *Ciência e Cultura*, 37 (1985) 1879.

13 For details see National Research Council, Opportunities in Chemistry; Committee to Survey opportunities in the Chemical Sciences, National Academy Press, Washington D.C., 1985.

Table 6. Main factors that increase the efficiency of research and postgraduate activities in chemistry by region

Category of Analysis	North		C.West		Northeast		Southeast		South	
Factor	#pts	%	#pts	%	#pts	%	#pts	%	#pts	%
Intel. Capital										
Qualities of researchers	14	20.4	13	25.0	28	20.9	74	17.7	32	20.7
Partic.of students	-	-	7	13.5	8	6.0	42	10.0	16	10.3
Post-grad. degree holders	5	10.2	3	5.8	16	11.9	4	1.0	9	5.8
motiv. working atmosphere	6	12.2	-	-	-	-	26	6.2	9	5.8
Collaborations in the country	4	8.2	-	-	22	16.4	27	6.5	18	11.6
Nb. of qualified R.	-	-	-	-	10	7.5	12	2.9	10	6.4
Collaborations with other countr.	-	-	-	-	-	-	11	2.6	-	-
Participation in congresses	1	2.0	-	-	1	0.7	2	0.5	-	-
Infrastructure										
Equip & Lab infrastruct.	8	16.3	6	11.5	7	5.2	31	7.4	2	1.3
Avail/Access to bibliogr.	-	-	7	13.5	3	2.2	16	3.8	8	5.2
Technical support	-	-	-	-	-	-	16	3.8	-	-
Physical space	6	12.2	-	-	2	1.5	-	-	1	0.7
Computer res.	-	-	1	1.9	5	3.7	-	-	-	-
Support Dynam of dept.	2	4.1	6	11.5	5	3.7	-	-	5	3.2
Investment										
Availability of budgetary res.	-	-	3	5.8	-	-	-	-	-	-
Availability of budgetary extramural res.	5	10.2	3	5.8	7	5.2	67	16.0	16	10.3
Availability of scholarships	-	-	-	-	7	5.2	16	3.8	-	-
Research at low costs	-	-	-	-	-	-	10	2.4	1	0.4
Applied Research	-	-	-	-	7	5.2	-	-	8	5.2
International Coop.	-	-	-	-	-	-	-	-	6	3.9
Others	2	4.1	3	5.8	4	3.0	48	11.5	7	4.5
TOTAL	49	100.0	52	100.0	134	100.0	418	100.0	155	100.0

Even though the post-graduate courses in Chemistry, present a poor level of performance, when compared to other courses we discover some positive features: in December 1986, the post-graduate courses in Physics employed 927 Doctor/faculty-members, and there were 1291 students attending such courses[14], which gives us a student/advisor ratio of 1.0/1.39. Their idle capacity is therefore very great. To this we should add that, while in Chemistry the great majority of faculty members are involved in experimental research -and that there is indeed a lack of Theoretical Chemists whose role will be of increasing importance in the future development of Chemistry research, according to prospective studies from the European Chemical industry, especially in the sector of pharmaceuticals, dyes and fragrances[15]- in Physics, 52% of the faculty-members are Theoretical Physicists[16]. This distortion, even though it may appear to favour scientific production in Physics[17], since experimental work takes longer, and is often more costly to produce than theoretical work, must raise a question that merits further analysis; Brazilian Physics theoretical research may be too much dependent on foreign inputs[18].

Infrastructure

Table 5 clearly shows that in all the regions of the country the major obstacles to RPG can be attributed to poor infrastructure. There are, however, a few groups (one from the Central-West -Brasilia's Organic Chemistry- and three from the Southeast -São Paulo's Organic and Physical Chemistry, and to a lesser extent, Rio de Janeiro's Analytical Chemistry) with a better quality of infrastructure. These groups are responsible for the Good responses when asked to rate the quality of their laboratories and equipment (Tables 3 and 4), and for listing it as one of the positive factors promoting efficiency in RPG (Table 6).

The lowest grades attributed to infrastructure in the Central-Western Region come mainly from the Federal University of Mato Grosso do Sul (UFMGS), which is the newest institution to be involved in research activities (basically Organic Chemistry), and where the greatest obstacle is the lack of scientific equipment (Table 6).

The worst ratings for infrastructure come from the Northeast, the South and certain areas of the Southeast[19] (especially from the state of Minas Gerais). Such

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14 According to the Report of the Brazilian Physics Society (SBF), Física no Brasil, 1987.

15 U. Colombo, Research, Innovation and Renewal in the Chemical Industry, *Futures*, April (1986) 170.

16 SBF, op. cit. note 13.

17 M.A.H.Cagnin, Patterns of Research in Chemistry in Brazil, *Interciencia*, 10(1985) 64.

18 J. Danon, Depoimento 1977, Convênio FINEP/CPDOC - História da Ciência, FGV/CPDOC, Rio de Janeiro (1985) 63.

19 The scientific conditions for research within the Southeast are uneven, and the discrepancies between the Northeast and the Southeast are less significant if the State of

precarious conditions of Chemistry research are even more striking when one considers that, among the five main factors given as being favourable to RPG, infrastructure is not included (Table 6). The brief mentions that we get to this factor relate to facilities that can be borrowed from neighbouring institutions (distances are not mentioned) and references are made to efforts underway in these institutions to improve their own facilities.

There seems to be a contradiction in the evaluations received from the Northern region, since on the one hand infrastructure is rated as being Fair in the general sense (Table 3) and also when the component items are being examined. However, infrastructure is cited as one of the obstacles to a more efficient RPG (in Table 5). This contradiction is apparent again when we compare Table 5 with Table 6.

The poor availability of imported materials was perceived as being Very Bad by 36% of the respondents, and as Bad by another 39%, and this was further exacerbated when the maintenance of imported equipment was discussed; the problem of maintenance was rated as being Very Bad or Bad by 86% of those surveyed. This last factor was of greatest concern to those researchers from the Southeast, since they were the most privileged ones with regard to the availability of such equipment for the performance of their work (Table 5). One exception to the problem of availability of imported materials is the University of Brasilia (UnB), which enjoyed certain legal privileges that were not extended to other research institutions (it is allowed to use a more favourable exchange rate and the need for an imported license is waived)[20].

In short, at the most advanced research institutions, those which are the best equipped, there is greater awareness of the limitations with regard to scientific development, but it is precisely at these institutions that we heard the greatest number, and the greatest intensity of criticisms with respect to working conditions. Paradoxically, the groups of researchers who work at the most rudimentary and precarious conditions seem to have full consciousness of what little support structure they have available and, rather than seeing it as an obstacle, regard any facilities that they do have as a positive factor that contributes to their work.

From what was shown, the main bottleneck seems to be the lack of resources to be directed towards the improvement and maintenance of a ever more

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São Paulo is treated separately. Many facts appeared when comparing the evaluations of the items in Topic 1, considering the researcher and the state in which he/she worked. For example, the item regarding equipment for RPG was rated, on average, as Fair in São Paulo, near Bad in Rio de Janeiro, and Bad in Minas Gerais just as in the whole of the Northeast.

[20] After several years of continuous pressures of the scientific community, mainly through the Brazilian Society for the Progress of Science (SBPC), the National Congress approved in April 2, 1990 the Law Nº 8010 which removes taxes on imports of machines, equipment and material for scientific ends, and this includes accessories, replacement parts, raw materials and intermediate products for all those institutions listed by CNPq. The results are not still felt over the system.

developed infrastructure, that is a fundamental requirement for competitive RPG. To get better research facilities it is necessary that the National and the state Assemblies recognize that there is an urgent need of a special credit line for Programmes involving the creation, maintenance and modernization of research laboratories, outside the ordinary funding mechanisms[21] (which also need to be increased). Unless such measures are taken, the number and type of institutional and individual worthy research projects will continue to be subject to restrictions, and this in turn will contribute to the loss of qualified researchers who are attracted abroad by the better facilities and conditions offered by foreign research institutions.

Investments

Even though the researchers attributed a low relative value to investments in the second and third questions (Tables 5 and 6, respectively) when the matter was approached directly, as in the first question, they were rated as Fair by researchers in the North, Southeast and South of the country, and as Bad by those in the Northeast and Central-West (Table 3).

The situation appears to be most critical in the Northeast since the researchers from that region gave the worst possible rating, Very Bad, in their evaluation of the financial support for their research institutions, and also of the extra-budgetary resources derived from federal funding agencies. The lack of the latter was seen as being as great an obstacle to research as was the lack of scientific instruments (Table 5). In the Northeast the only exceptions to this rule are the departments of Organic Chemistry, at the Federal University of Ceará (UFCe), Physical Chemistry at the Federal University of Pernambuco (UFPe), and Inorganic Chemistry, at the Federal University of Paraíba (UFPb), which rated investments as Fair.

We find that it is in these same universities that CNPq invests the most, using such mechanisms as research-fellowships, which are the best individual reward it has to offer[22]. Thus the higher evaluation ratings given for investments in these

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21 It happens even in industrialized countries. See, D. Hanson, Many University Research Facilities Need Repairs, *Chemical and Engineering News*, November 14 (1988) 42.

22 Of the fellowships awarded for Chemistry by CNPq in the Northeastern Region, 15%, 8%, and 45% of them are respectively centered on UFPe, UFPb and UFCe [While the first two institutions established post-graduate programmes in the second half of the 80's, UFCe's dated from the 70's and is considered an excellent course, even though its scientific production per capita is equal to that of UnB, whose course was evaluated as Good]. As described in M.A.H. Cagnin, op. cit. note 16, the Northeast is the third most prolific scientific producer in the country. Its contribution in the 70's was around 7%, which was very close to the second, the South (7.5%), but far behind the first, the Southeast.

institutions must reflect their recognition of the support lent by CNPq through the peer review system[23].

In Chemistry departments of the Southern Region we find an emphasis that is very similar to what we observed in the Northeast in relation to the barriers that have their origin in the lack of institutional support. The only two groups which gave more favourable ratings with regard to investments were the Physical Chemistry and Organic Chemistry groups (Tables 3 and 4) of the Federal University of Santa Catarina (UFSC). Most of the Chemistry researchers on CNPq fellowships in the Southern region were centered on UFSC[24]. Thus, once again, a relationship can be perceived between CNPq activities and researchers' responses.

Close examination of researchers' answers leads us to conclude that the average conditions for RPG with regard to Intellectual Capital and to Infrastructure are similar in the Northeastern and Southern regions of the country. When it comes to Investments, however, the situation in the South is deemed to be better. Both in the South and in the Northeast, Investments, in the form of extra-budgetary funds, are considered to be a crucial factor for the promotion of the efficiency of RPG (Table 6).

CNPq's and Finep's performance were rated as Very Bad or Bad, respectively, by 40% and 63% of the respondents. An explanation for those low ratings is that science is dependent on governmental funding agencies and very few resources have been driven to chemical research. Concerning, for instance, the individual CNPq research grants for Physical and Earth-Sciences in the 1951/84 period enjoyed a growth rate 3.6 times greater than Chemistry, 3.9 times greater than Geo-Sciences, and 6.5 times greater than Mathematics[25]. In recent years, CNPq relative contribution to chemistry research among the "hard sciences" decreased[26] as shown in Table 7.

Referring to human resources capacitation, the 85% increase in the 1986/1988 period in the number of CNPq scholarships distributed nationwide, hardly affected the relative support to Chemistry which remained around 5% of the total. Regarding overseas scholarships granted to chemists, whereas the number remained stagnant, the total number of scholarships offered by CNPq rose by

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[23] CNPq Advisory Committees are formed by prominent researchers selected with the participation of the respective academic communities.

[24] If the different kinds of support CNPq has given to the Southern Region since 1976, it is observed that between 53% and 66% of the fellowships were awarded to UFSC.

[25] M.A.H. Cagnin, D.H. da Silva, *A Ação de Fomento na História do CNPq*, Assessoria Editorial, CNPq, Brasília, 1987.

[26] In 1987, CNPq total budget for supporting its research grants programme totalized US$ 31,420 million. Around 30% were directed to fund Physical and Earth Sciences projects.

112% in the 1986/1988 period, which means that there was a relative decrease of 1.7% for chemical studies abroad[27].

Table 7. Relative distribution of resources in the fields of physical and earth-sciences research grants programme, in the 1980's.

FIELD	1981/1984 (%)	1987 (%)	1988 (%)
Physics	44.0	44.1	36.7
Chemistry	24.8	19.3	19.3
Mathematics	11.8	21.5	29.4
Geosciences	19.4	15.1	14.6

Source: Cagnin and Silva, 1987, Activities Report 1988 - CNPq

Within the scope of Finep, which is to provide institutional support for infrastructure, new buildings and new equipment, through the National Science and Technology Development Fund, Table 8 shows the priority given to Chemistry recently[28].

Table 8. Relative distribution of FINEP's Institutional grants in the field of physical and earth sciences, in the late 1980's.

FIELD	1986 (%)	1987 (%)	1988 (%)
Physics	61.8	58.7	58.8
Chemistry	20.5	21.0	26.2
Mathematics	4.3	10.1	4.3
Geosciences	13.4	10.2	10.7

Source: Activities Report 1988 - FINEP

Therefore, the federal investment in Chemistry is meagre, reinforcing the reasons why researchers in this field gave the agencies such low ratings in their answers to the questionnaire. This picture is not more dramatic due to the Programme of Support for Scientific and Technological Development (PADCT)[29], whose aim is to complement the ordinary channels of support, by

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27 For the scholarships programme, CNPq total budget summed up US$ 118,343 million, which meant the distribution of 20.146 scholarships inside the country, and 1.307 overseas. For Chemistry, CNPq provided 949 scholarships of the first group, and 51 of the second.

28 25% from a total budget of US$107 million were allocated to Physical and Earth Sciences, in 1987 by FINEP (the Agency for Financing Studies and Projects).

29 The PADCT Fund is composed by a sectorial World Bank loan of US$72 millions plus the Brazilian government counterpart of US$ 108 millions. Out of this total amount, US$32 millions were allocated to Chemistry and Chemical Engineering for the 1984/1989 period.

inducing demand for specific projects. But this programme is not a sufficient alternative to the traditional incentives.

A perusal to Table 5 shows that the researchers from the most developed centers in the Southeast are those who express the greatest concern with regard to the negative effect of a weak financing system for research, and that they see this factor as being of even greater worry than the problem of the lack of resources. These researchers, together with the Northeastern group, are the ones who stress that the lack of a clear, long-term policy of support for research, which encompasses the regional question, is a great hindrance to RPG.

It is because of the lack of such a policy that many groups of researchers find themselves obliged to leave aside their research activities and take on administrative duties in organizations such as the Brazilian Society for the Progress of Science and the Commission of the Scientific Societies, to lobby the Executive and Legislative branches of the government and persuade them of the importance of science as an investment item, rather than a consumption item, which is how it has so often been perceived in underdeveloped countries[30]. Even with such a pressure, the available resources are so scarce that they are used in a stop-gap manner, so as to cover the permanent past shortcomings. As a result, it is a challenge to sort out priorities either at the level of the federal sponsoring agencies, or at the level of the internal bureaucracies of the universities.

In the case of Chemistry, due to its multiple linkage with the general economic activity and the well-being of the population, the non-existence of a scientific and technological policy linked with an industrial planning is a deep drawback to its progress, still to be overcome.

In Brazil, the chemical industries participate with around 5% of the GNP[31]. They constitute the largest industrial complex in Latin America and the Caribbean Region, being also among the biggest ten worldwide[32]. On the one hand, these industries are mainly owned by foreign companies, and they are generally polluting, based on obsolete technologies, and carry out most of their research and development abroad. On the other hand, the low profits of the local firms inhibit investments, and they do little and, in general, unsophisticated research. Thus, jobs, especially for graduated people, are neither numerous nor attractive in terms of professional accomplishment. Therefore, enhancing a greater chemical development would necesitate the growth of those segments of the chemical industry where science and technology are required, such as fine chemicals and specialties. Thus, research and post-graduate activities in Chemistry would naturally be affected. This would modify the isolated system that now prevails, which produces highly qualified human capital for an almost exclusive but finite market-job: universities and government research institutes.

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[30] C. Cooper, Science, Technology and Production in the Underdeveloped Countries: An Introduction, *The Journal of Development Studies*, 9 (1972) 1.

[31] PADCT, Subprograma de Química e Engenharia Química, Documento Básico, June, 1990.

[32] PADCT, op. cit. note 30.

In order to transpose this scenario where science is totally dependent on government and strengthen the ties between science and production, besides the recommendations contained in Cagnin[33], with some of them already incorporating the 1988 new constitutional text, the following measures are here placed:

The Chemical companies operating in the country ought to open a formal and systematic programme of support for research in Chemistry. One way of implementing it would be through their participation in the current science and technology programmes sponsored by the federal and state agencies, as it is done in other countries[34]. Such participation could be structured along the lines of agreements between CNPq/industry, or Finep/industry, and should include funds, equipment, and trained personnel for research projects that are of common interest to the different parties, whether in basic or applied science.

If these suggestions can be implemented, the next step in the middle term, shall be the creation of new research centres, where there will be a large-scale cooperation between industry and university[35], within a triple alliance of university, industry, and the sponsoring agency (the latter would have a role of decreasing importance with the passing of time).

It should be emphazised that the implementation of such measures is greatly dependent on political power, economic stability, and governmental regulations.

CONCLUSION

The survey of Chemistry researchers shows that the conditions for development of this field of science have been far from ideal. Although the quality of the research produced in post-graduate activities is reasonable, the small number of people involved in Chemistry, and the precarious conditions in which they work -the poor quality, the obsolescence and lack of maintenance of research facilities- are serious constraints. The vitality of Chemistry research is still hampered by the complex redtape to import scientific materials.

The environment in which Chemistry research is carried out is, of course, reflected in the scientific production of the country. Brazil is Latin America's leading producer of Chemical research[36], and of scientific research in general[37].

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[33] M.A.H. Cagnin, Química e Desenvolvimento Nacional, *Revista Brasileira de Tecnologia*, 18 (1987) 10.

[34] J. Long, Industrial Role in NSF Program Growing, *Chemical and Engineering News*, Sept. 4 (1989, 16).

[35] J. Long, op. cit. note 33.

[36] M.A.H. Cagnin, op. cit. note 16.

[37] M. Krauskopf, R. Pessot, R. Vicuna, Science in Latin America. How much and along what lines?, *Scientometrics*, 10 (1986) 199.

Chemical research generated fewer papers than Physics in Brazil, while world-wide, Chemistry produces more papers than Physics[38].

The poor amount of resources available for research and to training of human resources in Chemistry is a serious bottleneck, and is further exacerbated by the little influence that Chemists appear to have within the brazilian Science and Technology funding system. In addition, the lack of linkages between university and industry means that research is carried out in an atmosphere that is completely divorced from market pressures and society in general. Another evident concern is the uneven rates of development in Chemistry in different regions of the country, reinforcing the inequality of the centre vs the periphery within the country itself.

These elements clearly reveal that a process of change must take place in order to break the vicious and self-perpetuating circle of the poor and backward conditions under which scientific research is carried out. The focus of this process must be the formal recognition by government of the important role that Chemistry has to play in Brazil's social and economic development. The participation of the scientific community, together with the technicians and entrepreneurs of the Chemistry sector is vital in this process, because they themselves must be not only the agents of change but also those who should have the responsibility for providing inputs to decision-makers on the best strategies for promoting this development.

The deep economic crisis that Brazil is facing and the absence of a formal policy for the endogenous development of Chemistry, make it imperative that we begin now to build new options for the future, starting from the best diagnosis as possible, and taking into consideration not only the direct variables and those factors which appear to dominate the scenario in which Chemistry is conducted, but also the alternative possibilities for integrating Chemistry into the general context of the Brazilian society. This is a challenge which must be faced, and which brings to mind that "the solution of the apparently insoluble problems of developing countries, namely unemployment, poverty, and hunger, requires a significant and critical input from chemical science and technology"[39].

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38 D. Solla Price, Nations Can Publish or Perish, Science and Technology for Technical Men in Management, October (1967) 84; National Science Foundation, Science Indicators 1982. An Analysis of the State of US Science, Engineering and Technology. National Science Board, Washington D.C. (1983) 203.

39 H. Szmant, Chemistry - a tool of socio-economic progress. *Ciência e Cultura*, 34 (1982) 892.

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THE MISSING LINK IN THE INFRASTRUCTURE OF SCIENCE: AGRICULTURAL RESEARCH IN MALAYSIA

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ABSTRACT

This paper analyzes the infrastructure of science development in Malaysia in an attempt to identify appropriate indicators comparable with those used in developed countries. The bibliometric indicators, widely used in the study of science in developed countries, had their origin in information-rich societies. The impact indicator by way of citation counts demonstrates that the Law of Cumulative Advantage has been in operation, thus perpetuating the slim chance of science in developing countries to have any impact internationally. This study contends that, though science is universal, the conduct of science is not. Therefore the indicators will vary according to the factors contributing to the infrastructure of science in each country. As a case study, agricultural research in Malaysia is explored, using bibliometric indicators as well as non-bibliometric methods. The results indicate that scientists in agricultural research place a high priority on quality scientists, funds, access to up-to-date information, and status of scientists as factors contributing to bringing agricultural research in Malaysia to the forefront of international science, while bibliometrics-related factors are considered of low priority. Malaysian scientists cite publications originating in Malaysia more than those published outside Malaysia. However as these journals are not covered by Science Citation Index, their visibility and availability to scientists in the developed countries are very poor, thereby eliminating the chance of being cited.

RESUME

Cet article examine l'infrastructure du développement scientifique de la Malaisie afin d'identifier des indicateurs appropriés comparables à ceux des pays développés. Les indicateurs bibliométriques ont été constitués dans les pays riches en information. Le facteur d'impact qui utilise les mesures de citations démontre que la loi de l'avantage cumulatif a largement fonctionné, perpétuant ainsi le faible impact international des pays en développement. Cette étude prétend que bien que la science soit universelle, sa pratique ne l'est pas. Ainsi, les indicateurs varient en fonction des facteurs qui contribuent à l'infrastructure de la science dans chaque pays. Le cas de la recherche agricole en Malaisie est examiné au moyens d'indicateurs bibliométriques et non-bibliométriques. Les résultats indiquent que les chercheurs en agriculture donnent une haute priorité sur la qualité des chercheurs, le financement, l'accès à l'information à jour et le statut des chercheurs comme des facteurs qui contribuent à placer la science malaisienne sur le front de la recherche mondiale, alors que les facteurs d'ordre

bibliométriques sont moins importants. Les malaisiens citent les publications émanant de Malaisie plus que celles publiées hors du pays. Cependant ces publications ne sont pas couvertes par le Science Citation Index, leur visibilité et disponibilité pour les chercheurs des pays développés est faible, diminuant ainsi leur chance d'être cités par des auteurs étrangers.

INTRODUCTION

It is generally agreed that science development and science productivity in any country do not exist in a vacuum. Several factors have been identified as contributing to the progress in science which in turn provides the impetus for the socio-economic and technological advancement of nations in the modern world. These factors differ in terms of quantity and quality from one country to another. They are not exclusive of one another and most often they create a chain reaction between and among themselves. These factors are summarized in Figure 1.

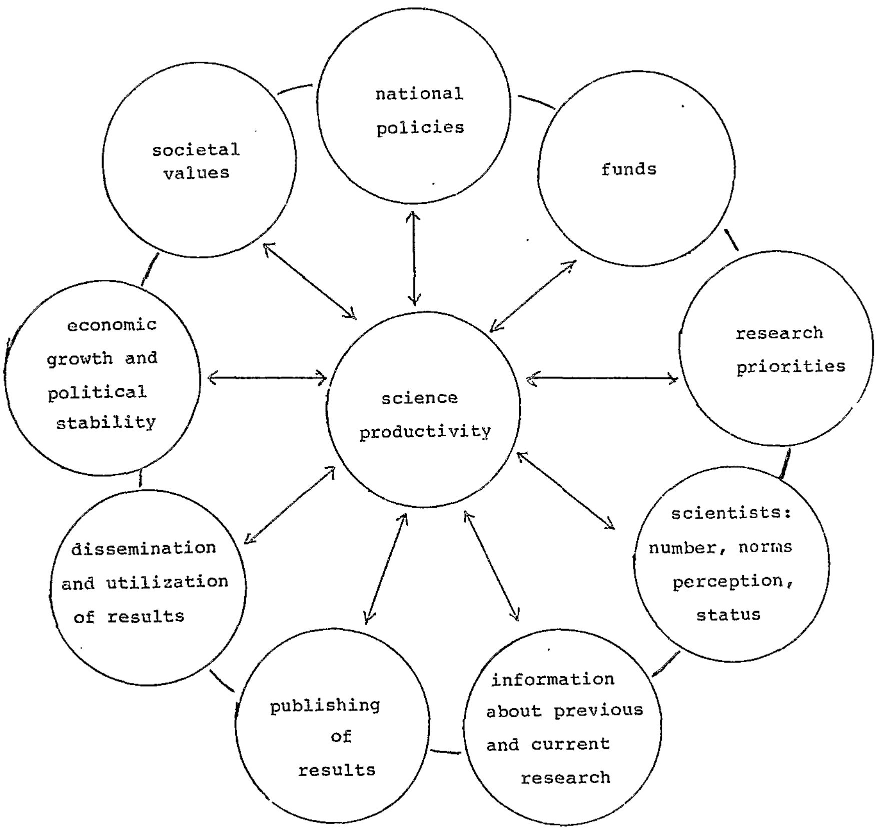

Figure 1. The interrelationship and chain reaction of factors contributing to science productivity (1)

Within the above framework, this paper discusses the state of science development in Malaysia in general, and agricultural sciences in particular.

SCIENCE AND TECHNOLOGY RESEARCH IN MALAYSIA: BACKGROUND

The research and development (R & D) in science and technology (S & T) in Malaysia have always had emphasis on improving the productivity and production of primary commodities which make the largest contributions to the Malaysian economy. Hence, the establishment of the Rubber Research Institute (RRI) in 1925, the Malaysian Agricultural Research and Development Institute (MARDI) and the Palm Oil Research Institute (PORIM) in 1967 and 1975 respectively. Another agriculture-based institute, i.e. the Forest Research Institute (FRI), established in 1929, is also of special significance as forest products are essential to forest-based industries of the country. It has been reported that "these R & D institutes have done exceedingly outstanding work as is evident from the highly competitive status enjoyed by Malaysia in the world market in rubber and palm oil" (2).

The establishment of the University of Agriculture in 1971 has provided for another major development in agricultural research as the university not only conducts research but also provides education and training for scientists, researchers, and field workers who are needed in the process of information transfer.

Besides these institutions, science research in Malaysia finds homes in the Institute for Medical Research, another one of the oldest research institutions established in 1900, the Tun Ismail Atomic Research Center (PUSPATI), and institutions of higher learning, such as the University of Malaya, the University of Science Malaysia and the National University of Malaysia. These universities were established in1949, 1969 and1970 respectively. The years of establishment of these research institutions reflect the very young age of science development in Malaysia compared to that of the developed countries. This factor has a very important bearing on the number of research activities, the publications in science and technology and the number of scientists and researchers.

SCIENCE POLICIES AND THE NATIONAL IDEOLOGY

The RUKUNEGARA (The National Ideology), adopted since 1969, contains a declaration dedicated to "building a progressive society which shall be oriented to modern science and technology" (3). In addition, in 1983 the Prime Minister, in his address to the National Council for Scientific Research and Development, gave specific guidelines for R & D as follows :

(i) Research carried out in Malaysia will have to be applied research;
(ii) It must be relevant to the social, cultural and economic needs of the country;
(iii) Research should be conducted in applied fields in which Malaysia is already competent, such as in agriculture;
(iv) Linkages between public and private sector research agencies have to be increased to ensure that research results are fully utilized;
(v) The development of appropriate technology is of high priority particularly in areas where the development of design and fabrication is appropriate to Malaysia's climate and cultural practices;
(vi) The utilization of wastes or byproducts has to be intensified so that these byproducts will not be polluting but will result in higher economic value (2).

From the above statement, it is very clear that applied sciences and technology, not pure sciences, have been given priority for the country's R & D. Since then, the government has taken several steps to accelerate its machinery and programs to fulfil the country's aspirations. Hence, the National Science and Technology Policy was formulated and approved by the Parliament in 1986, which provides another major landmark for R & D in science and technology in the context of the overall national development plan. The Policy places emphasis on: "1.(...)the utilization of science and technology as a tool for economic development, the improvement of human physical and spiritual well-being and for the protection of national sovereignty being an integral part of the socio-economic development policy of the nation. 2. (...) the promotion of scientific and technological self-reliance in support of economic activities through the upgrading of R & D capabilities by the creation of an environment conducive to scientific activity and the improvement of scientific, educational and other relevant infrastructures". (4)

PRIORITIES

The Policy specifically lists, among others, the following areas to be given prioritiy in R & D:
(1) the utilization of agricultural and other resources and the development of appropriate production and processing technologies.
(2) health and primary health care.
(3) the establishment of an efficient research management system and the development of research infrastructures such as science information centres, technology parks, patent offices and other institutions involved in research, design, consultancy and information.

In the area of scientific research, emphasis is on applied and adaptive research. Basic research is undertaken when necessary in order to develop specific areas important to the country.

FUNDS

The National Science and Technology Policy recognizes the importance of funds necessary to materialize its implementation. Thus, the national expenditure on R & D has been increased from around 0.5% of the GNP prior to 1986 to almost 1% in the vote for projects during the Fifth Malaysia Plan of 1986 - 1990 (5). Though this increased budget allocation for R & D in Malaysia is still lower than that of many developing countries (Table 1), it is a clear indication of the country's commitment to R & D. Compared with another developing country, for example Thailand, Malaysia's expenditure on R & D almost doubled that of Thailand in 1984.

TABLE 1 : EXPENDITURE ON R & D BY SELECTED COUNTRIES

Country	Unit (Million)	Amount	As% of GNP
Malaysia (1982)	Ringgit	290 - 295	0.5
Korea (1982)	Won	457.688	0.95
Japan (1982)	Yen	5,881,539	2.78
U.S. (1980)	US$	62,220	2.36
U.K. (1975)	Pound	3,622	2.47
W.Germany (1977)	DM	41,320	3.04
*Malaysia (1984)	Ringgit	n.a.	0.66
**Thailand (1984)	US$	122	0.34

Sources: * Medium and Long Term Industrial Master Plan. Malaysia, 1986-1995, page 26; ** Y.Yuthavong. Basic Issues and Recent Development in Science and Technology Policy in Thailand. ASEAN Journal of Science and Technology Development 4, no. 1 (1987) 2 - 11.

And, if the latest report is accurate, the government has allocated 614 million ringgit (6) for R & D under the Sixth Malaysia Plan of 1991 - 1995. Compared to the 400 million ringgit during 1986 - 1990, the budget for R & D in 1991 - 1995 has increased by 50%.

Besides funds, some other important steps taken by the government to accelerate R & D in science in technology are as follows. The Ministry of Science, Technology and the Environment (MOSTE) has been strengthened with full authority and resources to ensure effective S & T policy formulation, research, coordination and monitoring. The MOSTE has been adopting since 1987 a strategy called "Intensification of Research in Priority Areas (IRPA)" in coordinating research activities and funds in line with national development needs. A permanent Cabinet Committee on S & T, headed by the Prime Minister, is to be set up in mid-1990. An Advisory Council on S & T with membership from the government and research community with 50 percent of its membership from the private sector is also being set up. The establishment of an effective and vigorous national S & T intelligence and information system to be operational in 1991 has also been recommended (7).

PUBLIC AWARENESS OF S & T DEVELOPMENT

The successful implementation of any development plans ultimately falls back on the citizens and residents of the nation. With that realization, the government has embarked on several undertakings aimed at educating and creating public awareness of the significance of S & T in nation building, and encouraging innovation and participation in S & T programs from the public. The National Science Week and the Malaysian Invention and Design Exhibitions have been held annually since 1987. The establishment of the Science Center, Technology Park, and Agriculture Park is yet another implementation of the S & T plans of action. The Agriculture Park, in particular, is reported to be the first of its kind in the world. During its preparation and after its official opening in August 1990, it has continuously been visited by an overwhelming number of people from all walks of life, including visitors from other countries.

Thus far, it can be seen that the Malaysian National Policies have played a very important and crucial role in S & T development in Malaysia. The above policies, funds, and machinery indicate a very positive direction the nation is taking on the path to development. They dictate the directions appropriate for a developing country to follow, i.e. emphasis on the applied sciences, not basic sciences. The results of R & D must also be reflected in the improvement of the socio-economic well-being of the nation. The above factors are important "Input Indicators" for science productivity.

SCIENTISTS AND RESEARCHERS

Another input indicator which is difficult to measure, yet plays a similarly crucial role, relates to human resources, i.e. scientists, researchers, their quantity and quality, their status and perception towards S & T development within the context of the overall national development.

The number of science and technical manpower of a country is not easy to come by, what more to compare it with that of other countries. Unless there is an agreed-upon definition of scientists and researchers to be employed in a systematic and consistent manner, the comparison is subject to further scrutiny and clarification. As a rough guide, the population of Malaysian scientists and researchers has been culled from two sources. The NSTP (4) estimates the number of full time research scientists and technologists in Malaysia in 1986 to be approximately 3,300. This gives a ratio of 236 S & T personnel per million population, compared to 1982 per million as reported in Japan, 2464 per million in the US, and 1100 per million in West Germany. In 1988, another authority reported that Malaysia had 10,000 personnel qualified in science and engineering in government and statutory bodies (8). This figure brings the ratio of S & T personnel to 583 per million population. (The population of Malaysia in 1988 was estimated at 17.150 million (9). Relatively speaking, the number is still much lower than that of developing countries.

The number of scientists, accurate or inaccurate though the case may be, needs to be balanced with the quality. The latter is indeed very difficult to measure. If the Nobel Award in science signifies the utmost excellence of its recipient, then it is clear that developing nations possess none of the quality scientists. This fact speaks for the slow progress of science in developing countries.

SCIENTISTS' PERCEPTION ON AGRICULTURAL RESEARCH IN MALAYSIA

In the absence of previous studies on Malaysian scientists in all fields of science and technology and the nonexistence of a directory of Malaysian scientists and researchers, it is not possible to estimate a suitable sample size of scientists for sociological studies of science in Malaysia. However, this paper takes agricultural research as a preliminary case study of scientists' perceptions due to the fact that agricultural research has been identified as the most developed field of science in Malaysia for which bibliometric data are more readily available compared to other fields. The results of the findings therefore are not representative of scientists' perception as a whole.

In order to have some idea about the scientists' perception on the state of development of agricultural research in Malaysia, a questionnaire was sent to 200 scientists working in the six major agricultural research institutions, namely, University of Agriculture, Malaysian Agricultural Research and Development Institute, Palm Oil Research Institute, Rubber Research Institute, Forest Research Institute, and the Ministry of Agriculture. Eighty respondents (40%) returned the questionnaire (Table 2).

Results of the data analysis indicate that the majority of scientists rank "quality scientists devoted to research" as the most important factor contributing towards bringing agricultural research in Malaysia to the forefront of international science.

It should be noted that although the ranking by means and the ranking by frequencies do not produce identical results, the data from Table 2 are indicative of scientists' perception about their priorities in science productivity. It is definite that they consider "quality scientists" and " f unds " the two most important f actors . The " status of scientists" is almost equally spread out among rank 1 to 3; nevetheless it ranks high and competes with another factor "access to up-to-date information" for no. 3 and 4 position. The important conclusion that can be drawn from this group of data is that these factors which are ranked high (1-4) by scientists are non-bibliometric, while factors that are bibliometric, i.e. "quality journals", "visiblity of journals" and "publishing in international journals", receive low rank (5 - 8) . This finding has implications for our definition of "science indicators" for developing countries.

TABLE 2. FACTORS CONSIDERED IMPORTANT IN CONTRIBUTING TOWARDS BRINGING AGRICULTURAL RESEARCH IN MALAYSIA TO THE FOREFRONT OF INTERNATIONAL SCIENCE

Rank by Frequencies / Factor	1	2	3	4	5	6	7	8	Means	Rank by Means
Quality scientists devoted to research	36.7	19.0	13.9	11.4	10.1	5.1	2.5	1.3	2.70	2
Funds for research	33.3	24.4	17.9	5.1	10.3	3.8	2.6	2.6	2.69	1
Access to up-to-date information	2.6	18.2	22.1	20.8	11.7	11.7	6.5	5.2	4.15	3
Status of scientists	15.6	16.9	15.6	10.4	5.2	11.7	11.7	13.0	4.19	4
Quality journals to disseminate results	3.9	10.5	10.5	14.5	27.6	19.7	11.8	1.3	4.64	5
Applications of research findings at large scale	7.9	2.6	7.9	11.8	19.7	21.1	13.2	15.8	5.27	6
Visibility of Malay-sian journals among international scientists	3.8	7.7	3.8	11.5	9.0	16.7	25.6	21.8	5.75	8
Malaysian authors publishing more in international journals	9.2	3.9	10.5	15.8	6.6	10.5	18.4	25.0	5.36	7

Other non-bibliometric indicators that are investigated are the education and qualif ications of scientists and the proportion of time they spend on research. The quality of scientists may be associated with the former while science productivity may be associated with the latter. In this study all 80 scientists (100%) possess Bachelor's degrees, while 65 (81.25%) and 46 (57.5%) hold Master's and Doctorate degrees respectivey. These figures may be compared among scientists across countries in the same field of research. In developing countries, with the exception of research assistants, one would expect all scientists to have Doctorate degrees.

It cannot be denied that science productivity depends on the time spent on doing research. In this study the proportion of time for research is compared with that for teaching and administration. Data indicate that only 50% of scientists spend between 70 - 100% of their time on research. And if 70 - 100% is considered full time research, then it may be desirable to have more scientists devote their time to research.

BIBLIOMETRIC INDICATORS

What has been discussed so far centers around non-bibliometric indicators, namely national policies, funds, scientists, their number, quality and their perceptions related to science development. The next elements in the infrastructure of science (as shown in Figure I) deal with bibliometric indicators derived from the analysis of literature generated and literature used by scientists.

INFORMATION INFRASTRUCTURE

It has been established that progress in science is dependent upon the free flow of scientific information, that the rate of scientific advance is determined in large measure by the speed with which findings are disseminated among scientists who can use them in further research. The basic premise of research is the advancement of existing knowledge. Thus the scientist must investigate what has been done in his particular area of research before he proceeds with his investigation. The practice of "literature search" is both a norm and a requirement in science. This requires that the scientist has at his disposal information and data on previous and current research relevant to his work.

Unfortunatelv, in many developing countries including, Malaysia, science information systems seem to be the weakest, if not the missing, link in the infrastructure of science. At least two previous studies testify to this phenomenon. Inman's study (10) found that poor access to major international publications had serious implications for the research effort of scientists in developing countries. The inadequate access to current information may be associated with (a) their failure to refer to relevant literature, (b) duplication of research already carried out elsewhere, or (c) work falling outside the mainstream of current research interests. These three factors are major reasons for criticism or rejection of papers submitted by scientists from less developed countries (11) .

Such a situation creates a vicious cycle whereby the scientist's paper has no chance of being studied or cited by other scientists. The "Matthew effect" in science ultimately creeps into operation and scientists seek their retirement in the unproductive state of science. Velho's study (12) of Brazilian scientists in agricultural research also pointed out that the inaccessibility of Brazilian journals and their inconvenient locations contributed to the poor use of Brazilian journals by scientists. The journals are not abstracted and made available to increase the scientists' awareness of research work done in Brazil.

In Malaysia, scientists face the same problems as their colleagues in Brazil. As recently as June 1989, an authority at the University of Agriculture stated, "though much research has been carried out ..., information pertaining to these research activities is fragmented and its retrieval not adequately coordinated. We still do not have comprehensive data on who is studying what, when and where. The gap in information about agricultural research programmes, projects, institutions, researchers and their research experience will surely have to be filled before major programme changes in research strategies can be contemplated" (13). The significance of access to information on previous and ongoing research has been given third rank by scientists in this study (Table 2).

AGRICULTURAL INFORMATION SYSTEM

The above statement prompted an investigation by this study. Since Malaysian agricultural research is said to be the most developed, it follows that proper systems for managing information in the field have been established. As a matter of fact, the agricultural information system (AGRIS) is the first and so far the most comprehensive system, covering agricultural and related disciplines in Malaysia. No other science or technology discipline in Malaysia has a well-developed information system comparable to agriculture. Coordinated by the University of Agriculture library, the database receives inputs from various institutions dealing with agriculture all over the country. Inputs from Malaysia are sent to the regional center in Manila (AIBA), which in turn forwards all Asian entries to the headquarters in Rome (FAO). At any point in time, scientists may browse through the printout of bibliographic information or enquire from the library about the items they need. It was reported that entries from Malaysia numbered 8,826 during the period 1976 to 1989. Another sister system to AGRIS, called CARIS, which deals with agricultural research projects in progress and coordinated by MARDI, lists 466 projects in Malaysia (14). Besides, MARDI has also established two inhouse databases covering abstracts of research and theses completed by its officers.

Unfortunately, perhaps the existence of such a system is not commonly known to scientists. Data from this study indicate that 50% of scientists do not use the AGRIS service for accessing information, and 18.8% of scientists use AGRIS only 10% of the time, while 9.4% of scientists use it 20% of the time. The most frequently used method of accessing information is via references from the articles they read. This method may, no doubt, lead the researcher to a selective list of relevant items, but it suffers from comprehensiveness and exhaustiveness of information search. It has yet to be confirmed also whether the literature search service provided by their respective libraries is efficient and meets their needs, because 48.5% of scientists use the service only 5-10% of the time, 14% of scientists use it 20% of the time while 18.8% of scientists do not use the service at all.

CITATION ANALYSIS

Though quality agricultural journals in Malaysia have been in existence since the early days of establishment of RRI, MARDI, PORIM, and FRIM, none of these journals have been covered in Science Citation Index (SCI). Reputable journals such as the Journal of the Rubber Research Institute, MARDI Research Bulletin, The Planter, Pertanika, are covered by Biological Abstracts, and/or Chemical Abstracts and/or Bibliography of Agriculture. Malaysian authors and their papers appear in the SCI only when they publish in international journals which are covered by SCI. This again may be associated with the low citation rate and the low impact of Malaysian science in the international scene.

In order to investigate the characteristics of citations in Malaysian publications, a total of 848 citations from source articles from the above five major agricultural journals published in 1984 were analyzed. The results indicate that publications generated in Malaysia receive the highest number of citations (Table 3).

Data from the survey complement this bibliometric data, as 57.5% of scientists consider journals published in Malaysia of similar standard compared to those published in developed countries. This is a healthy situation for a country relatively young in science development, unlike Brazil, where scientists cite 80% of publications orginating in the US (12).

Another source of data for comparison is the input statistics from AGRIS database. During 1975-1981 Brazil input 10,342 items, while Malaysia input only 3,809 items into the AGRIS database (15). This means that Brazil scientists have more chances of citing Brazilian items than do Malaysian scientists citing Malaysian items. Scientists' attitudes, non-bibliometric by nature, as pointed out by Velho influenced the pattern of citation.

Though the information infrastructure for agricultural research in Malaysia is well-established, that of other branches of science and technology is not. The National Plan of Action for industrial technology development, 1990, reports: "The information infrastructure is out-dated and ineffectual, unable to support technology development. Information, particularly documents containing technical facts and figures, appears to be held in low esteem. Accumulated knowledge and the vast experience within the industries of the country are very rarely documented for systematic use due to the inadequate appreciation of the value of documented facts. Even available documents from abroad are not properly disseminated and used by local industries ..." (16). The above statement very well sums up the generally poor state of information management in technology, which also applies to other branches of science. Steps have been taken by the Ministry of Science, Technology, and the Environment, to establish a coordinating body with a view to managing, acquiring and disseminating science information both for researchers and the public. Without this systematic science information management, the missing link in the infrastructure of S & T development in Malaysia will continue to exist.

TABLE 3. COUNTRY OF PUBLICATIONS OF CITATIONS

Country	No. of Citations	%
Malaysia	245	28.89
USA	226	26.65
UK	134	15.80
Australia	28	3.30
The Netherlands	24	2.83
India	23	2.71
Japan	15	1.76
The Philippines	14	1.65
France	14	1.65
International Organizations	14	1.65
FRG	12	1.41
Canada	9	1.06
Nigeria	8	0.94
Brazil	7	0.82
Costa Rica	6	0.70
Kenya	5	0.60
Singapore	4	0-47
Bel_gium	3	0-35
Colombia	2	0.235
Denmark	2	0.235
Ghana	2	0.235
Indonesia	2	0.235
Italy	2	0.235
Thailand	2	0.235
Yugoslavia	2	0.235
*Unidentified	32	3.77
Total	848	100

*The inconsistency of citation formats, i.e. abbreviations of titles, missing dates or volume numbers contributes to the items being unidentified. This reflects in a way the quality of the journals.

BIBLIOMETRIC INDICATORS AND THE INFORMATION POOR NATIONS

The appropriateness of using bibliometric data as science indicators needs to be viewed from another angle. "Bibliometrics" had its origin in the information-rich nations. It was employed as a method for measuring certain characteristics of written communication as has been well difined by Pritchard since 1969 (17). The early studies of literature in science such as that of Bradford (18), Price (19), and Groos (20) emerged due to the phenomenon common to all information-rich countries, i.e. "information explosion". The citation analysis studies have all pointed to the fact that scientists' must publish in a number of journals that are made visible to other fellow scientists. Due to the information explosion, citation studies have also been used to gauge a selective list of journals that are considered highly used that are most appropriate for subscription by research libraries. Results of citation studies have also been associated with quality science and quality scientists (21).

In most developing nations, the publishing and the information industries are in the infant stage of development so much so the countries may be considered "information poor". In such a situation, bibliometric data are scanty, scattered, if not difficult to locate. Therefore they may not be valid as a tool for measuring science for comparison with developed nations.

CONCLUSION

The present study is a preliminary investigation and is considered a step towards a more systematic and continuing effort in assessing science and technology development in Malaysia. Several science indicators have been described as having impact on science development, namely national policies, funds, and scientists themselves. The starting point should come from the national policy that will provide the framework for the science development, R. & D, education, human resources, and other infrastructures needed to implement the policy. It can be seen that all the elements shown in Figure I are cause and effect to each other. For example, scientists themselves are users and generators of information infrastructure in science; the proper system for information dissemination leads to more research and more publications and wider use of research results. For Malaysia, the utilization of research products is of prime concern due to economic values expected from R & D. The wide acceptance of economic benefits derived from R & D by the public at large will also lead to policies and funds that will stimulate more R & D activities.

Bibliometric indicators can only be used in areas of research where a systematic body of literature and information system has been well-established, such as agricultural research. Other areas of S & T in Malaysia are still out-of-bounds for bibliometric analysis. In these areas, a proper system for information creation, acquisition and dissemination is needed.

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TROISIEME PARTIE

COLLABORATIONS SCIENTIFIQUES
ET
GEOSTRATEGIES

SCIENCE AND POLITICS: SOME BIBLIOMETRICS ANALYSIS

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ABSTRACT

Several studies that have used bibliometric methods to look at various interactions between science and politics are described. In two studies the sources cited by Cuban and Egyptian scientists, over considerable periods of time, were examined to determine whether changing citation patterns (in terms of countries cited) could in any way be influenced by changes in the political alignment of the countries in which the scientists reside. A third study, underway, is looking at the sources cited by South African scientists to determine whether or not these sources have been influenced by an academic boycott of South Africa in some countries. A fourth study is examining the sources cited by East European scientists to test the hypothesis that scientists from those countries more closely aligned doctrinally to the Soviet Union will cite proportionally more Soviet and East European sources than scientists from those countries less closely aligned to the Soviet Union.

RESUME

Différentes études qui utilisent des méthodes bibliométriques sont présentées. Dans deux études, les sources citées par les chercheurs cubains sur une assez longue période de temps sont examinées afin de savoir si les modes de citation (pays cités) dépendent des relations politiques internationales de Cuba. Une troisième étude en cours examine les sources citées par les chercheurs d'Afrique du Sud afin de savoir si elles ont été influencées par un boycott académique. Une quatrième étude examine les sources citées par certains chercheurs d'Europe de l'Est pour tester l'hypothèse selon laquelle les chercheurs des pays plus alignés sur l'Union Sociétique en termes politiques mentionnent plus souvent les articles de chercheurs soviétiques ou d'autres pays de l'Est que les chercheurs de pays moins étroitement alignés sur l'Union Soviétique.

INTRODUCTION

Looking at the science/politics interaction from a different perspective, a study has been completed to determine whether scientists who contribute to the popular literature are more likely than others to influence political decision making and whether they are also heavily cited in the science literature.

Bibliometric techniques have been applied to perform national and international analyses of the science literature. Some studies have looked at how much of this literature is contributed by various countries at a certain period of time (e.g., Hulme, 1923; Narin and Carpenter,1975; Schubert et al., 1989) and some have produced data to show how much various countries are cited (e.g., Narin and Carpenter, 1975; Schubert et al., 1989). Besides the analyses of truly international scope, others have applied bibliometric methods to examine the science output of individual countries (e.g., Arunachalam et al., 1984; Velho, 1986) or groups of countries (e.g., Arunachalam and Markanday, 1981) or to compare countries (e.g., Lancaster et al., 1984). Despite this activity, little has been done to study the influence that one country might exert on another, although some investigations have touched upon the extent to which one country might cite the work of a neighboring country (e.g., Rabkin and Inhaber, 1979).

Over the last few years several studies performed at the Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, have applied bibliometric methods to look at various aspects of the interaction between science and politics. This paper describes the studies that have been completed so far and mentions those now in progress or planned for the future.

Political influences on the sources used by scientists

Two complementary studies were undertaken to determine if the information sources cited by publishing scientists appear to change when a change occurs in the political alignment of the country in which they live. If science were completely insulated from politics, one would expect a change in political alignment not to affect the use of information sources. On the other hand, such a change could have a profound effect, not because of ideological preferences among the scientists themselves but because of practical considerations, such as changing patterns in education, in language competencies, in institutional collaboration, and in publication availability.

The sample

The studies were based on journal articles published by scientists associated with institutions in Cuba and in Egypt. Both countries, at various times, have been aligned politically with the Western bloc (defined in this study as members of the North Atlantic Treaty Organization) and with the Eastern bloc (defined as the Warsaw Pact nations). In the case of Cuba, the move from West to East began when Castro assumed power in 1959. For Egypt, the situation is a little more complicated: before 1958 the country was aligned primarily with the West, from 1958 to 1975 primarily with the East, and it has been aligned primarily with the West again since 1975.

The problems involved in putting together a sample representative of the publications of the scientists of these countries during these various periods have been described in detail elsewhere (Lancaster et al, 1986, Sattar, 1985). Cuban papers published in Cuban science journals were selected by the random sampling of about 20 such journals accessible in the libraries of the University of Illinois. For Egyptian papers published in Egyptian journals, random sampling was applied to six journals available in Illinois. For articles published by Cuban and Egyptian scientists outside their own countries, however, the sample had to be "opportunistic" rather than random. For the period since 1967, various products of the Institute for Scientific Information (primarily the Science Citation Index, Who is Publishing in Science, and printouts from the Scisearch data base) were used to identify papers authored by scientists from Cuba and Egypt. For the earlier periods, however, the location of Cuban and Egyptian papers, published outside their own countries, was a very tedious process, involving the identification of names of scientists in biographical and directory publications and the checking of these names in a wide variety of bibliographic sources in printed form.

The sample finally used in the study consisted of 1316 periodical articles authored or co-authored by Cuban scientists, published between 1950 and 1983, and 1182 articles authored or co-authored by Egyptian scientists between 1957 and 1983. The Cuban papers yielded 18,991 bibliographic references and the Egyptian papers yielded 15,222 references.

All of the bibliographic references--more than 30,000 for the two samples--were examined and categorized by place of publication. If place of publication was unclear from the reference itself, the item was categorized as "unidentifiable". Place of publication, not place of authorship, was the variable studied. Thus, an article in a U.S. journal was considered a U.S. influence despite the fact that not all such articles emanate from U.S. authors. It was the influence of the publication source that we were most concerned with. If an author cites a U.S. journal the publication influence can be considered American, wherever the author cited may come from.[1]

In the case of Cuba, we decided to define the period of Western influence (i.e., pre-Castro) as 1950-1964 and the period of Eastern influence as 1965-

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[1] This decision is easily justified. Political influences or barriers occur at the level of the journal rather than at the level of the individual paper. For example, Denmark no longer sells its journals to South Africa. This makes it more difficult for South African scientists to acquire Danish publications, whatever the nationality of the contributors, but does not affect access to the work of Danish scientists published outside of Denmark.

1983.[2] That is, we used a lapse of five years after the Cuban revolution (1959) to allow for effects to be felt on the use of information sources as reflected in citation behavior. In the case of Egypt, however, the division between Eastern and Western alignment is much less clear. One could consider Eastern influence to begin in 1955, when the first arms agreement was signed between Egypt and the USSR, but Soviet commitment to Egypt increased in 1958 and direct Soviet involvement seems to have been at its peak in the period 1967- 1972. The move back to the West could be considered to begin in 1972, when Soviet military advisers and personnel were expelled from Egypt. On the other hand, the agreement signed by Egypt and Israel in 1975 might be considered to mark the real return of Egypt to the West, even though the Soviet-Egyptian Treaty of Friendship and Cooperation was not formally terminated until 1976. Taking all of these things into account, it was decided to define the period 1957-1960 as Western, 1961-1978 as Eastern, and 1979-1983 as Western again. In this case, there is an implicit lag of about three years between a major step to political re-alignment and the beginning of the period of influence as defined in this study.

The major results are presented in Table 1, which reveals notable differences between Cuba and Egypt. For Cuba, the move to Eastern influence brings a very substantial increase in citation to the Eastern bloc. This trend, however, is not at the expense of citation to the West, which remains little changed, but at the expense of citation to other countries (especially Cuban scientists citing Cuban sources and, to a lesser extent, sources from elsewhere in Latin America).

In Egypt, on the other hand, the period of Eastern influence is characterized by a substantial decline in citation to the West with only a moderate increase in citation to the East. The period 1979-1983, reflecting a return to Western influence, shows a surprising continuation of the earlier trend, with citations to the East continuing to rise and citations to the West to decline, suggesting that it may take more than three years for any significant effects to be felt. The situation in Egypt differs markedly from that of Cuba in one other respect: citation to the "other country" group increases with time for the former and decreases with the latter.

It is possible, of course, that the rate at which Cuban and Egyptian scientists cite Eastern sources does not differ significantly from the rate at which Eastern sources are cited by any non-Eastern author. We are not aware of any studies that have determined the rate at which Warsaw Pact nations as a group are cited. However, Nalimov and Mul'chenko (1969) reported that the rate of citation of Soviet authors in the journals of other countries was in the range of 3 to 4% and was never found to be more than 5.5%. This suggests that the Cuban and

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[2] To avoid any trace of subjectivity, very strict and unequivocal definitions of "East" and "West" were adopted. Eastern countries were defined as those belonging to the Warsaw Pact and Western countries as members of NATO. All other countries were considered politically uncommitted.

Egyptian rates of citation to the East may not differ significantly from the rates of citation of Eastern sources by any country outside the Warsaw Pact.

Table 1: Place of publication of sources cited by Cuban and Egyptian scientists

	Western bloc (NATO)		Eastern bloc (Warsaw Pact)		All other countries		Total *
	No.	%	No.	%	No.	%	
CUBA 1950-1964 Western influence	3239	67.4	20	0.4	1548	32.2	4806
1965-1983 Eastern influence	8789	65.1	1533	11.3	3186	23.6	1358
EGYPT 1957-1960 Western influence	1254	84.0	63	4.2	175	11.7	1492
1961-1978 Eastern influence	7325	74.7	717	7.3	1765	18.0	9807
1979-1983 Western influence	2606	69.9	401	10.8	718	19.3	3725

* Citations judged "unidentifiable" by country are excluded.

It is only when Cuban authors collaborate with Eastern authors or publish in Eastern journals that they cite Eastern sources more than expected. Of 14,693 references in papers authored by Cubans alone, only 641 are to Eastern sources (4.4%) whereas, among 3,256 references from papers written jointly by Cuban and Eastern scientists, 889 (27.3%) are to Eastern sources. The influence is even stronger in the reverse direction--when a Cuban collaborates with a Western author, references to the East drop to little more than 1%, while references to the West increase to 80%. However, this is based on only 42 papers (709 references), the only ones we could locate involving collaboration between Cuban and Western scientists.

When a Cuban publishes in an Eastern journal, 20.1% (764/3,792) of the references are to the East. Only 4.9% (202/4,094) of the references are to the East when a Cuban publishes in a Western journal.

A similar pattern was found for Egyptian authors (e.g., when an Egyptian collaborates with an Eastern author 38% of the references are to Eastern sources) but the numbers involved are too small to be significant: only 5 papers were found in which an Egyptian collaborated with an Eastern author.

These two studies were unable to confirm that a change in the political alignment of a country leads to an overall change in the information sources cited by scientists of that country. Our results suggest that a scientist may cite some political bloc more than expected only when he publishes in one of its journals or collaborates with one of its scientists.

The influence of scientists on political decision making

The other side of the coin involves the influence of scientists on the political process and the extent to which this phenomenon can be examined bibliometrically. One study of this kind has been completed so far (Abdullah, 1989).

The purpose of the investigation was to seek answers to the following questions:

1. To what extent do scientists contribute to the popular literature?
2. Are scientists who contribute to the popular literature more likely to influence policy makers than those who do not?
3. Do scientists who contribute to the popular literature also influence their fellow scientists?

Two hypotheses guided the study:

A. Influential scientists are more likely to publish popular items than noninfluential scientists are.

B. Influential scientists receive more citations from their fellow scientists than noninfluential scientists do.

In this context "influential" refers to influence on policy makers. "Influential scientist" was defined as one who had testified before the U.S. Congress at hearings on acid rain issues. A noninfluential scientist is one engaged in acid rain research who has not so testified. The underlying assumption is that a scientist who is called upon by policy makers to give testimony is more likely to influence these policy makers than one not called upon. In the second hypothesis, influence on fellow scientists is measured by the number of citations a scientist receives.

Searches were performed on November 2, 1987 and September 19, 1988 in the Congressional Information Service (CIS) database to identify all hearings on acid rain before the U.S. Senate or House Joint Committees or Subcommittees through December 1987. The first reference to acid rain in Congressional hearings occurred in 1975. The texts of all relevant hearings were retrieved in order to identify scientists who had testified ("influential scientists"). Most scientists were identified as such by checking names against the International Directory of Acid Deposition Researchers (IDADR), 1983 and 1985/86 editions (1332 names in the first edition and 1618 in the second). A few individuals giving testimony at acid rain hearings but not in the directories were judged to be scientists on the basis of their institutional affiliation, the nature of their testimony, how they were referred to in the hearings, or through consulting biographical dictionaries. To qualify as an influential scientist, for the purposes of our study, an individual had to be a scientist and have testified at a hearing on acid rain. Non- scientists who testified were excluded even though their names appeared in the IDADR (this directory includes some economists and other professionals as well as scientists). According to this definition, 97 influential scientists were identified. Individuals giving acid rain testimony were not counted as scientists when we were unable to verify that they are.

The size of the science community involved in acid rain research was estimated to be 2177 individuals. Of these, 2137 were identified through the IDADR and forty more by other procedures.

For the purpose of our study the science literature on acid rain was defined as those items listed or referred to in three publications of the (U.S.) National Acid Precipitation Assessment Program (NAPAP). The works referred to in the seven NAPAP volumes were selected by specialists in the area of acid rain research as being high quality items. In all, the seven volumes refer to 4891 items, mostly in English, in the form of books, articles, reports and conference proceedings.

The identification of the "popular" items on acid rain was more difficult. Basically, we wanted articles appearing in newspapers and popular magazines. The former present no problems but the latter do. There is no good definition of "popular magazine", much less a list of items fitting the definition. Intuitively, we felt that a popular magazine is one that can be purchased at a news stand in the United States, but no list of such items exists. Consequently, we decided that popular magazine items on acid rain would be defined as those retrievable on the term "acid rain" (or "acid deposition" or "acid precipitation") in two databases: the Magazine Index and the Readers' Guide to Periodical Literature. This is justified by the fact that both of these sources are generally considered to cover periodicals that commonly appear in public libraries in the United States and thus can reasonably be considered "popular". Nevertheless, these sources do include some journals that many would not consider truly "popular" (e.g., Science).

Searches were performed in these two indexes for the period 1972-1987. The search began with 1972 because it was in this year that the term "acid rain" began to appear regularly in English language publications.[3] Online searches were performed in the databases, but supplementary searches were conducted in the printed versions to account for the fact that articles published in 1971 and 1972 do not appear in the online version of the Magazine Index and the online version of the Readers' Guide dates back only to January 1983. Searches in these databases, performed in March 1988, retrieved 677 popular magazine items on acid rain. A second search was performed on April 29, 1988 in the National Newspaper Index database. This retrieved 747 acid rain items from the five major sources covered.

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[3] The term appeared sporadically earlier and can be traced back at least to 1872.

In summary, the size of the science community involved in acid rain research was estimated to be about 2177 individuals. Of these, 97 had given acid rain testimony and were considered "influential scientists". The size of the "quality" acid rain literature (scholarly) was estimated to be about 4891 items. Some 677 popular magazine articles and 747 newspaper items were also identified.

Of the 677 items in popular magazines only 59 (8.7%) are written by scientists. The majority are written by nonscientists (427 or 63.1%), while the rest (191 or 28.2%) are anonymous and presumably contributed by reporters or science writers. Only one of 747 newspaper items was written by a scientist. The total number of popular items written by scientists, then, is 60 and 102 scientists contribute to these items.

Of the 102 scientists who have contributed to the popular literature on acid rain, 19 have testified at acid rain hearings. Our first hypothesis, that influential scientists are more likely to publish popular items than noninfluential scientists are, was looked at in two ways. The conservative way of looking at the issue is in terms of the relative contribution of the two groups (influential and noninfluential scientists) to the 60 popular items. Authors of the 60 items were given fractional credit based on extent of joint authorship (e.g., a scientist who co- authors with one other individual gets .5 credit, one who co- authors with two others receives .33 credit, and so on). The 19 influential scientists earned an average (mean) of 1.092 credits in authorship of the 60 items while the 83 noninfluential scientists earned an average of 0.445 credits. A t-test for independent samples was applied to test the null hypothesis of no difference between the means of the two groups. The result indicates the difference to be highly significant at a probability level of .0001. Therefore, the alternative hypothesis, that influential scientists are more likely to publish popular items than noninfluential scientists are, is supported by these data.

Of course, this is an ultraconservative way of looking at the issue: it takes into account the entire population of popular items on acid rain but not the entire population of scientists involved in acid rain research. In actual fact, of the 2177 scientists involved in acid rain research, only 102 (4.7%) contributed to the popular literature and 2075 (95.3%) did not; only 97 testified before Congressional hearings in the period 1975-1987 (4.5%); 2080 (95.5%) did not; only 19 (0.87% of the 2177) both testified and contributed to popular items; 83 (3.81%) contributed popular items but did not testify.

We can see, then, that while 19 of the 97 influential scientists contributed to the popular literature (19.6%) only 83 of the 2080 noninfluential scientists (about 4%) made such a contribution. In other words, the probability that an influential scientist will contribute to the popular literature is almost five times the probability that a noninfluential scientist will.

To test the second hypothesis, the following procedures were used. From the 4891 science items on acid rain, identified in the seven NAPAP volumes referred to earlier, all books, reports, conference papers and items of any kind published before 1974 and after 1983 were excluded. This left 1607 journal articles published in the period 1974-1983. To obtain citation counts only first-author status was considered. In all, 39 influential scientists were identified as first authors of 100 papers and 608 noninfluential scientists as authors of 1507 papers. The 100 papers by influential scientists were all used to obtain citations. Of the 608 noninfluential scientists contributing papers, 235 were selected at random. These scientists contributed 388 acid rain papers (first author status).

Using the Science Citation Index database, citations were obtained for all 100 papers by the influential scientists and all 388 papers by the sample of noninfluential scientists. Since publication dates of these varied, it was necessary to standardize citation periods so that each had an equal period in which it could be cited. A period of five years was chosen. Thus, for a paper published in 1974, citations received in the period 1974-1978 were used, for one published in 1983 the period 1983-1987 was used, and so on.

The difference in citation rate for the two groups, influential scientists and noninfluential scientists, was determined on the basis of fractional citation and without fractionation. In the case of fractional citation, a scientist appearing as first author earns units of citation credit dependent on the number of co-authors (for a paper cited once, written by three authors, the first author earns .33 credit, and so on).

The 100 papers by the influential scientists earned an average of 24.18 citations per paper in the first five years after publication, while the 388 papers by noninfluential scientists earned an average of 15.745 citations per paper. When fractionation is used, the 100 papers of the influential scientists earned 12.036 citation credits while the 388 by the noninfluential scientists earned 8.606 credits. When fractional citation is considered, t-tests indicate that the difference between the two groups is statistically significant at the probability level of .05 and even at the level of .01. When full citation is considered, the difference is highly significant at the probability of .01 and even at the level of .001. Whether full citation or fractional citation is considered, then, the hypothesis that influential scientists receive more citations than noninfluential scientists is supported by the data.

Further analyses of the citation data were performed to take into account the variable of contributions to the popular literature. Of the 488 papers for which citation data were available, 74 had first authors who had also contributed to the popular literature and 414 had first authors who had not. The 74 papers earned an average of 26.892 citations and the 414 earned an average of 15.790. In terms of fractional credits, the first author of the 74 papers earned 13.498 citation credits on the average and the first author of the 414 earned an average of 8.560. When t-tests are applied to these two groups, the difference is highly significant at the probability of .01 whether full or fractional citation is considered, indicating that scientists who contribute to the popular literature are also likely to be more cited in the science literature.

For the final analysis, the papers for which citation data were available were divided into four groups:

1. Those in which the first author was an influential scientist who had contributed to the popular literature (51 items).
2. Those in which the first author was an influential scientist who had not contributed to the popular literature (49 items).
3. Those in which the first author was a noninfluential scientist who had contributed to the popular literature (23 items).
4. Those in which the first author was a noninfluential scientist who had not contributed to the popular literature (365 items).

A one-way analysis of variance (ANOVA) was applied to test for differences among these groups when full or fractional citations were considered. Results indicate a highly significant difference among the groups. When fractions are considered, the F value is 5.27 (df = 3/484, $p < .01$). When full citations are used, the F value is 11.99 (df = 3/484 at $p < .001$).

To test which pairwise differences are statistically significant, Tukey's Studentized (HSD) tests were applied to the results obtained from the ANOVA. The Tukey tests indicate that, when fractional citations are considered, the only pair to differ significantly is that of the influential scientists who have published popular items and the noninfluential scientists who have not (statistically significant at $p < .05$). However, when full citations are taken into account, the difference is significant at $p < .05$ for two pairs: the influential scientists publishing popular items versus the noninfluential scientists not publishing popular items and the noninfluential scientists publishing popular items versus the noninfluential scientists not publishing popular items. It seems, then, that those scientists who contribute to the popular literature, far from being ignored by their fellow scientists, are more likely to be cited than scientists who do not contribute to the popular literature.

In summary, for the field of acid rain research, and within the particular contraints of the study, the data indicate that scientists who contribute to the popular literature are more likely than others to be called on to give Congressional testimony (and vice versa) and that the work of these same scientists is well recognized by their peers as judged by rates of citation. Indeed, scientists who contribute to the popular literature are more highly cited than those who do not whether or not they are called upon for expert testimony. Since those who give testimony are more highly cited than those who do not, some evidence also exists that scientists called before Congressional hearings are among those most influential in the science community.

Studies in progress or planned

Two further studies are ongoing and others in the series are planned. One ongoing investigation is looking at the academic boycott of South Africa. While this is far from universal, certain elements do exist; e.g., absolute ban on export of publications from some countries, some libraries refusing to honor interlibrary loan requests from South Africa, and scholars from South Africa being denied participation at certain international meetings. Specifically, we are trying to determine whether or not this boycott has had any effect on the information sources used by South African scientists. A pilot study (Haricombe, 1989) has looked at the sources cited in the South African Journal of Chemistry in the period 1977-1988. In this period the journal published 456 articles (441 by South Africans) and these generated 6391 bibliographic references. When sources cited in 1977-1979 are compared with those cited in 1986-1988, no significant differences are observed. No evidence exists, in this journal at least, that South African scientists are drawing less on the publications of any other country or that they are relying more heavily on internal sources of information. Either the academic boycott, such as it has been so far, has had no effect on the information sources used or not enough time has elapsed to allow an effect to be observed.

The largest study now underway involves an analysis of the sources cited by East European scientists. Samples of the publications of scientists from all six East European countries have been drawn for the year 1986. The samples include contributions of the scientists to domestic journals as well as to international journals. As in the Cuban, Egyptian and South African studies, the country of publication of the sources cited is now being analyzed. The hypothesis being tested is that scientists from those countries who have been ideologically "closest" to the Soviet Union (Bulgaria, East Germany, Romania) will cite proportionally more Soviet and East European sources, and fewer Western sources, and vice versa for the countries (Poland, Hungary, Czechoslovakia) that have adhered less closely to the Soviet ideology.[4]

One further study is in the planning stage but has not yet begun. It will involve an analysis of the information sources cited by Chinese scientists before and after the Cultural Revolution.

Relevance to the developing countries

The studies performed have not always supported our initial hypotheses, and some of the results have surprised us, but we believe we have shown that bibliometric methods can be applied to investigate various facets of the interaction between science and politics and, in particular, the influence that the political environment of a country might have on the information sources used by scientists of that country.

Our objective in all these studies has been to look at phenomena not previously investigated bibliometrically. They represent bibliometric research of a "pure" variety and do not necessarily produce results of obvious practical utility.

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4 It will be interesting to see to what extent these citation patterns reflect the sequence with which the Eastern European countries have declared their political independence in the recent changes taking place in that part of the world.

Nevertheless, studies of this kind do have potential relevance and interest to the developing countries.

Studies of where scientists choose to publish, over a period of time, reflect certain forms of progress in a country. For example, if scientists published significantly more in their domestic journals at the time X+1 than they did at time X, this might reflect a strengthening of the national journals or national progress in higher education (more scientists taking advanced degrees at home rather than abroad). On the other hand, a country might prefer to see its scientists publishing more internationally, especially in the most prestigious journals, since this would tend to indicate that they were producing work of a higher quality.

The effect on science of changes in the political alignment of a country may be reflected in changing patterns of collaborative authorship and changes in the sources cited (country and language of publication) as well as changes in the languages and sources in which scientists publish.

Bibliometric methods can also be used to look at differences between national and international influences in science. For example, are the scientists most called upon by politicians for advice or evidence in a country those who are most cited in the national journals?; in the international journals?; do they publish more domestically or internationally?; do they publish in more prestigious journals than the scientists who have less political influence?

Finally, bibliometric studies can be used to investigate the effects of political barriers on the exchange of information. For example, to what extent do academic and cultural boycotts impair scholarly endeavors in a country? Do they change the sources used (cited) by scientists? Do they alter their publishing patterns? Do political enmities really impede the free exchange of important and relevant information among nations? Questions of this kind can be looked at bibliometrically. One obvious example relates to Arab/Israeli relations. Israel is an acknowledged leader in irrigation research, a technology of great relevance and interest to the Arab countries. Is Israeli research, as reflected in Israeli journals and research reports, accessible in these countries?; is it used?; is it cited?

Bibliometric methods have been used to examine a wide range of phenomena over the years but little use has been made of them to investigate interactions between scholarship and the political establishment. Studies of this type deserve more attention.

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INTERNATIONAL SCIENTIFIC COLLABORATION IN LATIN AMERICA

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ABSTRACT

This study attempts to analyse the extend of the usability of international databases such as the Science Citation Index (SCI) for the observation of the international collaboration in lesser-developed countries. We have examined the adequacy of this data source (the SCI) in perceiving the international scientific activities of nine Latin American countries. We have studied the relationships of these countries with their main foreign partners in the large fields of science. It has been observed that some of these relationships are not covered by the data source under study. The creation of an information system storing complementary data suited for the identification of existing international collaborative projects is recommended. In the long-range future such a system would provide more appropriate information for the analyses of international collaboration.

RESUME

Cette étude tente d'analyser les limites de l'utilisation des bases de données internationales telle que Science Citation Index (SCI) pour l'observation des collaborations internationales dans les pays les moins développés. Nous avons examiné la pertinence de cette base (SCI) en prenant en compte l'activité scientifique internationale de neuf pays d'Amérique Latine. Nous avons étudié les relations de ces pays avec leurs principaux partenaires étrangers dans les grands domaine de la science. Nous avons ainsi observé que certaines de ces relations n'étaient pas couvertes par la base de données étudiée. C'est pourquoi la création d'un système d'information pour le stockage de données complémentaires permettant l'identification des projets menés dans le cadre de collaborations internationales nous paraît nécessaire. A long terme, un tel système fournirait des informations plus appropriées pour l'analyse des collaborations internationales.

INTRODUCTION

Many mesures of the scientific activities of a country have been employed, including counts of publications, author productivity, or collaborative projects. Measuring scientific production is relatively recent. One of the first studies on this subject counted and classified publications country by country (1).

Bibliometric indicators such as links between authors (reference coupling); study impact (citation analysis); source impact (impact factor, immediacy index, journal influence); subject relationship (co-references, co-citations and co-word analysis); (2,3) and coauthorship (4) have been developed .

In international collaboration, as shown by Frame and Carpenter (5), coauthorship is more frequent in fundamental science than in applied science. Geographical, political, and cultural factors also strongly influence international collaboration, as does the scientific status of a country.

Analyzing international collaboration in science using bibliometric indicators is becoming more and more frequent due to the fact that scientific activities are more internationalized than ever. Better facilities for study and training, increased financing by national and international organizations, and improved ways of communication enable scientific international relations between researchers, laboratories, and large organizations to develop.

Most of the bibliometric studies mentioned are comprised of quantitative information extracted from an international database, usually the Science Citation Index (SCI) of the Institute for Scientific Information (ISI).

Indicators for the measure of international collaboration are presently being developed by the Laboratoire d'Evaluation et de Prospective Internationales (LEPI) of the Centre National de la Recherche Scientifique (CNRS). Two databases developed at LEPI-CNRS, "BADIN" and "MEV-MAC", have been chosen for this study. The objectives of this study are to observe:

(a) the participation of nine Latin American countries in mainstream scientific journals;

(b) the collaboration between Brazil and other Latin American countries;

(c) the collaboration between six Latin American countries (Mexico, Chile, Argentina, Venezuela, Colombia and Peru) and France. For this third observation the BADIN and MEV-MAC database are compared with each other to determine their respective abilities in covering the collaboration in general and the selectivity of projects between France and its Latin American partners.

The work conducted at LEPI shows that interpretation of data from the SCI database can be useful for the analysis of international activities in developed countries (DCs). The question of analyzing these activities in lesser-developed countries (LDCs) is still under discussion and merits further study. However, by using the SCI's database, it is possible to obtain a views of the development of the scientific activities of a country in a specific field and of the scientific relationships between countries. We attempt to compare selective and non-selective databases and to analyze the effect of the "selectivity" in observing Latin American international activities.

METHODOLOGY

The question of the "visibility" of science in the LDCs (6) could be reconsidered by using "non selective" data bases such as BADIN. This database is an inventory which identifies the international projects between the CNRS and its partners throughout the world. The BADIN data has no selectivity criteria.

The MEV-MAC matrix is made up of projects having produced publications in mainstream journals and therefore shows selective scientific activities between countries. This database is derived from the Science Citation Index (SCI) produced by the Institute for Scientific Information (ISI, Philadelphia, PA, USA). The SCI data contains the number of publications and the number of internationally co-authored articles, notes and reviews in over 3,000 journals. In the present study we have used the 1981's fixed journal set processed by Computer Horizons Inc. (CHI). SCI's main advantage is its coverage of data in fundamental science. The SCI database also includes the affiliations of all of the authors for each article. This detailed information enables quantitative studies of international collaboration in the eight large divisions of the sciences.

In this study we show data concerning the nine most scientifically productive countries in Latin American: Brazil, Mexico, Argentina, Venezuela, Chile, Colombia, Peru, Cuba, and Jamaica.

We use Carpenter's classification of eight scientific fields (7), accepted by the National Science Foundation (NSF). These fields, represented by the following abreviations, are: MAT (Mathematics), PHY (Physics), CHM (Chemistry), ENT (Engineering & Technology), EAS (Earth & Space Sciences), BIO (Biology), BIM (Biomedicine), and CLI (Clinical Medicine). The countries are identified using the ISO codes, e.g.: Brazil=BRA, Peru=PER. The data corresponds to the six-year period from 1981 to 1986. The count represents the number of international co-authorships for each country.

RESULTS

During the period 1981-1986 the nine Latin American countries under study produced a total of approximately 30,000 articles in the fields considered: 17,602 in the Life Sciences (Biology, Biomedicine and Clinical Medicine), 4,805 in Physics, 3,961 in Chemistry, 1,677 in Earth & Space sciences, 1,141 in Engineering & Technology, and 746 in Mathematics.

International activities varied widely in the nine Latin American countries studied (Table 1).[1] Observing the percentage of internationally co-authored articles in the total scientific production in these countries, during the period 1981-1986 in the eight fields combined, we see that some countries produced

[1] Tables and figures are presented at the end of the paper.

more locally than internationally: Brazil (26% internationally), Chile (23%), Mexico (31%), and Argentina (13%). In Cuba (50%), Colombia (48%), and Jamaica (41%), these two forms of production were almost equally represented. Peru had the highest proportion of international coauthorship (61%). In Table 1 we see that the three Life Sciences fields had the largest percentages of the total coauthorship activities in each country, varying from 10 to 30%, except in Clinical Medicine which was even higher in Colombia and Jamaica. Physics also had high rates but only in three countries: Brazil, Argentina, and Mexico. These countries had similar proportions in almost all fields. Cuba should be noted for its rate of 24.9% in Chemistry. Chile should be noted for its rate of 27.4% in Earth & Space science. Activities of the European Spatial Observatory (ESO), at La Silla, and of the Cerro Tololo Inter-American Observatory, at La Serena make up a large part of this rate. Colombia was more active in Biology (31.2%) than were the other eight countries. Neither Engineering & Technology nor Mathematics had rates greater than 6.2% in any of the nine countries.

1) Participation of eight Latin American countries in mainstream journals: MEXICO, ARGENTINA, VENEZUELA, CHILE, COLOMBIA, PERU, CUBA, JAMAICA

Figure 1 shows the principal partners of the four Latin American countries, Mexico, Argentina, Venezuela, and Chile. The order of representation of the 12 largest partners was somewhat similar in Mexico, Venezuela, and Chile. During the period 1981-1986, Mexico produced 878 co-authored articles with the USA, whereas the three other countries, Argentina, Venezuela, and Chile, produced less than half this quantity with the USA. The remaining 11 partners co-authored less than 150 articles each with each of the four countries. Argentina collaborated actively with Brazil, in second place after the USA.

Representation field by field of collaboration between these four countries and the USA can be seen in Figure 2. For three of the countries, the Life Sciences, especially Clinical Medecine, were the most active fields and were followed by Physics. In Chile, Earth & Space was the most active field.

A series of charts are in annexe (Charts 1-4) in which partners are classified by the number of their coauthorships with the four Latin American countries under study. In each chart the number of partners listed in the "ALL" column corresponds to the number of partners in the most diversively collaborating field of the country under study. We define here "the most diversively collaborating field" as the field which had the largest number of partner countries producing at least 5 co-publications with the country under study. For instance, for Mexico (chart 1), 13 countries are listed in the "ALL" column because there were 13 partners producing at least 5 co-publications in the Physics column, Mexico's most diversively collaborating field. That is why all of the partners in the Physics column are printed in upper case characters. The number of co-authored articles

(COAs) for each partner in the "ALL" column is given. The total number of coauthorships for each field (COA-WORLD, horizontal row) is given, as is the total number of partners with at least 4 coauthorship during the period, for each field (PARTNERS-WORLD, horizontal row). In each field column, countries with 2 to 5 articles in the period are listed in lower case characters for general information.

Mexico had 28 partners in the world having at least 5 co-authored articles, notes, or reviews in the six-year period, all fields combined. Five out of the thirteen largest partners listed in chart 1 were in the highest positions. FRA, CAN, GBR and DEU followed the USA in different orders in the different fields. France was well situated in the second horizontal row in 4 fields, notedly in Chemistry and Physics, and Great Britain, the second partner in Clinical Medicine, was well placed in the third row in the Life Sciences and Engineering & Technology. Canada was the second largest partner in Engineering & Technology and Mathematics. Germany was second in Biomedicine. Spain, the sixth partner in the ALL column, was fourth in Physics. Brazil, the seventh partner in the ALL column, was the fourth in Biomedicine. In the fifth row partners were more diversively represented: ESP (Engineering & Technology, Biology), SWE (Clinical Medicine) and ITA (Earth & Space Sciences). From the sixth to the eighth row Latin America (BRA, VEN, COL, CHL) and Spain were more visible. Poland was linked with Mexico through Chemistry (7th row) and Mathematics (3rd row). Switzerland, Belgium, and India should be noted in Physics. Sweden in Clinical Medicine had its only field attachment with Mexico. Life Sciences had 12 partners represented in its fields' columns: 7 in Biology, 7 in Biomedicine, and 8 in Clinical Medicine. However, the largest number of partners having published at least 5 co-authored articles with Mexico was found in Physics. Physics in Mexico was the country-field producing the largest number of co-authored articles in all of the 4 countries under study (391 papers). Clinical Medecine was the second largest having 368 papers co-authored by Mexico.

Argentina had 20 partners with which it produced at least 5 papers during the six-year period, all fields combined. In chart 2, we see that five countries were placed in the first and second rows in most of the fields (USA, BRA, FRA, DEU, GBR). France replaced the USA in the first row in Chemistry. Brazil was Argentina's second largest partner in Physics, Biomedicine, and Mathematics, and its third largest partner in Chemistry and Clinical Medicine, but there were no articles with Brazil in Engineering & Technology. Two other Latin American countries, Venezuela and Chile, appeared in medium positions. Germany was well placed in four fields as the second (Engineering & Technology, Biology) and the third (Earth & Space Sciences, Biomedicine) partner. As in Mexico, Great Britain was the second partner in Clinical Medicine, and France was second in Earth & Space Sciences. Italy, Spain, and Canada co-authored in several fields (rows 5 to 10). The Netherlands in Earth & Space Sciences, Sweden in Physics, and Belgium and Switzerland in Clinical Medicine and

Biomedicine, all had links in a few fields with Argentina. Clinical Medecine and Physics both had the largest number of partners having produced at least 5 co-authored articles with Argentina: 10 countries are listed in upper case characters in these columns. Biomedicine, Earth & Space Sciences and Chemistry followed as the most diversively collaborating fields.

Venezuela had 16 partners with which it produced at least 5 coauthorships during the period, all fields combined. In chart 3, we see that three countries were in the highest positions in several fields (USA, GBR, FRA). Great Britain replaced the USA in first place in Chemistry, and as was the case for its collaboration with Mexico and Argentina, it was well placed in Life Sciences. France was situated in the second horizontal row in Physics and Japan was second in Clinical Medicine and Engineering & Technology. Venezuela's links with Spain were visible in Chemistry, and links with other Latin American countries were most significant in Biomedicine (ARG, BRA, MEX). Canada was present in various rows and in five fields. Venezuela had its greatest number of partners in Biomedicine (7).

With 25 partners having produced at least 5 coauthorships during the period of study, 38% of Chile's links was with the USA, in first place all fields. In chart 4 it should be noted the second place in Chemistry occupied by Spain, because it published with Chile nearly as much as did the USA (33 and 35 articles respectively) and was Chile's second partner in Biology. Chile was linked with Belgium in Physics (11 articles) and with other European countries. Germany (37 articles), Great Britain (37 articles), France (28 articles), and Canada (26 articles) were very active in Earth & Space Sciences, owing to the ESO and to the Cerro Tololo activities mentioned above. France came second in Biomedicine and third after Brazil in Clinical Medicine. Only Brazil and Argentina (the third partner in Biomedicine) were significant partners in Latin America. Earth & Space Sciences and Clinical Medicine had the largest number of partners. Earth & Space Sciences in Chile was the country-field producing the third largest number of co-authored articles (358) in all of the four countries.

Figures 3, 4, 5 and 6 show the largest partners and the breakdown of fields for coauthorships between Colombia, Peru, Cuba and Jamaica and the world during the period 1981-1986. In figures 4 and 6, concerning Peru and Jamaica only eight partners are shown as there were only eight which produced at least 5 co-authored articles with these countries. Except for Cuba, the USA was the first partner for this group of countries. The Life Sciences were the most active fields and were followed by Chemistry and Physics (in Colombia, Cuba, and Jamaica) or Earth & Space Sciences (Peru). The relative positions of the partners field by field is not shown because the number of papers co-authored was often less than 5.

Nevertheless, some of the links seem to be of particular interest: the USA represented 47% of the links involving Colombia, and had hight rates in the Life Sciences: 151 articles out of 160 articles were made in these fields. Brazil, the fouth partner in all fields combined (Figure 3), co-authored 10 articles in Biology with Colombia, where it was in second position after the USA. Spain was Colombia's first partner in Chemistry (5 articles). In collaborating with Peru (Figure 4), the USA obtained the highest percentage of links for this group of countries (51%). Japan was an active second partner in Earth & Space Sciences (8 articles), following the USA (20 articles). France was Peru's first partner in Chemistry (5 articles) and Clinical Medicine (7 articles). Germany was specially linked with Peru in the Life Sciences: 17 articles out of 22 were made in these fields.

For the period in reference, the Soviet Union and the Eastern European countries were Cubas's most active partners (figure 5), making up 66% of the links in all fields combined and 24,5% for the Soviet Union alone. It is also notable that after the Life Sciences, Chemistry was the other important field of interest for collaboration, as is often the case in collaboration with Eastern European countries. Italy was the first western partner having produced five articles with Cuba in Clinical Medicine and six in Physics, and was followed by the USA. Cuba's Latin American partners were under-represented in the SCI database: Argentina, Chile, Colombia and Mexico, produced one co-authored article each, and Costa Rica produced two during the six-year period.

In Jamaica (Figure 6), the first positions were shared by the USA (32,5%) and Great Britain (28,7%). Great Britain was first in Clinical Medicine (45 articles) and Biomedecine (8 articles). The USA was second in Clinical Medicine (28 articles), in Biomedicine (7 articles) and the first in Biology (22 articles).

2) Collaboration between BRAZIL and its Latin American partners

In chart 5, all of the links between Brazil and its Latin American partners are given, and those with at least 2 co-authored articles are listed in the ALL column. We see that three Latin American countries, Argentina, Chile, and Mexico were particularly linked with Brazil. Nevertheless, Colombia was Brazil's largest partner in Biology, representing 50% of the links, but Venezuela's collaborative activities with Brazil were more diversified in Mathematics, Clinical Medicine, and Biomedicine. Engineering & Technology, Earth & Space Sciences and Mathematics were not active fields among these partners. Only the 5 largest Latin American partners are represented in figure 7, which summarizes Brazil's collaboration with these countries for the period in reference, in five significant fields (Physics, Chemistry, Biology, Biomedicine, and Clinical Medicine).

It can be observed that in the MEV-MAC matrix, which itself is based on the SCI database, some relationships were not present. For example, in MEV-MAC, in Engineering & Technology Brazil registers only 2 articles with its Latin American neighbors during the six-year period. In Chemistry, Argentina registers no coauthorship with Chile and Venezuela registers none with Mexico. In Mathematics, Peru and Cuba register no international partners, Jamaica registers only a total of two articles, and Colombia registers 3 articles all of them with the USA. This same situation of under-representation is similar in Earth & Space Sciences and in Engineering & Technology.

3) Collaboration of six Latin American countries with France

At LEPI-CNRS, analyses of international activities include studies on the mobility of researchers (9), and studies on spontaneous collaborative projects between scientists from the CNRS and from other laboratories throughout the world (10). For "macro" analysis, LEPI-CNRS also uses indicators to analyze relationships and trends between countries (11). For such analysis the SCI database is used.

Figure 8, derived from data in MEV-MAC, shows the number of co-authored articles between France and each of six countries (Mexico, Argentina, Venezuela, Chile, Colombia, and Peru) for the years 1982, 1984, and 1986. In 1982, 58 articles were written, compared to 71 in 1984, and 89 in 1986. Collaboration between the six countries combined and France grew by 35%.

The BADIN database, which identifies all projects between the CNRS and its partners throughout the world, stems from the spontaneous participation of CNRS researchers. This means that no sure numbers are obtained but a general appreciation can be determined of tendencies in fields and of the amounts of collaboration of different countries working with the CNRS.

Figure 9 shows that the 91 collaborative projects between the six Latin American countries under study and the CRNS teams identified in 1989 in BADIN produced 153 publications, 18 theses, and 12 instrument developments.

Figures from BADIN can also be correlated with the number of exchange visits by PhDs or post-doctorates. Exchanges between LDCs and DCs are often associated with graduate and postgraduate studies and with instrument development (technological transfer), as observed by LOMNITZ:

"The percentage of papers co-authored with foreigners ... reached a peak in 1969, owing to the return to Mexico of the first important group of PhDs who published papers co-authored by their thesis advisers. This collaboration reflects the most important entry of Mexican scientists into international networks, as contacts with foreign professors and colleagues are likely to be maintained for life." (12)

However, these activities are not always "seen" through SCI data, especially if the data is stored during the time the collaborative work is at an early stage.

Of the 153 publications in the 1989 BADIN study (Figure 9), we had enough information to cross-check 132, and it was found that 100 (75%) of these 132 publications were co-authored and published in high-quality journals, most of them in the mainstream category.

If we examine the typical process of publishing, we observe that it begins with the training of a researcher coming from a LDC for a PhD thesis.

Communications are prepared by one of the partner countries in that partner country's language. These communications are not always co-authored. Later, the co-authored articles are drawn-up, usually in English, in an international journal, usually in the mainstream category. It should be noted that of the 50 co-authored articles in the "selective journals" only one was in French and one in Spanish, while of the 22 co-authored communications, 7 were in English, 4 in French and 11 in Spanish.

Some evidence has been brought forward that a large part of LDC production is of a "high selectivity" nature when international collaborative works are performed (13).

CONCLUSION

MEV-MAC, based on the SCI database, enables useful interpretations and observations of the international activities between lesser developed countries and developed countries in fundamental science. For certain cases it could also be useful to observe the development of selective international projects between Lesser Developed Countries and the links between countries for a long period of time.

However, more appropriate indicators are necessary for identifying the output of LDCs not found in mainstream journals.

For a regular follow-up of results using adequate databases, the question of the criteria for selection of collaborative works remains under discussion.

National, regional, or institutional databases are necessary to the follow up of the activities of each collaborative project. Such databases would enable both the identification of the works being conducted and the future analyses of selected results.

LDCs would be able, not only to identify joint projects, but also to obtain more detailed and useful information. By using compatible formats for identifying collaborative projects, a more realistic and complete image of the activities involved could be achieved.

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Annex

TABLE 1

Scientific activity of Latin America (1981-1986)
Total number of articles (PROD)
Number of international coauthorships (COA) and percentage of 8 fields

	PROD	COA	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI
BRA	9997	2628	5.9	23.0	9.0	5.8	7.7	14.1	16.5	18.0
ARG	7081	922	1.8	22.3	9.9	5.5	10.7	12.1	18.7	19.0
MEX	4899	1525	3.3	22.0	12.1	6.2	10.4	14.2	11.7	20.1
CHL	3982	930	2.7	6.6	13.0	3.3	27.4	14.6	14.9	17.5
VEN	2154	679	6.0	16.6	11.6	4.4	4.8	13.4	17.3	25.9
COL	594	288	1.0	3.1	4.5	1.3	3.1	31.2	14.9	40.9
CUB	472	236	0	9.3	24.9	0	5.0	19.4	19.4	22.0
JAM	408	168	1.1	7.7	12.5	2.3	1.1	21.0	11.3	43.0
PER	345	221	0	1.0	3.6	2.2	13.1	23.5	28.0	28.6
WORLD	2265438	150877	4.0	19.6	12.1	6.0	8.0	8.1.	18.0	24.2

CHART 1

MEXICO'S PARTNERS IN EIGHT FIELDS (1981-1986) CLASSIFIED IN ORDER OF NUMBER OF COAUTHORSHIPS

	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI		ALL	COAs
	USA	USA	USA	USA	USA	USA	USA	USA	1	USA	878
	CAN	FRA	FRA	CAN	FRA	FRA	DEU	GBR	2	FRA	136
	pol	DEU	CAN	GBR	DEU	GBR	GBR	FRA	3	CAN	103
	che	ESP	GBR	FRA	GBR	DEU	BRA	CAN	4	GBR	97
	deu	CAN	DEU	ESP	ITA	ESP	FRA	SWE	5	DEU	81
	gbr	BRA	ESP	jpn	CAN	ITA	CAN	CHE	6	ESP	64
	esp	CHE	POL	ind	ESP	CAN	VEN	VEN	7	BRA	40
		IND	bra	bel	ven	chl	che	COL	8	ITA	36
		GBR	jpn	deu	yug	isr	chl	bel	9	CHE	29
		ITA	dnk	chl	arg	bra	dnk	bra	10	IND	21
		BEL	arg	aus	sun	ven	yug	zaf	11	VEN	19
		DDR		ven	ind	arg	esp	arg	12	ARG	19
		ARG			pol	per	swe	ita	13	POL	19
COAs	58	391	195	109	184	229	216	368		WORLD	1750
PARTNERS	2	13	7	5	7	7	7	8	28	WORLD	

Column each field -> Upper case : 5 or more coauthorships
-> Lower case : 2 to 4 "

COAs WORLD Row = Total of coauthorships in the field
PARTNERS Row = Total of Mexico's partners with 5 COAs in the field

CHART 2

ARGENTINA'S PARTNERS IN EIGHT FIELDS (1981-1986) CLASSIFIED IN ORDER OF NUMBER OF COAUTHORSHIPS

	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI		ALL	COAs
	USA	USA	FRA	USA	USA	USA	USA	USA	1	USA	371
	bra	BRA	USA	DEU	FRA	DEU	BRA	GBR	2	BRA	117
		FRA	BRA	FRA	DEU	CHL	DEU	BRA	3	FRA	101
		DEU	DEU	GBR	NLD	FRA	GBR	FRA	4	DEU	100
		ITA	GBR	esp	CAN	bra	VEN	ITA	5	GBR	75
		GBR	ESP	ita	GBR	ita	CHL	DEU	6	ITA	48
		SWE	can	chl	CHL	nld	FRA	BEL	7	CHL	33
		VEN	ita	swe	bra	esp	ITA	SWE	8	VEN	30
		MEX	mex	che	ita	can	CHE	CHE	9	CAN	29
		ESP	aus		mex	aus	bel	CAN	10	ESP	27
COAs	19	248	97	53	123	127	216	231		WORLD	1114
PARTNERS	1	10	6	4	7	4	9	10	20	WORLD	

Column each field -> Upper case : 5 or more coauthorships
-> Lower case : 2 to 4 "

COAs WORLD Row = Total of coauthorships in the field
PARTNERS Row = Total of Argentina's partners with 5 COAs in the field

CHART 3

VENEZUELA'S PARTNERS IN EIGHT FIELDS (1981-1986) CLASSIFIED IN ORDER OF NUMBER OF COAUTHORSHIPS

	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI		ALL	COAs
	USA	USA	GBR	USA	USA	USA	USA	USA	1	USA	382
	CAN	FRA	USA	jpn	gbr	GBR	GBR	JPN	2	GBR	73
	FRA	GBR	FRA	aus	mex	CAN	ARG	GBR	3	FRA	48
	gbr	CAN	ESP	can	fra	fra	FRA	ITA	4	CAN	33
	chl	ARG	DEU	fra		col	BRA	MEX	5	ARG	30
		ITA	ITA	gbr		deu	ITA	FRA	6	ITA	29
		bra	can	mex		arg	MEX	esp	7	MEX	19
COAs	44	132	83	33	37	96	135	191		WORLD	751
PARTNERS	3	6	6	1	1	3	7	6	16	WORLD	

Column each field -> Upper case : 5 or more coauthorships
-> Lower case : 2 to 4 "

COAs WORLD Row = Total of coauthorships in the field
PARTNERS Row = Total of Venezuela's partners with 5 COAs in the field

CHART 4

CHILE'S PARTNERS IN EIGHT FIELDS (1981-1986) CLASSIFIED IN ORDER OF NUMBER OF COAUTHORSHIPS

	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI		ALL	COAs
	USA	USA	USA	USA	USA	USA	USA	USA	1	USA	436
	FRA	BEL	ESP	GBR	DEU	ESP	FRA	BRA	2	DEU	92
	deu	GBR	BRA	can	GBR	DEU	ARG	FRA	3	FRA	86
	bra	FRA	FRA	deu	FRA	ITA	DEU	GBR	4	GBR	79
	ven	deu	DEU	arg	CAN	ARG	CAN	CAN	5	ESP	75
		ita	NOR	mex	AUS	fra	ESP	DEU	6	CAN	60
		esp	can		NLD	gbr	GBR	SWE	7	BRA	49
		arg	gbr		ITA	can	BRA	CHE	8	ARG	33
		che	ita		DNK	mex	mex	COL	9	ITA	31
		mex	bel		JPN	per	ita	THA	10	AUS	27
			ven		ESP		aus	NGA	11	BEL	19
			sau		ARG		bel	aus	12	CHE	17
					CHE		jpn	ind	13	NLD	17
COAs	27	69	130	34	358	146	159	236		WORLD	1159
PARTNERS	2	4	6	2	13	5	8	11	25	WORLD	

Column each field -> Upper case : 5 or more coauthorships
-> Lower case : 2 to 4 "

COAs WORLD Row = Total of coauthorships in the field
PARTNERS Row = Total of Chile's partners with 5 COAs in the field

CHART 5

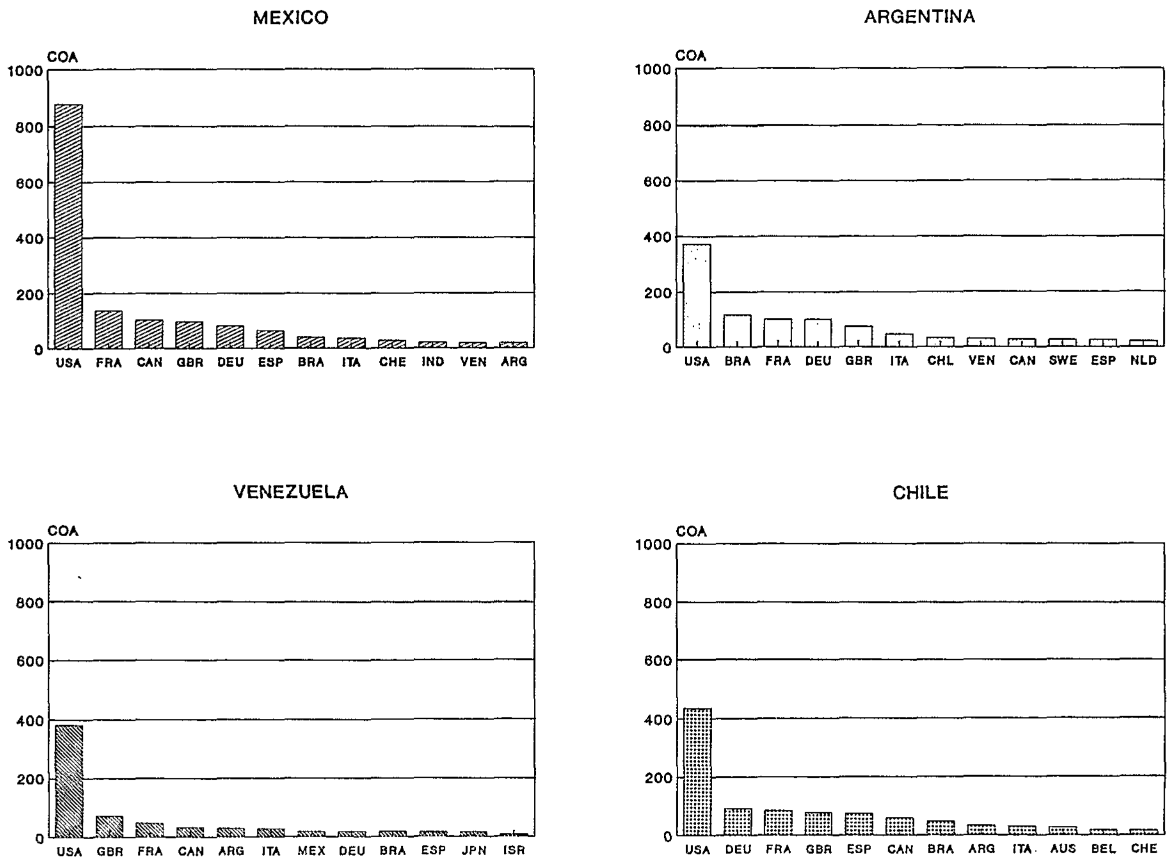
BRAZIL'S LATIN AMERICAN PARTNERS IN EIGHT FIELDS (1981-1986) CLASSIFIED IN ORDER OF NUMBER OF COAUTHORSHIPS

MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI		ALL	COA
arg	ARG	ARG		arg	COL	ARG	CHL	1	ARG	117
chl	MEX	CHL		chl	arg	MEX	ARG	2	CHL	49
	ven	mex			ury	VEN	URY	3	MEX	40
					mex	CHL	mex	4	VEN	18
						col	ven	5	COL	18
						cri	col	6	URY	9
							cri	7	CRI	6
							per	8	PER	5

Column each field -> Upper case : 5 or more coauthorships

-> Lower case : 2 to 4 "

Figure 1. Coauthorship number (COA), Latin America & their 12 largest partners, ALL fields, 1981-1986



CNRS-LEPI

Fig. 2 Coauthorship number (COA), 4 Latin America countries and the USA, field by field, 1981-1986

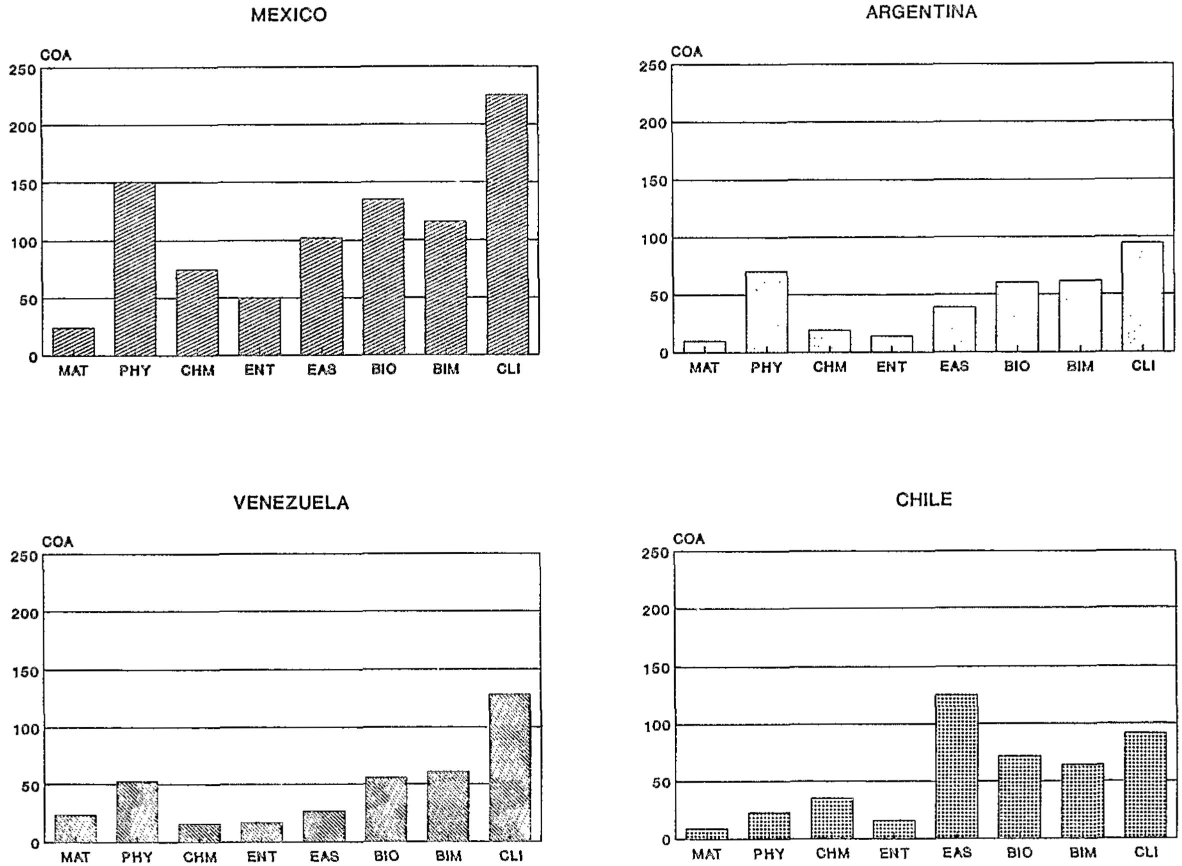


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Fig. 3 Coauthorship number (COA), COLOMBIA

a) LARGEST PARTNERS, ALL FIELDS, 1981-86

COLOMBIA & THE WORLD
b) IN EIGHT FIELDS (1981-1986)

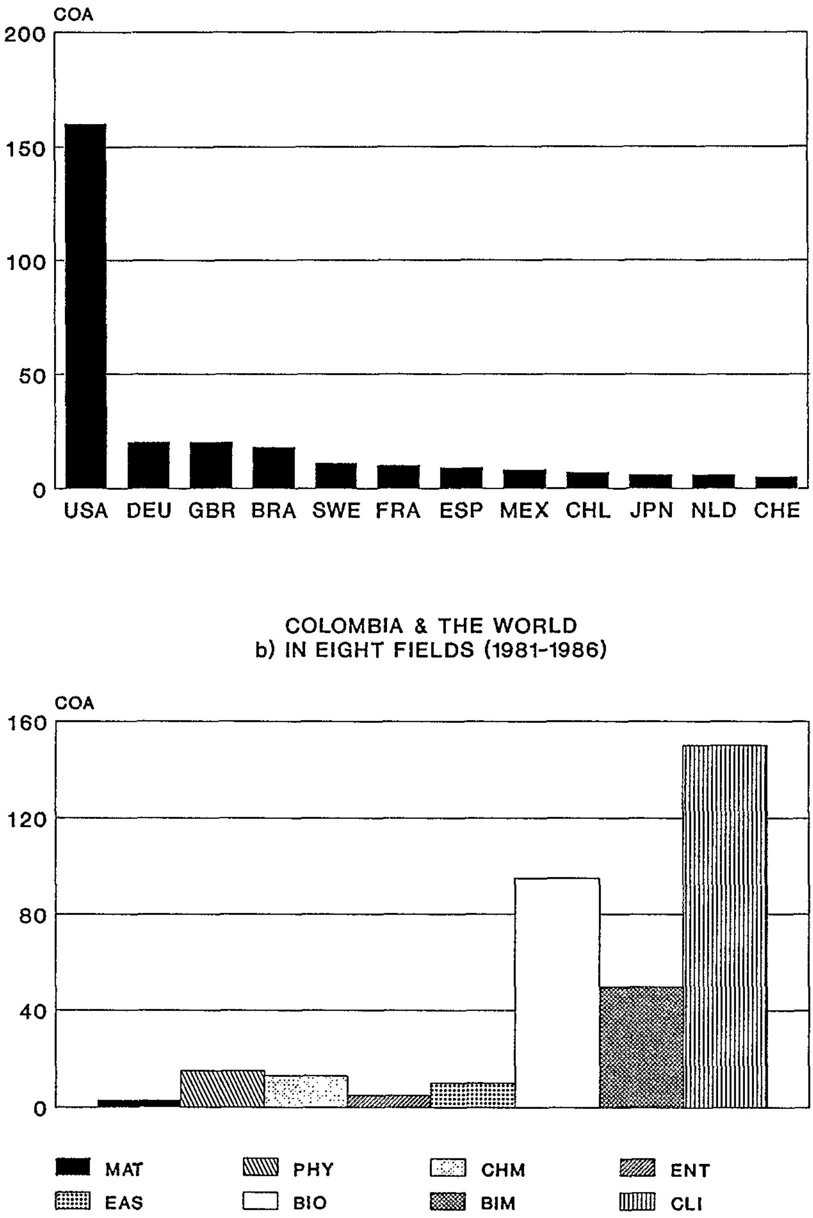

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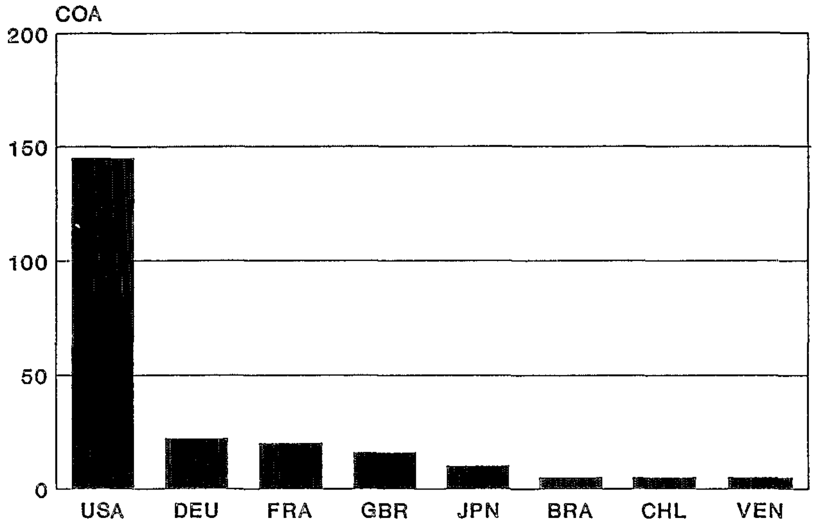
Fig. 4 Coauthorship number (COA), PERU

a) LARGEST PARTNERS, ALL FIELDS, 1981-86



PERU & THE WORLD
b) IN EIGHT FIELDS (1981-1986)

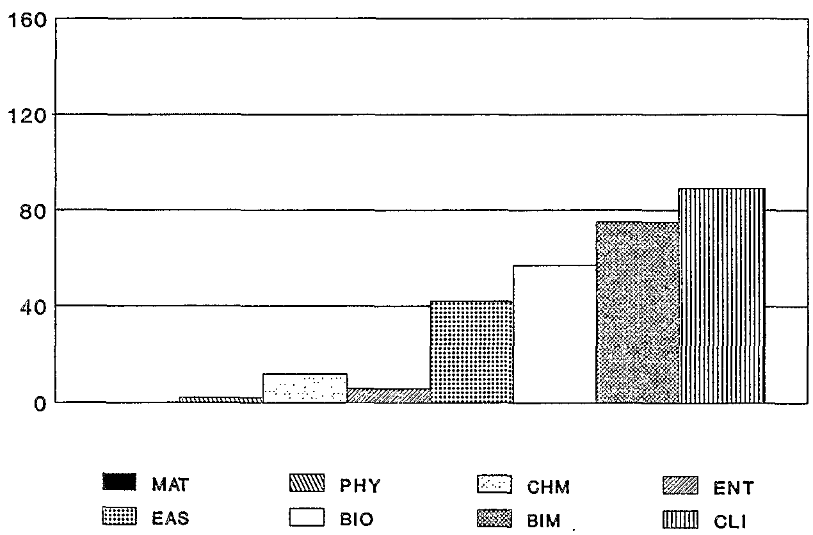


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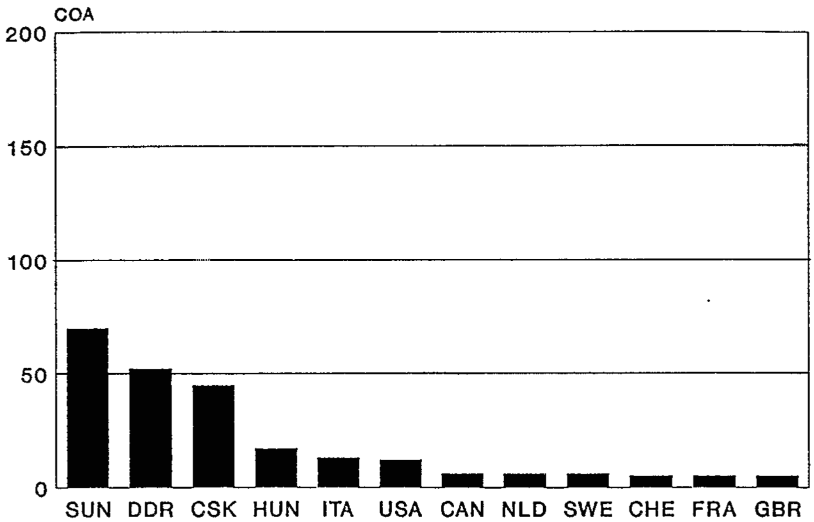
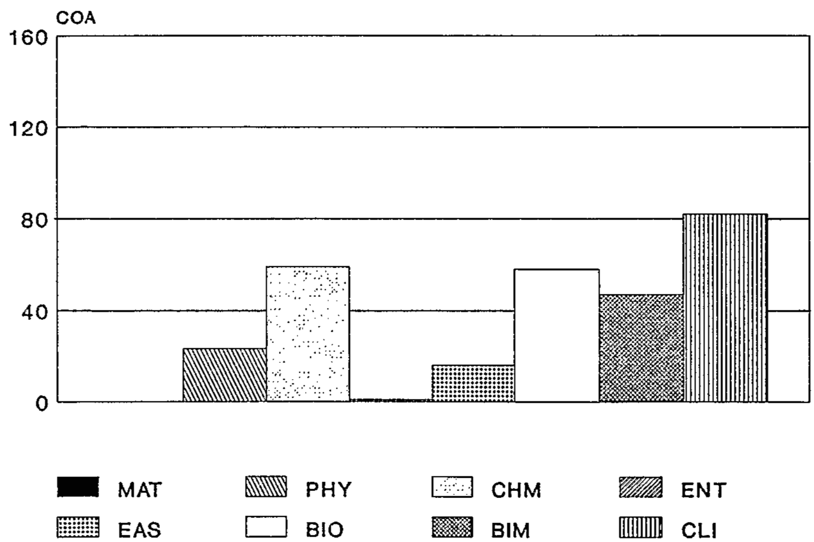
Fig. 5 Coauthorship number (COA), CUBA

a) LARGEST PARTNERS, ALL FIELDS, 1981-86



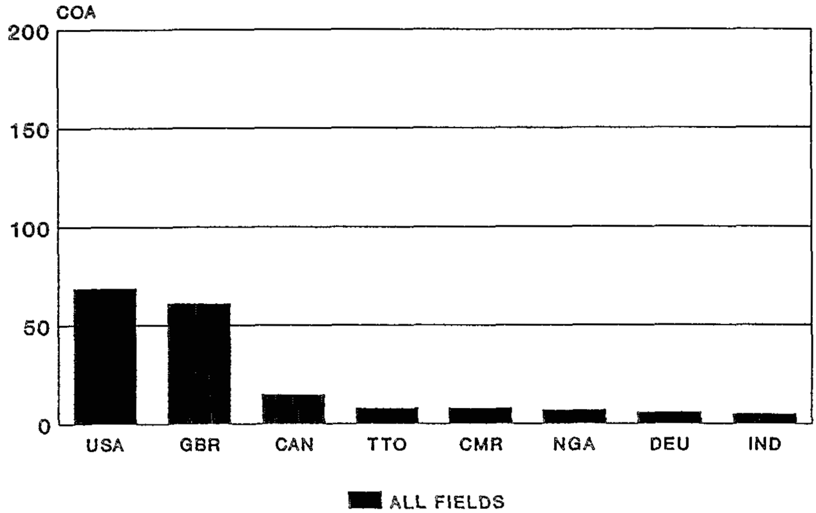
CUBA & THE WORLD
b) IN EIGHT FIELDS (1981-1986)



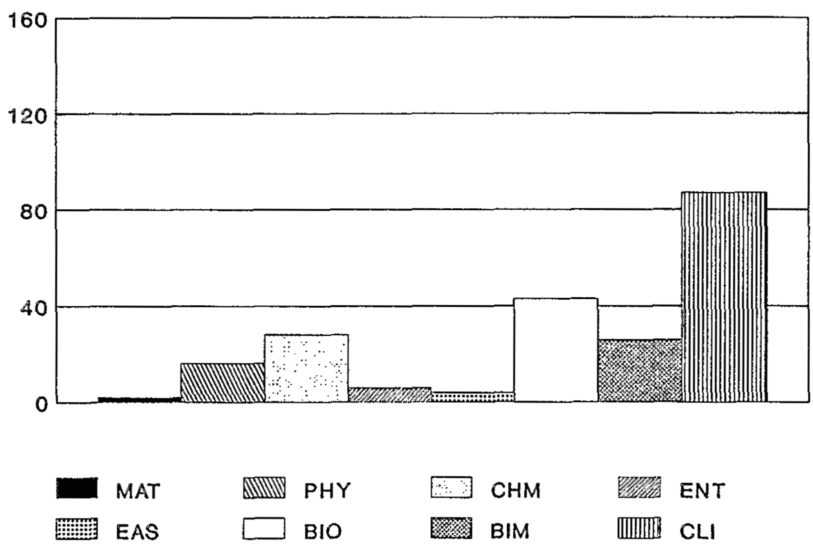
CNRS-LEPI

Fig.6 Coauthorship number (COA), JAMAICA

a) LARGEST PARTNERS, ALL FIELDS, 1981-86

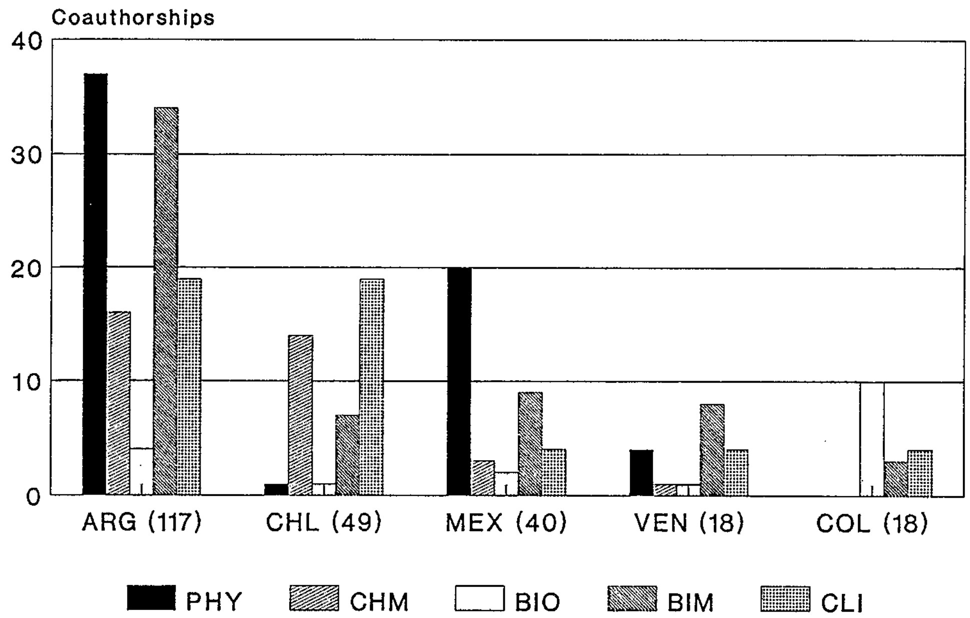


JAMAICA & THE WORLD
b) IN EIGHT FIELDS (1981-1986)



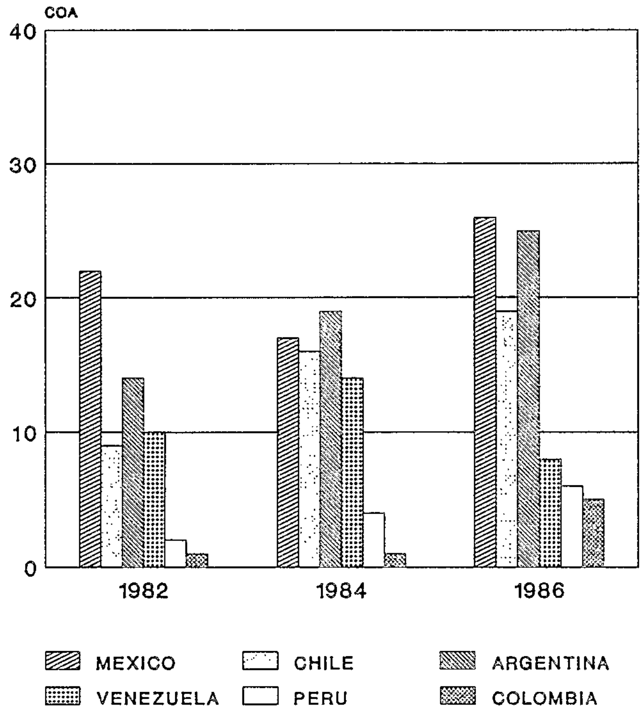
CNRS-LEPI

Fig.7 BRAZIL & OTHER LATIN AMERICAN
COUNTRIES IN FIVE FIELDS
1981-1986



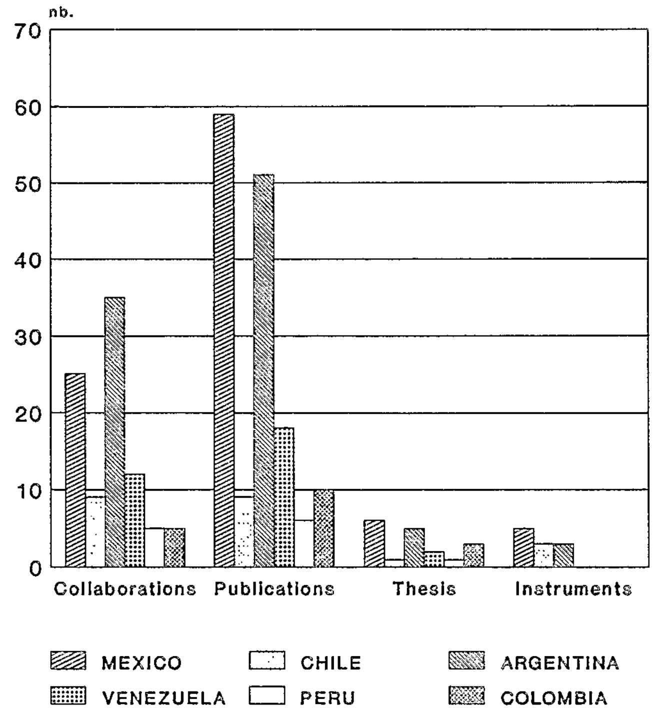
LEPI-CNRS

FIG. 8
FRANCE & LATIN AMERICAN COUNTRIES
ALL FIELDS



CNRS-LEPI

Fig. 9
CNRS AND LATIN AMERICA
RESULTS IN 1989 (ALL FIELDS)



CNRS-LEPI BADIN

INTERNATIONAL SCIENTIFIC COLLABORATION IN ARAB COUNTRIES

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ABSTRACT

International scientific collaboration between 9 Arab countries and with the 8 most productive countries in the world in 8 scientific fields is analysed using the MEV-MAC data base of the Laboratoire d'Evaluation et de Prospective Internationale (LEPI). An analysis of the scientific collaboration between Morocco and France during the year 1984 is also presented. The results obtained are compared with figures derived from a Moroccan data base "CONVENTION" in the field of chemistry.

RESUME

Les collaborations scientifiques internationales entre 9 pays arabes et avec les 8 pays les plus productifs dans le monde dans 8 domaines scientifiques sont analysées en utilisant la base de données MEV-MAC du Laboratoire d'Evaluation et de Prospective Internationale.(LEPI). Une étude des collaborations scientifiques entre la France et le Maroc au cours de l'année 1984 est également présentée. Les résultats précédents sont comparés avec les données contenues dans une base marocaine "CONVENTION" dans le domaine de la chimie.

INTRODUCTION

This study has been undertaken in order to observe the nature of international scientific collaborative activities in a few Arab countries and to draw conclusions about their fields of priority in research. We also attempt to evaluate the credibility of bibliometric methods by means of a study carried out on the international scientific activities of Morocco.

The study has been carried out using the methods developed at the *Laboratoire d'Evaluation et de Prospective Internationales (LEPI),* in order to facilitate the identification and evaluation of international scientific collaborations. The data for this study have been derived from analyses of the MEV-MAC database at LEPI and the CONVENTION base at the *Centre National de Coordination et de Planification de la Recherche Scientifique et Technique (CNR-MAROC).*

I - The MEV-MAC data base (1)

Data in the Science Citation Index (SCI) base of the Institute for Scientific Information (ISI) (Philadelphia, PA, USA), classified into 8 fields in a fixed journal set by Computer Horizons, Inc, has been reclassified by LEPI into a 97-country matrix concerning the six-year period 1981-1986. The SCI database gives listings of all published scientific articles in the over 3000 mainstream journals and indicates the affiliations of all participating laboratories. This enables the identification and counting of participating countries in international scientific collaboration in each of the eight major divisions of science used by the National Science Foundation (NSF), USA: Mathematics (MAT), Physics (PHY), Chemistry (CHM), Engineering & Technology (ENT), Earth & Space (EAS), Biology (BIO), Biomedical Research (BIM), and Clinical Medicine (CLI).

The SCI is a selective data base as it only takes into account international scientific journals whose works have a high citation index. The SCI base is used for bibliographical and bibliometrical research. The CHI treatment shows the classification and distribution of articles in each of the represented countries and fields. New journals are regularly added to the listings, but stable lists are maintained over long periods for statistical analysis. Articles, reviews, and notes are included, whereas editorials, letters to the editor, and presentations of seminar's or conferences are not. Lesser-developed countries have little representation. Journals edited in such countries, publishing articles on natural resources or on technical developments, are often missing from SCI. However, even though the figures obtained from the SCI base concerning lesser-developed countries are incomplete, they indicate trends in international collaboration between lesser-developed and developed countries, the selection of preferred subjects and fields, and the laboratories involved. Moreover, it has been observed from analyses of total production that similar trends exist in lesser-developed countries in their international collaborative works and in the research within these countries. A major proportion of coauthorships between lesser-developed and developed countries stem from collaborative works resulting from prolonged stays in industrialized countries of students doing doctoral theses or postdoctoral studies.

At LEPI, the "MEV" base was initially set up as an interface between partner countries and involved procedures such as the counting of coauthorships and the registering of scientific publications produced from international collaboration. This first phase of MEV, the "MEV-MICRO" base, has, since 1986, registered all international collaborative works involving laboratories at the *Centre National de la Recherche Scientifique (CNRS)* and its partners throughout the world. MEV-MICRO, therefore, is the recording of international scientific collaboration, by researchers, as it happens. The projet memory then becomes a subset of the total of the activities recorded by "MEV-MACRO" two or three years later, the time necessary for international data bases to register and publish their information.

Since the publications of the ISI CD-ROMs, the relationships between the "MICRO" follow-up of collaborative projects and the counting of international coauthorships have become more concrete.

II - Analysis of Scientific production carried out within the framework of international collaboration in the Arab countries which are represented the most in MEV-MAC

In this first section, we analyze the trends of production in international collaboration in the Arab countries which are the most represented in our data base. This will enable us to make comparisons between these countries, in the different scientific fields, and also to compare these countries with the most productive countries in the world.

The nine Arab countries taken into consideration are : Algeria, Saudi Arabia, Egypt, Iraq, Jordan, Kuwait, Libya, Morocco and Tunisia. In this study these countries are referred to by their ISO codes : DZA, SAU, EGY, IRQ, JOR, KWT, LBY, MAR, and TUN. For this we have two tables : (1) the table of the relation of scientific fields and international collaborative projects in the 9 Arab countries for the period from 1981-1986 (table 1); and (2) the table of the relation of scientific collaboration between the 9 Arab countries and the 8 most productive countries of the world, for the same period 1981-1986 (table 2).

TABLE 1. Relation between Scientific Fields and International Collaboration in 9 Arab Countries

COUNTRY	MAT	PHY	CHM	ENT	EAS	BIO	BIM	CLI
ALGERIA	11	69	73	19	15	28	46	101
SAUDI ARABIA	32	101	108	135	63	60	42	163
EGYPT	27	132	283	242	59	244	145	378
IRAQ	7	20	51	41	19	42	35	64
JORDAN	3	38	37	15	14	7	16	23
KUWAIT	26	28	23	48	5	20	31	75
LIBYA	7	12	13	12	10	21	14	14
MOROCCO	11	41	105	19	26	47	29	70
TUNISIA	11	64	155	13	22	31	44	76

CNRS-LEPI MEV-MAC 1981-1986

Table 2. Relations between the 9 Arab countries and the 8 most productive countries in the World.

COUNTRY	USA	GBR	SUN	JPN	DEU	FRA	CAN	IND
ALGERIA	13	8	7	1	3	230	5	27
SAUDI ARABIA	239	149	0	5	21	22	53	14
EGYPT	469	188	11	23	156	102	61	10
IRAQ	52	82	3	7	4	7	10	23
JORDAN	67	32	1	0	19	4	0	0
KUWAIT	70	47	0	2	5	7	26	6
LIBYA	29	20	1	0	4	6	6	15
MOROCCO	38	8	0	0	10	241	4	1
TUNISIA	20	4	0	0	10	314	3	1

CNRS-LEPI MEV-MAC 1981-1986

These tables are difficult to interpret, and the histograms of the fields and of the countries are only significant of parts of these tables. In order to understand the relationships which determine the various elements in their totality, we have used a technique which has become easier to carry out due to the most recent developments in personal computers. This method is the Factorial Correspondence Analysis (FCA) (3, 4), which does not attempt to produce new information from the tables, but aims to facilitate the readings by presenting the corpus of the data in an appropriate graphic (Factorial maps).

It is a method which enables a view of large amounts of information and has the advantage of bringing about more quickly the discovery of new and better formulated questions. This technique brings about a clear extraction of the main elements of information which exist in the table but which remain blurred. Similarities which may exist between various elements of the table also become more visible.

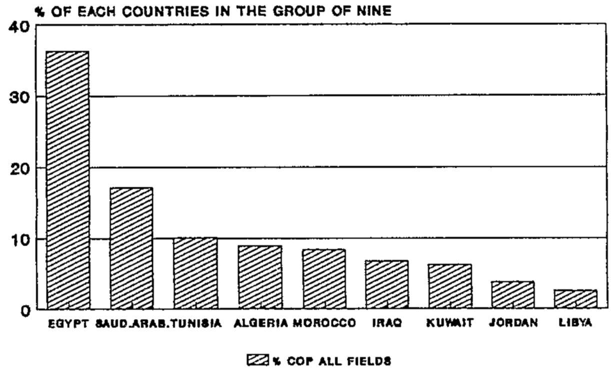
For these factorial analyses we have used a program written by us in Basic (5). In the following factorial proximity maps (6), three rules will help interpretation : 1)The relative closeness of two scientific fields corresponds to the relative similarity of the scientific positions in a group of countries. 2)The relative closeness of two points representing countries corresponds to the relative similarity of the international activities in the two countries. 3)The relative closeness of a point representing a scientific field to a point representing a country corresponds to the relative activity of the country in the scientific field.

Results

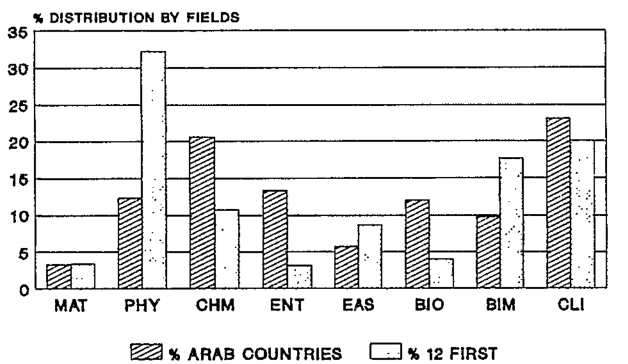
1- The scientific production of Arab countries carried out within the framework of international cooperation in each of the eight divisions or fields :

Firstly we are going to analyze the histograms drawn from the tables concerning the distribution of the nine countries in international scientific collaboration and then we shall examine the proportions in each of the scientific fields.

HISTOGRAM 1
INTERNATIONAL COLLABORATION
IN ARAB COUNTRIES



HISTOGRAM 2
INTERNATIONAL COLLABORATION
ARAB COUNTRIES & THE 12 FIRST PRODUCERS



CNRS LEPI MEV-MAC

In Histogram 1 we see that EGYPT is the most scientifically active country in international collaboration with a percentage of 36.5%. SAUDI ARABIA follows with 17.0%, then the three Maghrebian countries, TUNISIA, ALGERIA, and MOROCCO. IRAQ, KUWAIT, JORDAN, and LIBYA are in last positions.

Histogram 2 shows the relative distribution of the scientific fields. It shows that in international collaboration the scientific field most practiced in the Arab countries is Clinical Medicine (23.3%), followed by Chemistry (20.5%), Engineering (13.2%), Biology (12.1%), and Physics (12.2%). These figures can be compared with the proportions found in the international collaboration of the 12 most scientifically productive countries.

We can thereby see the specific fields of collaboration of the Arab countries. The percentages concerning Chemistry and Engineering are above the average of those of the industrialized countries. The rates in Biology demonstrate the need to exploit natural resources. Lastly, collaboration in Clinical Medicine stems from a necessity of having access to new methods.

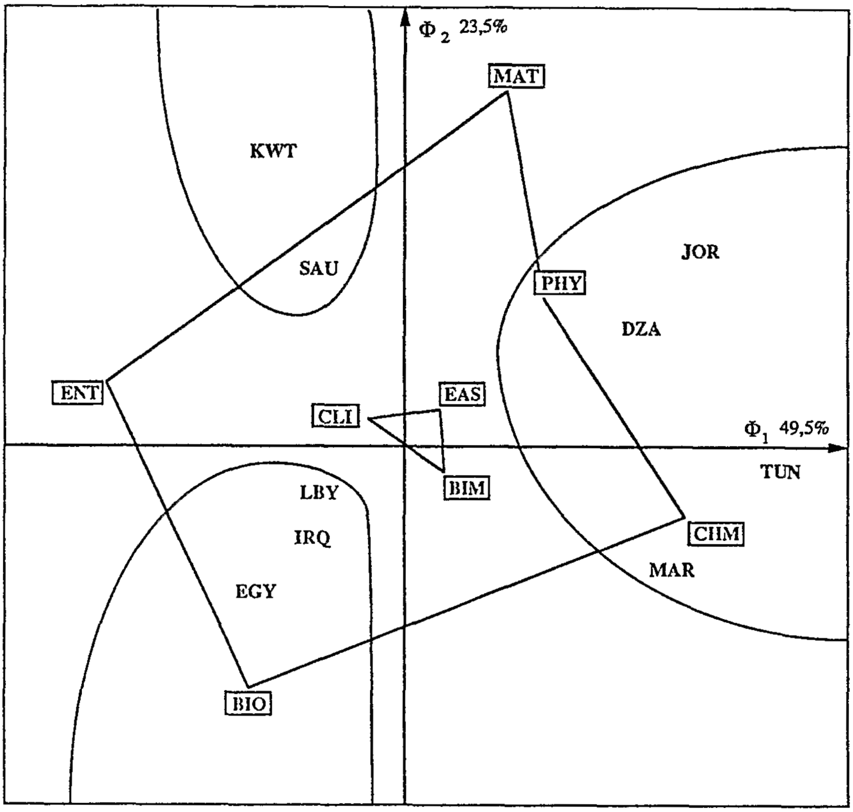
Analysis of factorial map 1 :

The correlation between the scientific fields and the Arab countries with the highest scientific international collaborations in journals selected by the SCI is presented on the factorial map n° 1. Using this 8 dimensional system the AFC brought together into the 5 first factors most of the variance of the system : 97.8%. The first two factors, which enable a plane representation of the correlation under study, alone bring together nearly 73.7% of the total variance. The first factor, Φ1, which unites close to half of the variance (49.6%) is the preponderant element of the organization of the relationship between the Arab countries and the scientific fields.

On the cloud of scientific fields, this factor is mainly dominated by Chemistry (CHM) and Engineering & Technology (ENT). These fields cover respectively 39.6% and 37.9% of the make up of this factor (Absolute Contribution "AC"). They also have a dominant character as they are explained by this factor for 0.84% and 0.87% respectively of their variance for the first factor [Relative Contribution "RC" $Cos^{2}(\Phi n)$]. Physics and Chemistry, having positive coordinates on Φ1,, are associated. They are opposed to Engineering & Technology and to Biology which have negative coordinates on this axe.

On the country cloud, the factor of Φ1, is mainly controlled by Tunisia (AC=43.5%, RC=0.94), Morocco (AC=11.8%), Jordan (AC=7.2%), and Algeria (AC=6.4%). These different countries are projected onto Φ1, with positive coordinates. They are therefore strongly tied to Chemistry and Physics and they are anticorrelated with research in Engineering & Technology.

The second factor Φ2 unites more than 24% of the total variance. It is dominated by Biology (with an "AC" of 37.3% and a "RC" of 0,67), by Physics (AC=25.9%, RC=0,47), and by Mathematics (AC=22.6%, RC=0,49). Biology with its negative coordinates is opposed to Physics and to Mathematics.



Factorial Map n° 1

COLLABORATION between Arab countries
and their partners in the world
in the 8 scientific fields

CNRS - LEPI MEV - MAC 1981 - 1986

On the country plane, the second factor is concerned with Egypt (AC=30.9%, RC=0,51), Saudi Arabia (AC=27%, RC=0,48), Kuwait (AC=20.0%, RC=0,30), Iraq, and Libya. Egypt, Iraq, and Libya, with their negative coordinates on axe Φ2, are strongly tied to Biology. Kuwait and Saudi Arabia, with their positive coordinates, are strongly related and share their preferences between Engineering & Technology and Mathematics.

The scientific fields Clinical Medicine, Earth & Space, and Biomedicine are close to the origin of the axis, which means that these fields, although of a variable relative importance, are also practiced, and show a good equilibrium within the different Arab countries.

2- The correlation between 9 Arab countries and the 8 most productive countries in the world

In analyzing TABLE 3, we note that the collaboration of the group of Arab countries with each of the 8 countries is distributed as follows : 33.0% with the USA, followed by FRANCE (31.0%), UNITED-KINGDOM (17.8%), WEST GERMANY (7.6%), and CANADA (5.5%). JAPAN, INDIA, and the USSR tail behind as they collaborate little with the Arab countries.

The total participation of each of the 9 Arab countries (TABLE 4) shows that the countries are in the same order in international collaboration and in the distribution of total production for each scientific field.

Table 3. Collaboration between the group of Arab countries and each of the 8 most scientifically productive countries

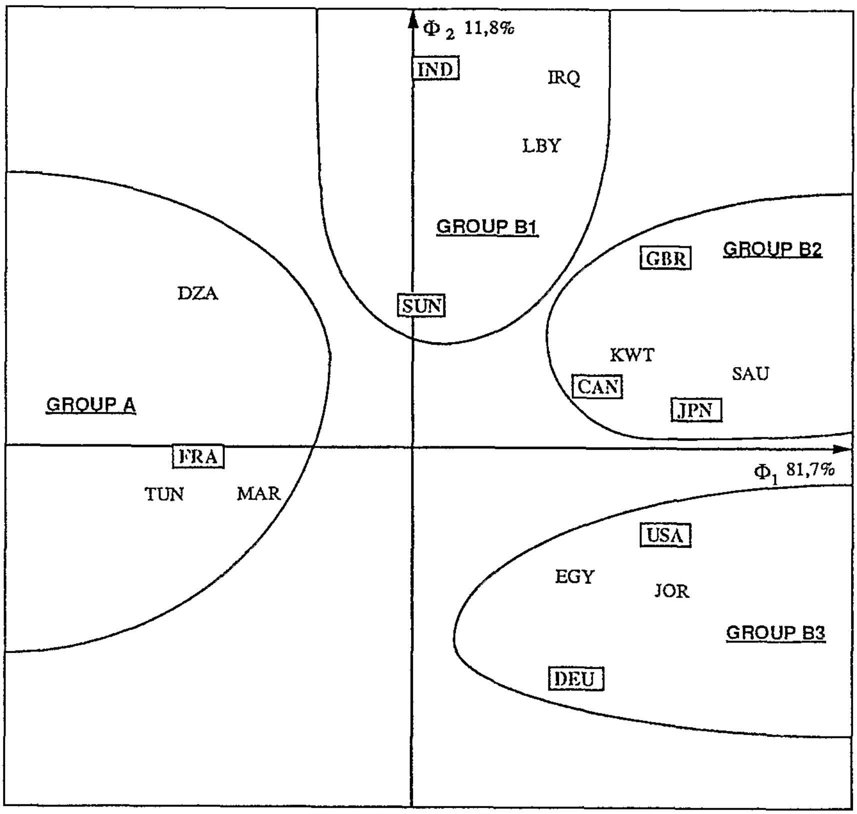
Country	Distribution in %
USA	33.0
FRA	31.0
GBR	17.8
DEU	7.6
CAN	5.5
IND	3.2
JPN	1.2
SUN	0.7
Total	100.0

Table 4. Distribution of total international collaborative production among each of the 9 Arab countries

Country	Distribution in %
EGY	36.5
SAU	17.0
TUN	10.0
MAR	8.4
DZA	8.8
IRQ	6.8
KWT	6.2
JOR	3.8
LBY	2.5
Total	100.0

Analysis of the factorial map 2 :

Group A strongly ties ALGERIA, MOROCCO, and TUNISIA to FRANCE. This result is not surprising due to the history of Franco-Maghrebian relations and also due to the role FRANCE plays in training Maghrebian researchers, who often continue in their relations and collaboration with French researchers once they return to their countries.



Factorial Map n° 2

COLLABORATION between 9 Arab countries
and the 8 first science producers in the world
All fields combined

Group B1 includes IRAQ, LIBYA, INDIA, and the USSR.

Group B2 links SAUDI ARABIA, KUWAIT, GREAT BRITAIN, CANADA, and JAPAN.

In Group B3 the USA, EGYPT, and JORDAN are brought together with specific links between Egypt and Germany.

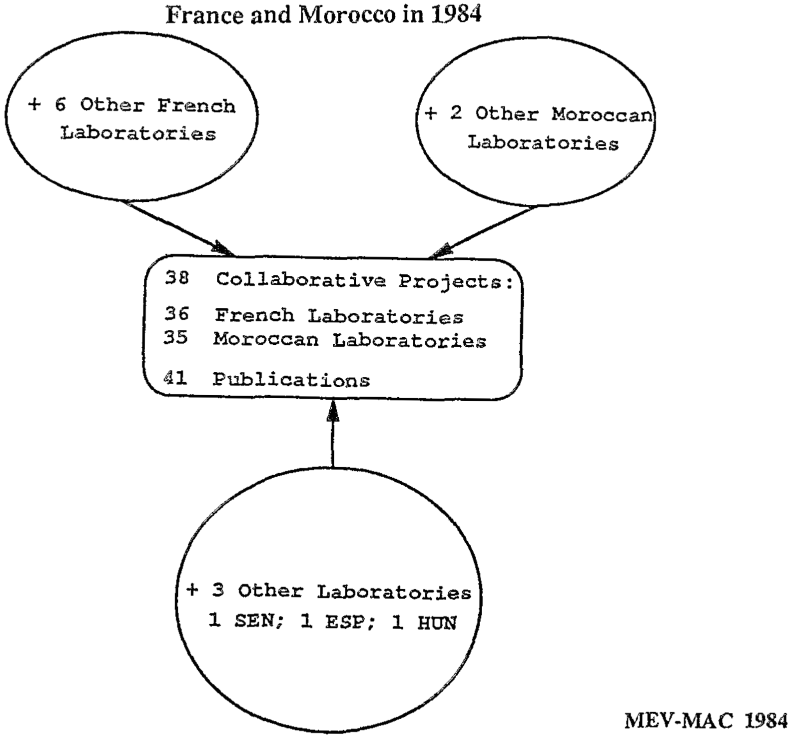
III - Analysis of the Scientific collaboration between MOROCCO and FRANCE during the year 1984

We found the collaborating laboratories by means of the co-authored articles registered in the SCI base and treated by CHI in 1984. Each publication was obtained from the INIST (l'Institut National de l'Information Scientifique et Technique, Nancy-France). These publications illustrate, in each scientific field, the collaborative projects between MOROCCO and FRANCE and the names of the researchers and laboratories involved. We catalogued the publications co-authored in 1984 between MOROCCO and FRANCE, and classified them into scientific fields and into Moroccan cities of origin (see appendix 1 for Chemistry).

Results

We see in figure 1 that MOROCCO had 38 projects with FRANCE, resulting in 41 publications. For fields such as Mathematics and Earth & Space, this collaboration was sometimes multilateral and involved other countries : SENEGAL, SPAIN, and HUNGARY also co-signed.

Figure 1
Partners in 38 collaborative projects between
France and Morocco in 1984

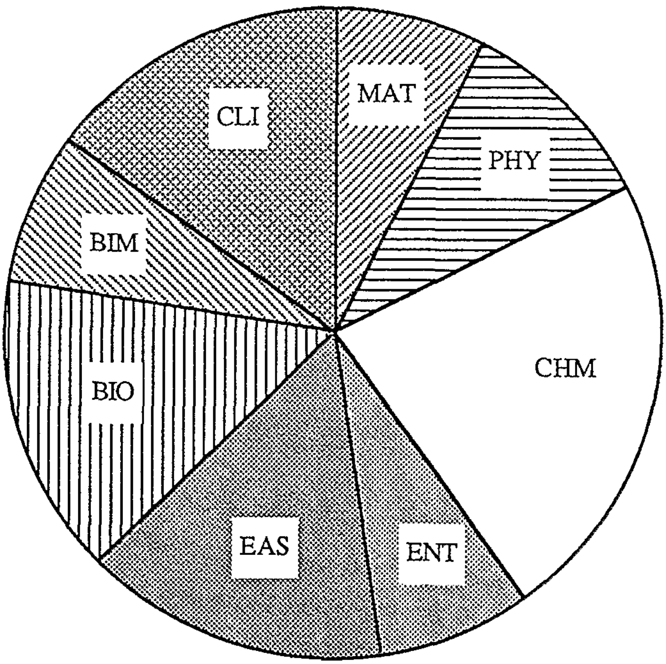


In Figure 2, we note that co-publication was most important in Chemistry with a proportion of 22.5%, followed by Earth & Space, Biology, and Clinical Medicine with proportions of 15%, Physics with a proportion of 10%, and Mathematics and Biomedicine coming last with proportions of 7.5%.

Figure 2

Distribution of "COAs" co-publications between France and Morocco

MEV-MAC 1984

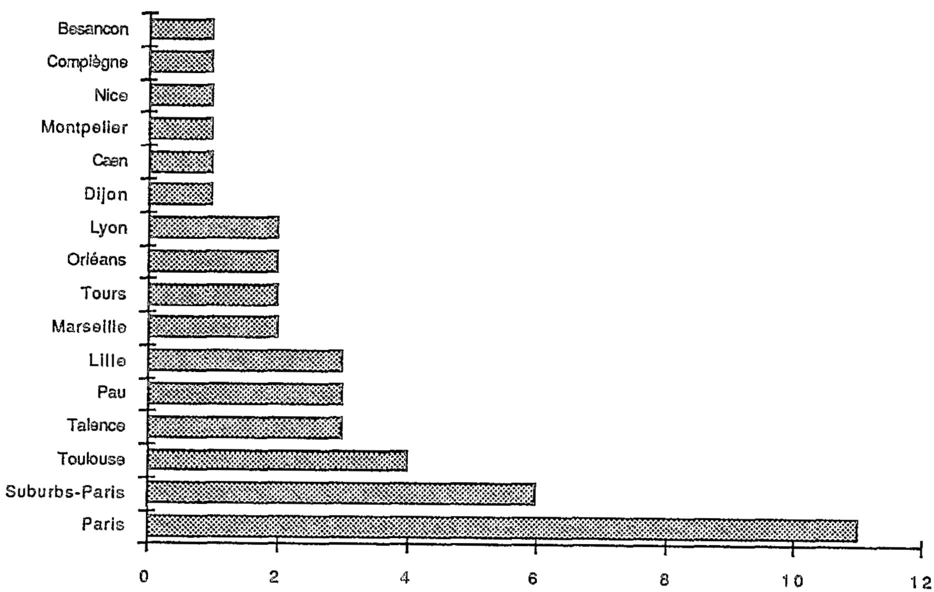


41 Publications

We also wanted to see if geographical location had an influence on the Moroccans' choices of French cities. The answer is demonstrated in Figure 3. We note that the distribution is in relation to the scientific size of the city as well as to traditions and to university relations.

Figure 3

The participation of french cities in co-publications
in the "SCI" base journals
between France and Morocco in 1984



IV - Comparison of the above results to data from a Moroccan data base and to a survey of Moroccan researchers

This section will show the representativity of the figures obtained from the SCI base concerning Morocco. In order to bring this about we tapped information from the Moroccan data base "CONVENTION". It lists and describes all the publications emanating from researchers having proposed research topics within the framework of the exchange agreement between the *Centre National de Coordination et de Planification de la Recherche Scientifique et Technique (CNR-MAROC)* and the *Centre National de la Recherche Scientifique et Technique (CNRS-FRANCE).* From this base we chose Chemistry, the most active area of research in Morocco. We also chose the year 1984, the year for which we obtained publications from original articles.

Through this research we found 24 articles in Chemistry in scientific journals for the year 1984 in addition to the 9 articles listed in SCI, without considering international conferences. Following is the list of these 24 articles, classified according to whether or not the journals in which they were published are retained in the SCI base.

Articles published by Moroccans in journals in the SCI base, not identified in the 1984 listing:

1) Inorg. Chem., 2) J. Soc. Chem., 3) Tetrahedron lett., 4) Bull. Soc. Chem. Bel., 5) Phys. Stat. Sol., 6) J. Chem. Research (S), 7) An. Chim, 8) J. de Chimie Physique, 9) Journal of Heterocyclic Chem., 10) J. Solid State Chemistry, 11) Tetrahedron letters, 12) Ferroelectrics, 13) Bull. Soc. Chim. France, 14) Nucleosides and Nucleotides, 15) Ferroelectrics, 16) Organometallics, 17) Polyhedron.

Articles published by Moroccans in journals not listed in the SCI base :

1) Science and Engineering, 2) Phytotherapia, 3) Parfums Cosmétiques et Arômes, 4) Bull. Soc. Brot., 5) Revue des Sciences de l'Eau, 6) Mat. Res. Bull., 7) Le Pharmacien du Maghreb.

Survey of Moroccan researchers

In order to explain this important difference in the publications, we carried out a survey questioning the researchers involved. We were able to determine that there were two categories of researchers : those who published in SCI-listed journals and those who published in journals which they thought to be of quality, even though they were not in SCI.

In the first case, the absence of these articles in SCI in the listed "international co-authorships" results from the non-affiliation of the Moroccan laboratories. The names of the Moroccan researchers in the publication are attributed to the French laboratory followed (and not always) by the mention : 'on leave from'.

Because of the fact that the selection of collaborative works in SCI is based on the address appearing in the title of the publication, the non-mention of the affiliation of the Moroccan laboratories leads to the exclusion of these laboratories from the list of international co-authorships.

This situation should urge laboratories participating in international collaboration to identify themselves. In the above described situation <u>both laboratories</u> and <u>both countries</u> involved in a collaborative work lose the accreditation of an international publication in bibliometric studies. One recommendation could be made, that each partner identify himself by mention of the address of his laboratory.

As for the journals not listed in the SCI base, the problem is of a different nature. It is directly related to problems that have lead to this conference : the absence of a specific data base on studies concerning developing countries. The criteria of selection of articles, based on the choices by internationally represented committees of referees, should be kept. Traditional criteria for mentioning participants should not necessarily be the same in this case and could be replaced by regulations that this meeting could suggest.

We also wanted to know if Moroccan journals are represented in the 3500 journals recorded by the SCI base. Of the 153 Moroccan journals, a majority of which have an internationally normalized "ISSN" number and are therefore internationally recognized, none are taken into consideration by the SCI base. Researchers publish articles in local journals in order to facilitate distribution within Morocco.

This confirms the conclusions of a study by J. GAILLARD (7) on the misinterpretation of the representation of third world countries in world science. When observers state that science in the third world does not represent more than 5% of the international production, allusions are made to international data bases that are very selective in their choice of scientific journals. Out of seventy thousand scientific journals, only three thousand five hundred are included in the SCI base. Therefore an incomplete image of the participation of third world researchers is given.

CONCLUSION

Third world countries participate actively in international collaboration but are poorly represented in the bibliometric bases most frequently used by the large scientific countries. Bibliometric studies must be interpreted cautiously, especially when describing scientific research or when making decisions concerning third world countries. However the SCI data base may be used for the analyses of international collaboration provided that each scientist clearly mention his/her affiliation.

We recommend that: 1) When two countries work together, each partner should identify himself through his laboratory of origin when an article is published. Otherwise the collaborative work could result in wasted effort for both countries; 2) Every developing country should create its own data base, and the data in such a base should be acquired from surveys of all of the establishments concerned within the country. After being identified, the data should be registered into an international base in order to enable exchanges between countries. This last recommendation is for the development of a specific data base.

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COOPERATIVE RESEARCH PROJECTS BETWEEN THE SPANISH NATIONAL RESEARCH COUNCIL AND LATIN AMERICAN INSTITUTIONS

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ABSTRACT

Research projects in cooperation between Spanish National Research Council and Latin-American Organizations, that have been developed in the last eight years, were studied. Around forty Spanish research institutes have cooperated with Latin-American ones, mostly with Cuba, Argentina, Chile, Brazil and Mexico. The interpretation of the collaboration rates with the different countries are discussed. Duration of the projects, number of researchers and research output were examined. The cooperation results were quantified through articles, presentations to congresses, reports, monographs, patents and thesis. Diffusion, languages and impact of the journals used for publication were studied. Non quantifiable outputs were also examined.

RESUME

Les projets de recherche coopératifs entre l'Espagne et l'Amérique latine, développés dans les huit dernières années, sont étudiés. Environ quarante institutions de recherche ont collaboré avec des institutions latino-américaines, essentiellement avec Cuba, l'Argentine, le Chili, le Brésil et le Mexique. Les taux de collaboration avec les divers pays sont analysés. La durée des projets, le nombre de chercheurs et la production scientifique sont examinés. L'effort de coopération est quantifié à partir des articles, des présentations à des colloques, des rapports, des monographies, des brevets et des thèses. La diffusion, la langue de travail et l'impact des journaux utilisés sont étudiés. Certains output non quantifiables sont également mentionnés.

INTRODUCTION

Presently there is a great interest on research projects in cooperation, both North-South cooperation, regional cooperation or with developing countries, as collaboration is supposed to enhance the quality of the research results and help diminish the technological and scientific gaps. There is a need to measure and evaluate the effects of this cooperation, what benefits it reports, both tangible and intangible. The tangible effects can be evaluated quantitatively and qualitatively, while the intangible ones, like the socio-economic effects of cooperation, are more difficult to measure.

International collaboration in research can be estimated through different partial indicators: such as the number of researchers exchanged between two countries, number of fellowships for foreign researchers, exchanges of ideas at congresses, dissertations, co-authored papers, etc. This latter indicator is the easiest to obtain through those bibliographic databases that record all the authors and their institutional addresses: the Science Citation Index as multidisciplinary and some other subject-oriented databases like Physics Briefs or INIS. Nevertheless, two important shortcomings have to be kept in mind when using this indicator: a) the number of multinationally authored papers is only a partial indicator that shows an apparently equivalent contribution of both cooperating countries, which is not always the case, and b) the validity of the results obtained especially for less developed countries is limited in accordance to the local publications' coverage by the database used, which is very low in the case of SCI (1).

Co-authoring of scientific papers between different sets of countries was studied by Frame and Carpenter (2) using the SCI database, and later by Schubert and Braun (3) and by the French LEPI group (4).

The quality of the resulting publications is difficult to determine; peer review is the traditionally used method. Other controversial indicators relate quality to the impact factor of the publication journal or to the number of citations received by the article itself. Both these indicators depend on the opinion of the international scientific community and can be considered as a measure of visibility or impact of mainstream science. Local publications, dealing with non mainstream problems, should be evaluated differently. When analysing the number of citations received by multiauthored publications, Narin observed (5) that impact increased from single to multiple-institution papers, and doubled in the case of multinational papers.

The European Community (EC) is promoting scientific cooperation projects in Europe to try to foster the development of less favoured regions. Indicators applied are : number of co-authored papers between researchers of different countries, study of the factors determining this cooperation and impact of the resulting publications. In the case of EC agricultural research projects, indicators for science policy evaluation used were international co-authorship in scientific publications and awareness of scientists through citations (6).

Another aspect studied is whether cooperation takes place in those subjects of direct interest for the peripheral countries or if it follows the central countries' interests. This was studied by one of us in the case of OECD cooperation in Physics (7).

The Spanish National Research Council (CSIC), a research institution that covers very different areas of knowledge, has established scientific agreements with many different countries and in many cases they have acted as a frame for the development of joint research projects. Among these projects, those with

Latin-American countries present a special interest due to our common culture and language. Recently the CSIC has decided to create a database with the on-going cooperative research projects with Latin-American countries in the last eight years. It contains information on the subject of the projects, summary and objectives, countries involved, institutions, scientific personnel, duration of the projects and different outputs obtained, as well as qualitative data on benefits derived from the joint projects and problems found. This database will be a useful tool to study scientific cooperation between different institutions and countries, to determine which disciplines are involved, as well as to analyse the results obtained from the cooperative effort.

At present, no evaluation of the results of the projects is being made, as the results obtained are not compared with the project's goals nor the economic and material resources involved. This will be only a first series of data and analysis obtained from the 94 projects now included in this new database, that can be used in the future by science policy makers.

METHODOLOGY

The data on the 94 cooperative projects between Latin-American institutions and CSIC have been obtained by its International Department through sending a questionnaire to the principal Spanish researchers responsible for the projects. Full information from the Spanish side of the projects was thus obtained. With the results of the questionnaires several related files in DBaseIV were created.

ANALYSIS OF THE PROJECT INPUT DATA

Countries

The Latin-American countries involved in the projects are shown in table 1. The country with which more projects have been developed is Cuba (26 projects), followed by Argentina with 21, Chile with 20, Brazil and Mexico with 13 each and Colombia with 1 project.

Institutions

The Spanish institutions are mostly institutes belonging to the CSIC, joint university-CSIC centers or some university departments sponsored by the CSIC. As a whole, 38 Spanish institutions are responsible for the 94 joint projects. In table 2 the most active of them are shown: an Institute on Catalysis, with ten projects, followed by centers working on Earth Sciences and Agrochemistry.

Table 1. Countries participating in the projects

Country	Number of projects
Argentina	21
Brazil	13
Chile	20
Colombia	1
Cuba	26
Mexico	13

Table 2. Spanish Institutions responsible for 4 or more projects

Spanish Institutions	Number of proiects
I. Catálisis y Petroleoquímica	10
Estacion Exp. "El Zaidín"	7
I. Agroquím. y Tecn. Alimentos	6
C. Investigacion y Desarrollo	6
I. Edafología y Biol. Vegetal	5
C. Investigaciones Biológicas	5
C. Nac. Invest. Metalúrgicas	4
M. Nac. Ciencias Naturales	4

As for the Latin-American institutions involved, they depend on how research is organised in each of the countries: they are mostly Universities, National Research Councils or Ministries in the case of Cuba (table 3).

Table 3. Latin American Institutions participating in the projects

Country	University	Acad. or Res. Council	Joint Centers	Ministries	Others
Argentina	2	9	8	1	1
Brazil	10	3	-	-	-
Chile	20	-	-	-	-
Colombia	1	-	-	-	-
Cuba	7	2	1	16	-
Mexico	10	3	-	-	-

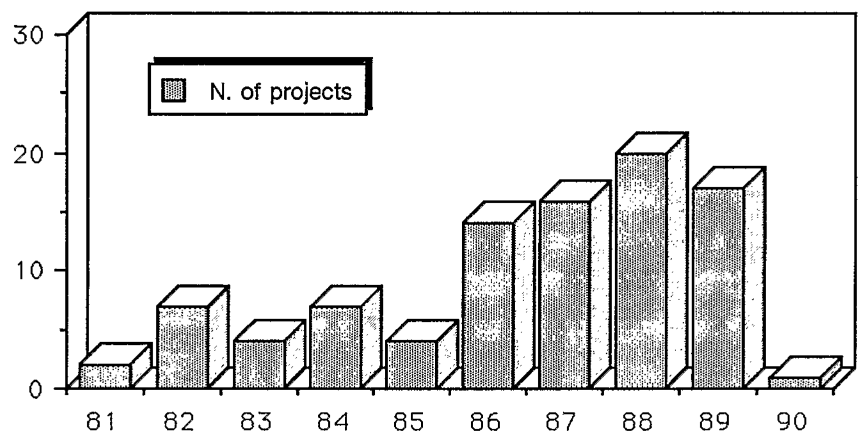
Scientists

The number of scientists participating in the projects, according to the data obtained, was 327 Spanish scientists and 363 from Latin America. The mean number of scientists per project was around seven. In some cases, the same people participate in several projects along the eight year period studied: one Spanish scientist took part in 5 projects, two in 4 projects, one in 3 and eight scientists took part in 2 projects each.

Time length

All the 94 cooperation projects analysed have started along the past eight years, with a clear increase from 1986 onwards: as can be seen in figure 1, 14 projects started in 1986, 16 in 1987, 20 in 1988 and 17 in 1989.

Figure 1. Starting year of the projects



The mean length of the projects has been of around four years, although this parameter changed a lot: the longest project has been developed along the whole time-period studied, while there are others that have just started in 1990.

Subject

According to the UNESCO subject classification (8), 90 of the 94 joint projects were included in science and technology scientific fields, while only four belonged to social science and documentation, as shown in table 4. As a rule, all of the countries involved had projects in the technological sciences and all but one in physics. According to the type of research, technology, agriculture and earth sciences represent very applied and local interests, while physics and life sciences are mainstream subjects. The low figure for medical projects is due to the lack of this research activity in the CSIC.

Table 4. Distribution of the projects by scientific field

Scientific field	Number of projects
Technology	20
Physics	16
Life Sciences	16
Earth and Space Sciences	14
Chemistry	11
Agriculture	6
Mathematics	4
Social Sciences	4
Astronomy	2
Medicine	1

We tried to analyse if any correlation existed between the scientific potential of Latin-American countries and their cooperation rate with the CSIC. The scientific output of the countries involved was obtained from two multidisciplinary databases in science and technology: the international database SCI and the Spanish database ICYT (table 5).

Table 5. Comparison between projects and papers recovered by two databases

Country	N. projects S & T	N. public. SCI 81-89	N. public. ICYT 80-88
Argentina	21	14.311	418
Brazil	13	17.945	45
Chi le	20	7.831	215
Colombia	1	864	22
Cuba	26	711	108
Mexico	13	8.682	94

With these databases we could only obtain a limited view of Latin-American scientific output, as SCI records only mainstream science and ICYT only Spanish journals in science and technology: thus no local publications are detected. No good correlation for the total data was found, but the four countries with a higher number of publications in SCI, Brazil, Argentina, Mexico and Chile, have quite an important number of cooperation projects too, as could be expected. The absence of Venezuela is striking, considering its research output. The case of Cuba is quite different: in spite of its small production in the SCI it is the country which has the most projects with the CSIC.

The scientific production of these countries in the ICYT database is different: Brazil has a very small number of papers, probably due to language barriers, as the database covers only Spanish journals, while Cuba has a greater production than Mexico.

The distribution of the cooperation projects is influenced partly by the scientific potentiality of the countries involved and partly by human and historical factors, for example scientists with a greater interest in cooperating with foreign colleagues. The political isolation of Cuba from its strong neighbour, the USA (the most frequent partner of Latin America in co-authored papers), has probably enhanced its cooperation with Spain and its publishing in Spanish journals.

Output data

The output quantifiable results obtained from the cooperation projects have been grouped under the following headings: scientific papers, contributions to congresses, reports, monographs, patents, dissertations and conferences. Under contributions to congresses both abstracts and proceedings have been included; thesis include both masterr's and PhD dissertations; conferences include several long specialized courses.

Most of the results obtained are scientific papers (435) followed by contributions to congresses (333), as shown in table 6. The results related to teaching are quite abundant: 156 conferences and courses and 46 dissertations have been produced. Several projects were specifically aimed at the organization of specialized international courses: two with Mexico on agricultural chemistry and computer science, others with Brazil and Cuba on molecular pharmacology.

Table 6. Output of the projects by document type

	paper	cong.	report	mon.	pat.	thesis	conf.	TOTAL
Argentina	65	73	15	7	-	4	17	181
Brazil	52	28	1	3	-	1	6	91
Chile	236	138	8	10	-	31	29	452
Colombia	4	4	-	-	-	1	-	9
Cuba	44	72	35	10	-	3	36	200
Mexico	34	28	1	3	1	6	58	131
TOTAL	435	333	60	33	1	46	156	1 064

Only one patent was obtained in spite of there being 20 projects classified as technological sciences, but these technological projects, together with earth sciences have originated 60 reports and a big proportion of the monographs. The majority of the technological projects aim at solving local problems and many of them were immediately applied by the local industry, as expressed by some of the researchers.

Table 7. Output of the projects by scientific field

	Argentine	Brazil	Chili	Colombia	Cuba	Mexico	Total
Technology	16	8	86	9	76	27	222
Physics	10	5	34	-	18	8	75
Life Sci.	34	-	211	-	12	32	289
Earth & Space	77	11	1	-	14	50	153
Chemistry	28	21	30	-	38	-	117
Agriculture	1	-	90	-	4	-	95
Mathematics	15	3	-	-	-	5	23
Social Sci.	-	-	-	-	38	-	38
Astronomy	-	12	-	-	-	9	21
Medicine	-	31	-	-	-	-	31
TOTAL	181	91	452	9	200	131	1064

Results per scientific field show that life sciences is the most productive field, mostly due to Chilean projects (table 7). Another important field is technology (projects with Chile and Cuba), together with earth sciences and agriculture.

When analysing the results per project, the mean number of results of all kinds obtained was little over 11; the most productive project was the one of the life sciences carried on with Chile with 148 results; it lasted the whole period of time studied and many scientists were implied.

Taking into account the time period and number of scientists involved, the productivity of the projects can be determined: a maximum of 2.2 results per year and scientist implied are obtained, while the mean is around 0.4.

Journals of publication

Nearly half of the results are scientific articles, the type of output easiest to detect through databases and to evaluate as to its scientific impact. A total of 435 articles have been published in 202 different scientific journals. In table 8 a rank order listing of those journals where 4 or more articles were published is shown. As many different subjects are covered, a great dispersion in the titles is observed.

Two main topics are present: life sciences, where the most productive projects are classified, published in mainstream journals; the second topic is agriculture and soil science, a very interesting topic for developing countries, published in Spanish language, mostly in Spanish or local journals, in accordance with their local interest (9).

Table 8. Journals more frequently used and coverage by two databases

Journals	N. Art.	SCI	ICYT
CELL BIOL. INT. REP.	19	x	
AN. EDAFOL. AGROBIOL. (Spain)	13		x
GENETICA	11	x	
ACTA BIOL. LEOPOLD. (Brasil)	10		
APPL. CATAL.	10	x	
AY. PROD. ANIM. (Chile)	10		
EUR. J. CELL BIOL.	10	x	
REV. AGROQUIM. TECNOL ALIMENT. (Spain)	8		x
CYTOBIOS	7	x	
EXP. CELL RES.	7	x	
MONOGR. MED. VET. (Chile)	6		
PROTOPLASMA	6	x	
REV. CIENT. TEC. AGRIC. SER. ARROZ (Cuba)	6		
ASCLEPIO (Spain)	5		
BIOL. CELL	5	x	
J. CELL SCI	5	x	
MUTAT RES.	5	x	
REV. METAL.	5		x
REV. MEX. ASTRON. ASTROFIS (Mexico)	5	x	
AGROCHIMICA	4		x
ALIMENTOS (Chile)	4		
CHROMOSOMA	4	x	
ESTUD. GEOL. (Spain)	4		x
ENOME	4	x	
J . CATAL .	4	x	
REV. CAMPO	4		

The diffusion of the journals in SCI and ICYT is analysed, as both these databases deal with science and technology fields. From all 202 journals used, 112 are covered by SCI and 20 by ICYT. Considering the total number of articles produced, this means that 55% of the articles are recorded by the SCI, 14% by ICYT and the rest, 31% is not recorded by any of the two. None of these journals are covered by both databases, as the SCI covers only very few Spanish journals, having a clear English language bias.

As for the country of publication of the journals used: 55% are "mainstream" international journals from USA and several European countries, while 23% are Spanish journals and 22% come from the Latin-American countries. Only one of these Latin-American journals is covered by SCI. These results agree with those of the Philadelphia Workshop (1): Third World Science is under-represented in international databases, in particular SCI, and only half of the output of developing countries of international level of excellence is included in this database.

Other non-quantifiable output results

Moreover, there are many other non quantifiable benefits that result from this scientific collaboration. According to the answers to the questionnaires they would be the following:
- cultural impact, with the advantage of having a common language, or a very related one in the case of Brazil,
- networking effects between scientists, relationships between partners have clearly changed before and after the project, casual contacts have changed into permanent collaboration and co-authoring; attendance to congresses has also contributed to this network
- transfer of knowledge between groups involved and towards industry, complementary points of view
- mobility of researchers
- training of human resources has been a very important result, through working together in the joint projects, courses and dissertations; several projects were especially focussed towards the organization of international courses.

Among the shortcomings of these collaboration projects, the following were pointed out:
- the scarce economic aid has been the most usually mentioned; too short visits were sponsored and scientists had to use funds from other sources,
- bureaucratic problems
- technical difficulties in communication with Latin-American partners, enhanced by the big geographical distance.

FINAL REMARKS

The creation and updating of this database on cooperative research projects can be useful in different ways. The scientific policy makers of the CSIC will be able to follow and evaluate these projects if, together with the present information on project length, subject and type of the research, scientists and institutions involved, tangible and intangible results, also data on economic and material resources are introduced in the data-base.

Another interesting feature is the possibility of determining adequate fields for future cooperation with all Latin-American countries. The scientific policies of these countries should be compared to that of Spain in order to determine in which fields we can collaborate and which are the topics of converging interests. This type of research on social sciences would help to bridge the "research gap" between Academy, public decision-making and industry, an important necessity especially in less developed countries, as highlighted by Vessuri (10), and would give a better distribution of the always scarce human and economic resources devoted to research.

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THE INTER-AGENCY DEVELOPMENT RESEARCH INFORMATION SYSTEM

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ABSTRACT

The Inter-Agency Development Research Information System (IDRIS) is a database containing information on research projects supported by a number of development aid (donor) organizations. Some 7,000 research projects are described--all for the benefit of developing countries. The scope of research is: agriculture, fisheries, forestry, health, education, information, environment, social issues, women in development, economic issues, and industry. The system is hosted by IDRC, Canada, which together with the other participating agencies, is committed to expanding participation/and or making the contents of the database available to agencies, institutions, and researchers interested in Third World research activities. The database may be accessed on-line and is available on tape or diskettes in a number of computerized formats.

RESUME

Le Système d'Information Inter-Agences de Développement (IDRIS) est une base de données qui contient des informations sur les projets de recherche financés par un certain nombre d'institutions d'aide au développement. Quelques 7.000 projets sont décrits. Les domaines de recherches couverts sont l'agriculture, la pêche, les ressources forestières, la santé, l'éducation, l'information, l'environnement, les sciences sociales, les femmes dans le développement, les questions économiques et l'industrie. Le système est situé dans les locaux du CRDI au Canada, qui est chargé, conjointement avec les autres agences participantes, à la diffusion du contenu de la base auprès d'organismes, institutions et chercheurs interessés par la recherche sur les pays en développement. La base de données est accessible en ligne et est disponible sur bandes et disquettes sous différents formats.

INTRODUCTION

The Inter-Agency Development Research Information System (IDRIS) is a database containing information on research projects in or for, developing countries. The information is entered by the donor organizations[1] (bilateral or non-governmental in structure) that fund the research projects.

The decision to create IDRIS was taken in 1983 by five donor organizations.[2] The initiator and sponsor of the database, IDRC, had the necessary technical expertise in the area of computerization and offered its mini-computer as the site for the data storage. The advent of telecommunications allowed the other agencies to access the database via a modem and a terminal.

The decision to contribute information to a common database had ideological aspects as well. The agencies recognized that project funding in, or for, developing countries often occurred in isolation. Donors, like the researchers they were funding, were in danger of recreating the wheel.

As of today's date, IDRIS contains information on 7,000 research projects of recipients in 106 developing countries. The database is growing at an annual rate of 850. Much of this information is available nowhere else.

The sectors of research are: agriculture, forestry, fisheries, environment, health, industry, information, education, social issues, and women in development.

The information is organized in such a way as to give an overview of the research activity. Each research project funded by an agency represents for IDRIS a unique record. So when we speak of 7,000 research projects, it is the same thing as saying that the database has 7,000 records.

A schematization of the database structure shows that each record is broken into three major areas: funding, the recipient, and the research. Besides indicating the total funding of the project, the information included is funding by fiscal year, the year funding started and the year it ended.

The block of information on the recipient includes the name of the researcher, the name and location of his or her institution, and a free-form address.

Research project information includes the title of the project, an abstract, keywords describing the research and the geographic area, and documents produced. The software used is in the ISIS family and includes MINISIS and CDS-ISIS, both of which are in widespread use in developing countries, in documentation centres and libraries. The software is menu-driven and can be characterized as a generalized information storage and retrieval system for the computerized management of structured non-numerical databases.

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[1] At present, the organizations participating are: International Development Research Centre (IDRC), Canada; International Foundation for Science (IFS), Sweden; Swedish Agency for Research Cooperation with Developing Countries (SAREC), Sweden; Board on Science and Technology for International Development (BOSTID); the Netherlands Universities Foundation for International Cooperation (NUFFIC); the German Appropriate Technology Exchange (GATE), the Japan International Cooperation Agency (JICA), and the United Nations University (UNU).

[2] The organizations mentioned in footnote 1 except JICA and UNU.

IDRIS RECORD

Donor Funding
Fiscal Year , Year Started, Total FundingYear Ended
The Recipient
Researcher Institution, Full Address
Research Project
Title Abstract, Keywords, Geographic Region, Documents Produced

The IDRIS group has responded to the current information boom in a number of ways that has made the database of greater scope and importance than would be the case for a strictly donor information retrieval system.

The participating agencies recently made the decision to open the system to research institutions who are pursuing research issues of relevance to developing countries, or who are conducting research in developing countries. This broadening of the database will make it a more valuable source of information on research that is taking place in developing countries.

The IDRC has made the database available to the public in two ways. One has been to arrange for many institutions in the development community such as the United States Agency for International Development (USAID), the International Monetary Fund (IMF), the World Bank, and the Institute of Development Studies (IDS) to access the database on-line.

The IDRC also arranges for the delivery of tapes or diskettes, with an up-date every six months, to a number of organizations, including UNESCO. Because of the development of a software that allows the database to be installed on micro-computers, requests for diskettes of the database are substantial. This is true for users in the Third World as well as in industrialized countries.

Customized sub-sets of the database are also offered, and include the sectors mentioned earlier in this paper: agriculture, forestry, fisheries, environment, health, industry, information, education, social issues, and women in development.

Sub-sets by geographic area are available as well and are as follows: Africa, Arab-speaking countries, Asia and the Pacific, Southeast Asia and the Pacific, Latin America, and the Caribbean.

QUATRIEME PARTIE

VISIBILITE ET STRATEGIES DE PUBLICATION

ACCESS TO THIRD WORLD SCIENCE IN INTERNATIONAL SCIENTIFIC AND TECHNICAL BIBLIOGRAPHIC DATABASES

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ABSTRACT

For the past eight years, the author has been examining trends in access to international scientific literature in major international bibliographic databases available on various information systems. A major portion of the research program examined and compared the languages of the documents and countries of publication for items published between 1970-1990 and recorded on MEDLINE, PsycInfo, BIOSIS, Chemical Abstracts, and several other databases on the DIALOG system. The second phase of this study is to examine the remaining scientific databases on DIALOG, including MATHFILE and AGRICOLA. A comparison of the international range of MEDLINE and EMBASE has also recently been completed. In order to attempt to assess actual amounts of literature produced, the Unesco statistics for literature production have been examined. In the course of this research the author encountered a variety of system attributes that affect the ways by which the Third World literature can be identified. Some of the policies and procedures that affect the inclusion of Third World science have been identified.

RESUME

Durant les huit dernières années, l'auteur a examiné les tendances de l'accès à l'information dans les principales bases de données de bibliographie scientifique internationale sur divers systèmes d'information. Une large partie de ce programme de recherche a consisté à examiner la langue des documents et les pays de publication et effectuer des comparaisons sur MEDLINE, PsycInfo, BIOSIS, Chemical Abstracts, ainsi que plusieurs autres bases de données accessibles sur le système DIALOG. La seconde phase de cette étude étudiera les bases de données restantes, notamment MATHFILE et AGRICOLA. Une comparaison de la couverture internationale de MEDLINE et EMBASE a aussi été completée. Afin d'estimer la production scientifique mondiale, les statistiques de l'Unesco sur la production littéraire sont également examinées. Les caractéristiques des systèmes d'information qui affectent l'identification de la production scientifique des pays du Tiers Monde sont étudiées, de même que les procédures et politiques qui affectent l'inclusion de la littérature en provenance des pays en développement.

INTRODUCTION

The role that bibliographic databases play in the international communication of scientific and technical information is critical. These databases represent what we know about research in medicine, psychology, engineering, education, and a host of other disciplines. As indexes to the world's literature on these subjects, they also offer a picture of research being conducted in the world's countries in these disciplines. They enable the assessment of developments in any given country with reasonable precision.

My own research over the last eight years has focused on the "internationality" of documents represented in major US scientific and technical databases. While there are many studies of the coverage of individual countries, this is an attempt to provide a comprehensive picture, from the United States perspective, of international developments in various scientific disciplines. International, for the purposes of this program, is defined as the languages in which the documents are written, and the countries from which they are published.

These are not the only measures of the "internationality" of science. Conference participation, funding patterns, and other forms of scientific communication were not examined. Publishing preferences in some disciplines for European and US journals are acknowledged but not addressed. The rapidity with which journals have changed journal titles from local languages to English, and increasing acceptance of papers only in English were not investigated. However, the assessment of languages being used, and sources of documents, adds to the current picture.

The overall objectives of the research program are (a) to determine the trends in the use of various languages being used to report scientific and technical findings in various scientific disciplines, (b) to determine the trends in the contributions by various countries in these disciplines, and (c) to determine trends in nationalities of authorship in these disciplines. The project has focused on the major bibliographic databases available on the DIALOG system, of DIALOG Information Services, Inc., a vendor of more than 350 different databases located in Palo Alto, California. This system was used because it is the US system with the broadest range of disciplines represented.

Necessarily, a fourth problem must be addressed, and that is the degree to which the databases do provide comprehensive international coverage of their disciplines. The databases cannot identify and include every single scrap of information in their disciplines. It would not be cost-effective to do so. The databases address the "important" literature for the US scientist. However, how much literature is being produced in medicine, or biology, or chemistry, is simply not known. The existence of the Hispanic American Periodical Index, and the Index Medico Latino-Americano suggest that there are literatures of interest to others in other countries.

In the course of the project, system and database attributes were identified that made it in some cases simple, and in other cases more difficult, to conduct the research itself: and these are the focus of this paper.

The research described below is a report of work in progress: the entire project will not be completed for another two years. Pieces are being reported as they are completed, however.

SUMMARY OF FINDINGS

The First Eight Databases

The detailed findings of the first part of this research project have been reported elsewhere[1] in general, the inclusion of materials in non-English languages has declined significantly over the last twenty years. While in 1970, in MEDLINE, for example, 60% of all records were for documents in English, in the late 1980's the proportion is closer to 80%. The proportion of records for English documents in Chemical Abstracts rose from 55% to about 65% in the same period. Similar increases were found for virtually all of the databases examined. Documents in French, Spanish, Russian, Portuguese are all declining in number. The two exceptions are Japanese and Chinese documents. In virtually all files, these two languages increased in presence, particularly after 1980. (A chart of individual languages studied and their overall trends is presented as Table 1 in the Appendix.)

Examining country of publication data illustrates the first of many problems identified in the course of research that inhibit the easy use of these databases to assess international contributions in various areas of research. DIALOG bibliographic records are organized into fields, such that the author is a separate piece of text from the title, for example. Not all databases contain the same fields: and the country of publication field is one that is not always present. As detailed below, this means that the information is either not readily accessible, or not available at all. Of the eight databases initially examined, only three contained the field. Table 2 of the Appendix indicates that, with the exception of materials from Japan and the People's Republic of China, materials from outside the United States generally have been in decline. Records for materials from the United States comprised 30% of the MEDLINE database in 1970; more recent figures are 45%.

The preliminary examination of eight scientific and technical databases focused on the United States and Europe because the study was targeted at the most frequently represented countries and languages. The data for countries making up 90-99% of a given database were examined. Varying percentages of

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[1]Gretchen Whitney, Language Distribution in Databases: An analysis and Evaluation, Metuchen, NJ: Scarecrow Press, 1990.

the databases were examined because varying numbers of countries contributed 90-99% of the database. This meant that records for documents from only Japan, the People's Republic of China, and in one instance India were included beyond the European, North American, and Oceanic communities.

In the MEDLINE portion of the study, for example, the nine countries most frequently found in the file were studied. All of these countries contributed 2.5% or more of the total records to the databases. To bring the study up to 99%, an additional 31 countries would need to be examined. These countries would have included India, China, Brazil, South Africa, Israel, Mexico, Argentina, Chile, Turkey, Taiwan, Thailand, Singapore, and Egypt. They (and a few other European countries) contributed 9% of the database. The remaining 57 countries in the database contributed 1% to the total file. There is no reason why the methodology could not be applied to further countries: it simply has not been done yet.

The same approach (the most frequent contributors) was used to identify languages. BIOSIS, for example, actually contained 54 different languages. Twelve languages were studied, which comprised 99% of the database. There were generally over 10,000 records for documents in each of these languages. There were but 149 documents in Thai, for example, 45 in Hindi, and 233 in Indonesian.

India, Kenya, China and Brazil in MEDLINE

Due to the recognized concentration of effort on the European community, additional countries -in specific Third World countries, were investigated for this report. An examination of the data for documents from four Third World countries suggests that these may not mirror the declining patterns shown in many other instances, and records for documents from these countries require further research. As noted below, however, this can only be done for a few of the databases, because the information is simply not available in the records.

Brazil, India, and Kenya were the most frequently referenced countries of publication for their geographic regions. China was selected as the next-largest non-English speaking country in the region. Records for documents from Brazil form a roughly stable pattern, ranging from 800-1200 documents per year. Kenya and India have stronger showings in the 1980's than they did in the 1970's, as the following charts show.

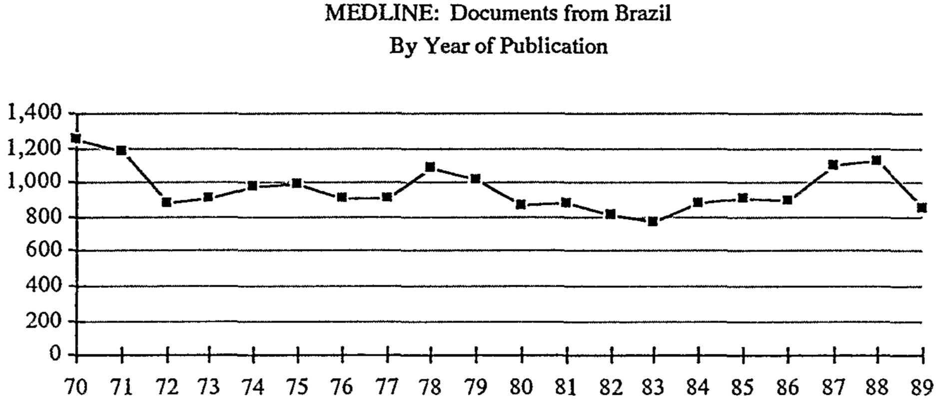

Chart 1: MEDLINE Documents from Brazil

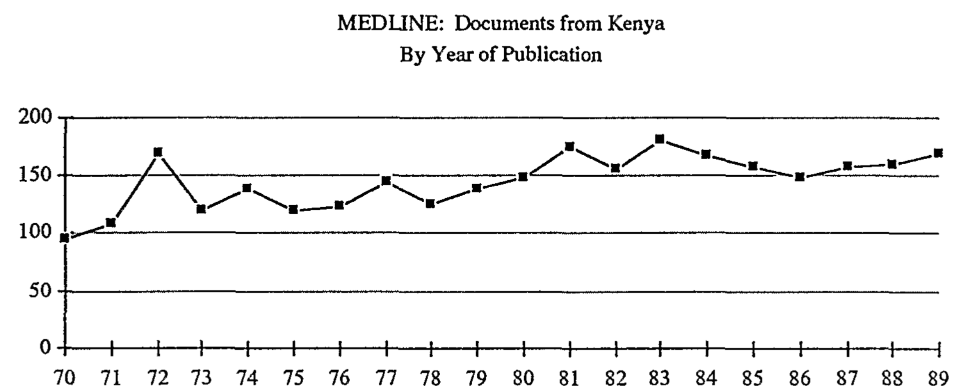

Chart 2: MEDLINE Documents from Korea

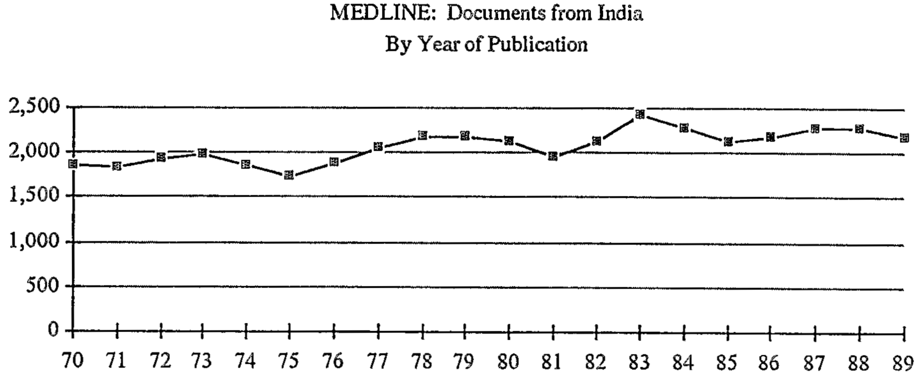

Chart 3: MEDLINE Documents from India

The chart for China shows a familiar pattern for documents from China in many databases: it is virtually absent until 1978, rises sharply in numbers until 1986, and stabilizes around 3500 documents per year after 1986.

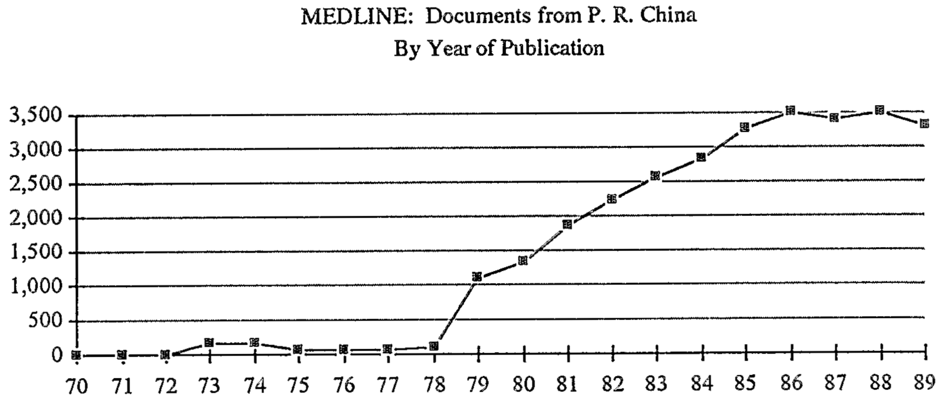

Chart 4: MEDLINE Documents from the People's Republic of China

Database Comparisons: MEDLINE and EMBASE

The structure of searching in DIALOG not only enables comparison of the quantity of research identified by different databases and different subjects, it also enables comparison of databases in the same subject. A recent project compared

MEDLINE and EMBASE, using the same language and country of publication fields.[2] EMBASE is generally considered the more "international" of the two. The results of the study revealed that in fact that was true (according to these specific criteria) up until 1984, when quantitatively MEDLINE became more so. That is, there were more records for documents published outside the US, and in languages other than English, in MEDLINE in more recent years. Details are presented in Table 4, in the Appendix.

Actual Literature Growth

The assessment of the actual growth of literatures in various disciplines is more problematic. Two resources were identified for study: the Unesco book production statistics, as reported in the annual Unesco Statistical Yearbooks, and the Online Union Catalog of the Online Computer Library Center in Columbus, Ohio USA. The latter project still is in the data gathering stage, and there is nothing to report at this time.

Examinations of the Unesco book production statistics[3] have suggested that while the data are incomplete, the trends are the opposite of what has been found in the databases. There is an increasing volume of literature in French, and Russian, and in Spanish for example. There are increases in disciplines such as medicine, the social sciences, and the sciences.

Asian production of pure science titles is increasing, as the chart on the following page shows.

Brazil, India, and Kenya were the most frequently referenced countries of publication for their geographic regions. China was selected as the next-largest non-English speaking country in the region. Records for documents from Brazil form a roughly stable pattern, ranging from 800-1200 documents per year. Kenya and India have stronger showings in the 1980's than they did in the 1970's, as the following charts show.

South American production is not. However, South American production gains show increases in the social sciences. Again, the chart is to be examined cautiously: the large number of countries reporting no data, or reporting erratically, affects the figures. A total of 80 countries reported this data worldwide in 1973, and maintained reporting in the late 1970's. Currently, only 60 countries report, and it is seldom the same 60 countries. If more countries reported, the increases would be even stronger.

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[2]Gretchen Whitney, The internationality of Medical Literature: EMBASE and MEDLINE, Unpublished ms., 1990.

[3] Gretchen Whitney, "The Unesco Book Production Statistics", Book research Quaterly, Winter 1989-90, 5(4): 12-29; Gretchen Whitney, "The subjects of the World's Books: A further Examination of Unesco's Book Production Statistics", Book Research Quaterly, forthcoming.

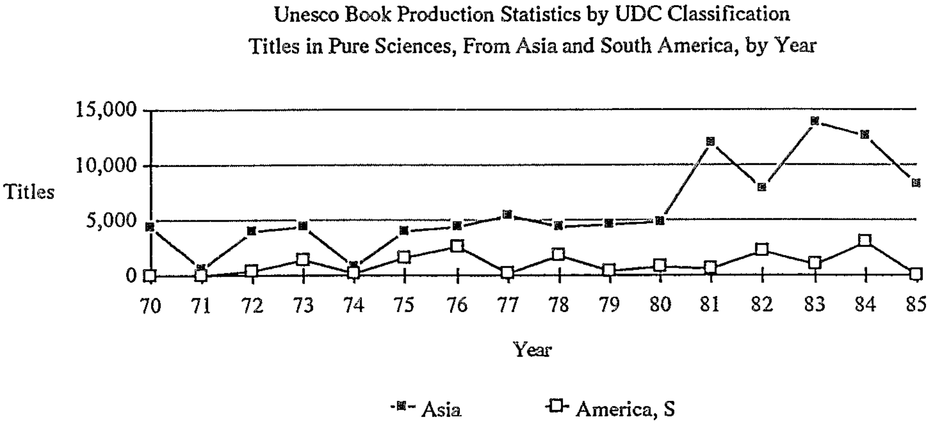

Chart 5: Unesco Book Production Statistics: Pure Science Titles from Asia and South America

A complementary project, investigating the Unesco statistics for serials, is currently underway.

In summary

Evidence gathered demonstrates that the inclusion of non-US publications, and those in non-English languages, has generally declined in major US scientific and technical bibliographic databases over the past twenty years. The exceptions are those materials from Japan and the People's Republic of China. Shifts in "internationality," as defined for the purpose of this project, are also occurring at the database level for biomedical information, in that MEDLINE is now quantitatively the more international file. Attempts to determine actual literature production have suggested, despite incomplete data, that in some cases the literature of given disciplines from different geographic regions is, in fact, increasing.

Feasibility of Using Bibliographic Databases for Research: System Software

The problem areas identified relate to (a) the DIALOG system searching software and that of the Online Computer Library Center, (b) the databases themselves, and (c) organizational variables such as collection development policies that affect the development of the files. The latter treats the Unesco book and serial production statistics as a data set.

DIALOG System Software

The DIALOG searching capabilities are strongly supportive of this type of research. Specific fields of information are readily searchable, multiple databases can be searched at the same time, and Boolean operators ("AND", "OR", and "NOT") are fully implemented to identify and clarify the use of values in different fields.

The only difficulty encountered is a problem with the algorithm that is used to identify duplicate records. Minor variations in titles cause the system to evaluate two records as different, when in fact they refer to the same document. This inhibited progress on an overlap study of two biomedical databases, MEDLINE and EMBASE. The problem was reported to DIALOG.

OCLC System Software

The ready ability to conduct this type of research on DIALOG is contrasted with the difficulties inherent in a similar project on the OCLC Online Union Catalog.[4] The Catalog, a database of 22 million bibliographic records representing the holdings of 10,000 libraries in the United States and abroad, allows for searching by the title, author, and several numeric fields only. This was by design. It was established as, in part, a cataloging system, and searching was to be "known item" searching for a work already in hand. Additional features such as subject access were planned for a later date. Languages and countries of publication also are inaccessible. My examination of serials records, therefore, necessitates the assignment of a programmer to write software specifically to extract the needed records.

That the new (as of January 1990) OCLC service, EPIC, is a full copy of the Online Union Catalog (without holdings), with DIALOG-type search capabilities. Language and country of publication are separate fields that could be searched readily to assess the holdings of Third World publications in libraries in the United States and abroad.

Feasibility of Using Bibliographic Databases for Research: Database Characteristics

While vendors, such as DIALOG, OCLC, and Unesco, offer databases and provide access to them, the databases are constructed by third parties. These database providers also affect their usefulness for research, because they are the ones that identify the fields for each record, and provide the data for each field.

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4 Gretchen Whitney, "The Language Distribution of Serial Records in the OCLC Online Union Catalog", OCLC Library and Information Science Research Grant Program Award, 1989-1990.

They also develop policies which affect the inclusion or exclusion of the materials for which records are developed.

ISI's Science Citation Index and Social Science Citation Index

While ISI has been used heavily as a resource for the analysis of the growth or incidence of country's literatures, its problems also have been documented. This work complements that of other researchers studying the ISI data, by addressing a similar set of problems from a different direction: that of the bibliographic databases constructed not from attributes of the literature itself, but from databases built by national libraries (MEDLINE, from the National Library of Medicine), by professional associations (PsycInfo, from the American Psychological Association) and other third parties. This "participation" by the third parties does introduce additional variables affecting the picture of given disciplines that these databases offer, and that is discussed below.

Selectivity in Databases

Necessarily, secondary services must be selective in the titles that they choose to index. It costs money to hire the indexers, and then to manage and print the results of the indexing and abstracting effort. The secondary services are under various pressures to curtail production costs. Sometimes, however, this selectivity affects the international character of the database. For example, Aspen Systems, Inc., the creator of the National Criminal Justice Periodicals Index, was directed by its monitors in the US National Institute of Justice in the middle 1970's to cut the number of records entered into the file, for several successive years. The foreign materials were the most expensive, difficult to acquire and to process; so acquisition of these materials was virtually ceased. This resulted in the following pattern of French-language materials:

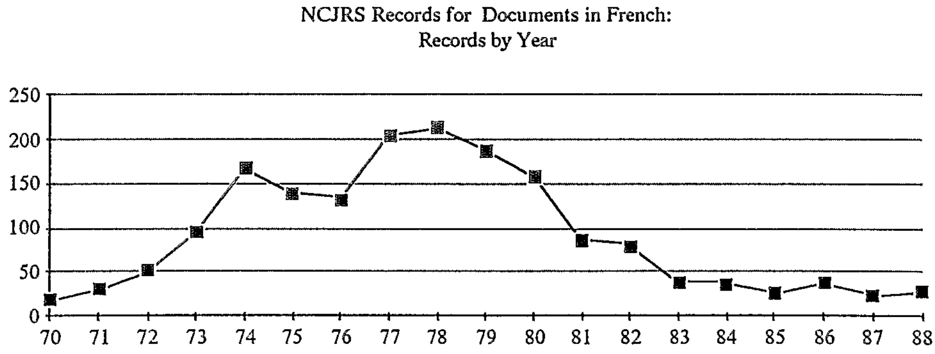

Chart 6: NCJRS Records for Documents in French

The staff, when interviewed in the mid 1980's, expressed great concern over these materials. Their numbers have not increased, however. There were only 47 items added with a publication year of 1988, as the chart indicates: and only seven with a publication year of 1989.

A similar impact was felt on materials from outside of the United States, and India will serve as our example:

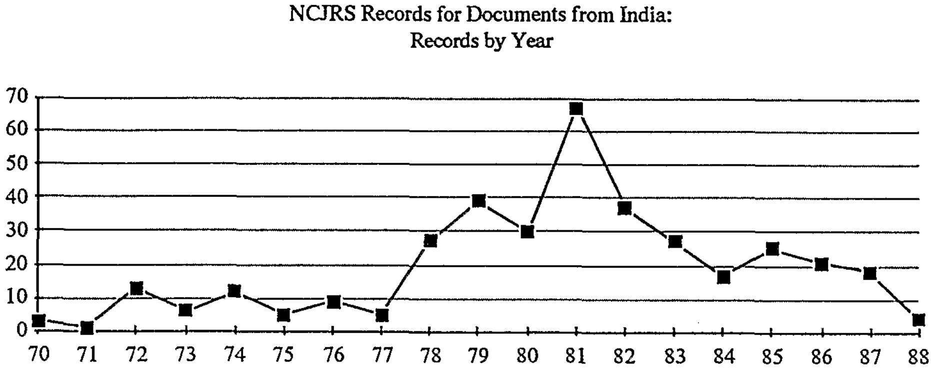

Chart 7: NCJRS Records for Documents from India

Eight materials were added with a publication year of 1988, and none with a year of 1989 or 90. (The database appears to have a significant lag-time in processing materials. As of this writing (August 1990) there are no materials in the database with a publication year of 1990.)

Fields and Field Tags

DIALOG made a substantial step forward in 1985 when it implemented field tags for display of records. While you could search for specific information in specific fields before 1985, the printed record, upon retrieval, had no tags. This made it quite impossible to download or capture records to a disk file for later processing in, for example, microcomputer software. With the implementation of DIALOG2, such processing and analysis is easily undertaken.

DIALOG in the last five years also added formatting capabilities, including a capability for specifying individual fields for output. For example, a set of records representing research produced from Thailand could be identified, and their full CS fields alone could be output for analysis.

Particularly relevant fields to this research are the language of the document, the country of publication, and the author affiliation or corporate source. The utility of the language field is readily apparent. And, straightforward analysis of countries of publication, or source countries, is also quite simple. All of the values in a given field can be examined by using an "expand" command. These identified values then can be paired with, for example, year of publication, to assess trends.

Combining these fields (language and country of publication, or country of publication and source country for author) would yield interesting results indeed. A comprehensive approach would be somewhat more tedious, because all of the countries in one field will have to be paired with all of the countries in the second field. It is not possible to identify a set of records (for example, those with Brazil in the country of publication field) and then examine the values in the language field for just those records, without printing them all out. (Technically, that is possible: but it would yield unwieldy numbers of records.) A sampling strategy is being developed to work on this problem.

Finally, not all databases contain the relevant fields identified above. While all do include a field for language and some sort of corporate source data, only Aerospace, Agricola, GeoRef, MEDLINE, NCJRS, NTIS, PAIS, and PsycInfo include fields that can be examined for corporate source or author affiliation data. And these are inconsistently defined across databases.

Values in Fields: Multiple Forms of Languages, Country Names

In most of the files, the language field is "clean," in that it contains only the name of the language. In some files, however, the field includes extraneous codes and data which must be removed for analysis. The same can be said of the country of publication field. The corporate source field, however, usually contains the entire source name (such as "Dep. Physiol., Fac. Sci., Mahidol Univ., Rama VI Road, Bangkok 10400, Thailand."). In determining the countries or institutions represented in the file, the EXPAND command must be used to list all values represented, and the individual countries must be identified. To identify specific countries, it is a simple matter to search for individual country names. MEDLINE encodes country names, and these must be interpreted from written documentation. (Text-searchable words are available from 1966-1974 and after February 1987.)

Not all databases are consistent in the designations that they use for names of languages or names of countries. In one database (Inspec), for example, there were multiple "versions" of various forms of language names ("Spanish", "Spansih", "Spansish", "Spnaish"; the same database contained eleven forms of "Russian"), and different spellings of country names. While these errors generally do not affect large numbers of records (in the Spanish example, 5 records were incorrect, 2,889 were correct), they do represent a problem to be taken into account.

There may be extraneous or coded information in the field, which can affect the number of records retrieved. In one of the databases (Agricola), the total number of records could differ by several thousand. The database provider should be contacted to determine, for example, if the coded records should be ignored in the total, or if they should be counted as English.

Databases have not always coded materials for language: one file (BIOSIS) did not start coding all materials until the middle 1980's. It is necessary, therefore, to calculate the percentage of records that have been coded with a language or country value.

To determine the percentage of non-English materials in a database, it is necessary first to determine the extent of English materials. Some databases explicitly note "English" for English language documents, others do not do so if the document is in English. And some databases have changed policies over time, which offers further challenges.

MEDLINE serves as an example of a database that uses a highly structured, hierarchical system of country codes for its country of publication field, and this structure must be understood and used in any analysis. The incidence of duplicate country codes must be managed as well.

Separate Vendor Handling of English and Non-English materials

There is an increasing trend to separate out English-language materials from non-English materials, to assist libraries and users in purchasing only the data that they really need. The Online Computer Library Center, one of the largest bibliographic cooperatives in the United States, for example, offers a CD-ROM-based cataloging service. Non-English materials are on a separate disk, and are purchased separately. In the middle 1980's, the American Psychological Association, creator of PsycInfo, one of the major secondary services, decided that the printed version would contain only the English-language materials, the foreign-language materials would be available only in the electronic version of the database. The measure was taken to save production costs for the printed service. While this does mean that the non-US materials are indeed electronically accessible to the rest of the world, countries may find that the printed versions are less expensive to acquire and use.

The OCLC Online Union Catalog

As a cooperative venture among thousands of libraries, the Online Union Catalog has been in development since it first went online in 1971. With 22 million records, it is perhaps the largest bibliographic file in the country. With so many participants in its development, and its immense size, errors and duplicates are unavoidable. OCLC has, at least since the middle 1970's, maintained a program of collecting error reports from participating libraries and diligently working on them. Detection of duplicates is a continuing item on the research agenda, and researchers currently are working on various algorithms for standardizing and improving records for serials. The current research project on the linguistic distribution of serials in the Online Union Catalog will, in part, further support the effort to determine the broad numbers of serials being published in various languages.

OCLC uses derived search keys (pieces of text from the target field, such as the first four characters of the author's last name as a part of the author/title search key) for the Online Union Catalog, and the language field is not one of those fields from which a search key has been taken. Therefore, direct searching for records in specified languages was not possible. Special programs are being written at OCLC to pull out a sample of the database for study. The small sample will be processed using standard microcomputer software.

The recently-released EPIC service does permit searching by language and other relevant fields. It was not available at the time this particular proposal was submitted and awarded.

The Unesco Statistics

The Unesco book and serial production statistics are important as indicators of not only scientific and technical developments in various countries, but they reflect the humanities as well. As such, they have the potential for enabling us to assess international work in all of these areas, and the progress being made to support educational, scientific, and literacy efforts around the world. Unfortunately, many countries, for reasons of lack of available data, or a lack of an internal reporting system, or political reasons, do not participate in Unesco's program to collect cultural data. My own country is no exception. But assessments from this potentially valuable resource will remain uncertain without wider participation in collection of the data.

Feasibility of Using Bibliographic Databases for Research: Organizational Variables Affecting Database Development

Organizational variables include the establishment of or changes in policies regarding what materials will be included in a database, corrections made to the file, and changes in the database developer's relationship with other agencies. These are frequently the most difficult to identify and relate to the database, because they are often buried in the archival memory of the agency.

The participation of the national libraries of England and France in the Online Union Catalog clearly will increase the visibility of their records in the database, and increase their accessibility for United States libraries. The national libraries will benefit mutually.

When Questel, the French database vendor, opened offices and a local telecommunications node in Virginia in the United States, US researchers had increased access to French databases.

Other examples include the separation of English-language and non-English records in PsycInfo, and the policy changes mandated by the National Institute of Justice, noted above. Finally, the incompleteness of the Unesco statistics prompted contact with Unesco itself, to determine why the data were so incomplete. While this does not make the data any more complete, it helps us to understand where the problem lies.

An analysis of the Population Bibliography, produced by the Carolina Population Center at the University of North Carolina, USA, provides a dramatic example of how difficult it can be to identify these variables.[5] A preliminary analysis of the language and country trends in the database could not readily be explained by funding patterns in the field, international contacts and agreements by the Center itself with centers in other countries, or acquisitions policies. Only a few years could be explained by staffing patterns, as determined by examination on site of the archives of the library. Only upon review of the draft of the paper resulting from the research did the librarian remember that, in preparation for sending the file to DIALOG, large numbers (50% in some cases) of non-English and foreign-produced records were removed from the file. The explanation for the patterns seen in the database were not in public or archival records: they existed only in the memory of the librarian. If the patterns as seen in the database were taken at face value, and used to understand the growth of the literature of population and family planning, they would have been quite wrong.

In this example, the author had the favored advantage of having worked at the Center during the years that the database was being developed, and staff critical to the study were still in place. If someone else had undertaken the project, the results could have been quite different.

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5 Gretchen Whitney " Organizational Variables Affecting the Conduct of Bibliographic Database Research: Factors Influencing the Internationl Coverage of databases", Information Processing and Management, forthcoming.

This is by no means to suggest that all database studies should only be undertaken by former employees of the developing organization. Rather, it is to re-state that databases are products of human beings, and organizations, and that it is important to look beyond the raw facts whenever possible.

CONCLUSIONS

Bibliographic databases such as those on DIALOG, and the Online Union Catalog and EPIC databases, are well suited for researching the output of Third World countries. The fields are available for examination, the searching capabilities are present. In some cases, custom software must be developed. There is a need to be concerned for, and account for, inconsistencies in data entry in some cases, the use of special codes, and the general development policies under which the database has been developed. Finally, it is important to take into account, as much as possible, the organizational variables which affect the database and its continuing development.

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Table 1: Trends Individual Languages Studied in the First Phase of the Project, by Database (Key to Abbreviations in Table 3)

Database

Lang.	Bio.	CA	Geo	Med	NCJ	OCE	PAIS	Psyc
Chinese	+	+	+	+		+		
Japanese	+	+	+	+	-	E		+
Bulgarian	+	-		+				+
English	+	+	+	+	-	-	-	+
Spanish	-	+	-	+	-	E	+	+
Korean	+					E		
Slovak		+		E				
Dutch				+	-			+
Danish				+				
German	+	+	-	-	-	E	-	+
Norwegian				-				
Romanian		E	-					
Portuguese	-	E		E		E	-	+
Serbo-Croatian				-			E	
Ukrainian		-						
Czech		+	-	-				E
Hungarian		E		-				-
Russian	+	-	-	E		+		E
Polish	+	E		-	-	E		E
Italian	+	-		E	-	E	-	+
Hungarian		E		-				-
Swedish				-	-			
French	+	-	-	-	-	+	-	+

+ = increased, - = decreased, E = too erratic or stable to classify

Table 2: Trends Individual Countries Studied in the First Phase of the Project, by Database (Key to Abbreviations in Table 3)

	Database							
Country	Bio.	CA	Geo	Med	NCJ	OCE	PAIS	Psyc
U. S.			+	+	-			
Netherlands			E	+	-			
U. K.			-	+	-			
China			+					
Japan			+					
Italy				+	-			
Australia					-			
Belgium					-			
Canada					-			
India					-			
Sweden					-			
Poland				-	-			
Switzerland				-	-			
France			E	E	-			
W. Germany			E	-	-			
Russia			-	-	-			

+ = increased, - = decreased, E = too erratic or stable to classify

Table 3: Abbreviations from Tables 1 and 2

Bio.	BIOSIS
CA	Chemical Abstracts
Geo	GeoRef
Med	MEDLINE
NCJ	NCJRS (National Criminal Justice Reference Service
OCE	Oceanic Abstracts
PAIS	Public Affairs Information Service
Psyc	PsycInfo

Table 4: Quantitative Dominance of EMBASE and MEDLINE Languages and Countries of Publication, 1974-84 and 1985-89

Language	EMBASE 1974-84	EMBASE 1985-89	MEDLINE 1974-84	MEDLINE 1985-89
English			*	*
German	*			*
French	*			*
Japanese			*	*
Russian			*	*
Italian	*			*
Spanish			*	*
Polish			*	*
Chinese			*	*
Country of Publication				
US			*	*
USSR			*	*
W. Germany	*	*(7)	*	
England			*	*
Japan			*(8)	*
France	*			*(9)
China			*	*

The asterisk indicates which database contained the largest number of records in the given language or with the given country of publication during that time period.
(7) computed from the spreadsheet, 105K to 102K records.
(8) computed from the spreadsheet, 123K to 127K records.
(9) computed from the spreadsheet, 43K to 46K records.

MISJUDGEMENTS AND SHORTCOMINGS IN THE MEASUREMENTS OF SCIENTIFIC ACTIVITIES IN LESS DEVELOPED COUNTRIES

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ABSTRACT

The bibliographic database widely used for measurement of scientific production (counting of publications) either for developed or developing countries is Science Citation Index. So then, only the contribution of each country to the "mainstream" of world science is evaluated. In the case of LDCs this contribution is negligible. The use of international specialized or multidisciplinary databases for the measure of eight LDCs production is presented, and the results are compared to those provided by SCI alone. Most of the specialized databases give more information than SCI for each country, as well as a great deal of data and features of each field that can not be possibly obtained by using SCI as unique data source. In the case of Cuba, Biosis and CA supply 17 and 15 times respectively as much information on Cuban scientific production in Biology and Chemistry than the SCI in the same period of time. The use of Cuban local database and its comparison with international ones is also discussed.

RESUME

La base de données bibliographiques utilisée le plus couramment pour mesurer la production scientifique des pays en développement comme des pays dévelopés est le Science Citation Index. Ainsi, seule la contribution d'un pays à la science "mainstream" est évaluée. Dans le cas des PED cette contribution est très faible. Ici nous présenterons les résultats sur la production de huit PED à partir de bases de données multidisciplinaires et spécialisées et nous les comparerons avec ceux de SCI. La plupart des bases de données spécialisées donnent plus d'information que SCI pour chaque pays ainsi qu'un grand nombre de caractéristiques de chaque domaine qui ne sont pas disponibles en utilisant le SCI. Dans le cas de Cuba, BIOSIS et CA offrent 17 et 15 fois plus d'information en Biologie et Chimie que le SCI pour la même période. L'utilisation d'une base de données locales et la comparaison avec les bases internationales est également présentée.

INTRODUCTION

The process of Science can be regarded as an input-output phenomenon, capable of being quantified. In general, input is much easier to measure than output, since all of its elements are tangible and input calculation does not require experience in science: manpower, financial resources, equipment, materials, buildings, etc. whereas the output of science consists of the knowledge generated during the research process, which is rather intangible and hence difficult to quantify directly.

It is very often assumed that the results of any research must have a close correlation with the investment made into the said research, and so input indicators have been used sometimes to estimate research results. However this assumption is very misleading. In fact, there is still no generally accepted system for output measurement, neither in terms of quantity nor of quality.

Nevertheless it is commonly accepted that the results of any research are worldwide diffused and made available to the scientific community by publishing them through established communication channels. Those publications generated during the research proccess, should represent the output of science. Consequently, the scientific level of any country is usually estimated by bibliometric methods measuring the output of its scientific activity using quantitative indicators based either on its scientific production (counting of publications), or on the worldwide diffusion of its publications (citation analysis, source quality, etc). All are "extrinsic" indicators easy to measure numerically.

Such traditional indicators are based on conditions and assumptions that are only relevant to industrialized countries where a very long tradition of scientific and technical activity exists, a well established information infrastructure and appropriate systems to collect reliable data are used, and where the "publish or perish" maxim is strongly enforced.

This is not the case with underdeveloped countries, which have very different conditions dealing with their severe social political, and economic problems. We should point out the "scientific isolation" or "island effect" that generally characterizes the status of science in the periphery. That means: lack of collaborative research projects with foreign institutions, dissemination of research results in local rather than in international journals, or through no conventional channels at all (internal reports, informal notes, oral discussions, etc., since researches are not rewarded for publishing their results), lack of information resources and absence of national bibliographies.

According to Frame (1), some of the facts that influence the tendency of LDCs to publish in local sources are: inability to write in English, the sense that local problems are not of worldwide interest, the urgency in certain research areas to solve critical problems and not to "waste time" in writing papers, and the lack of clerical support to assist in the writing of papers.

Gordon (2) examines the editorial evaluation of papers produced by LDCs authors and submitted to two prestigious physical journals during 1968-74. In this period, authors from LDCs had their papers rejected more frecuently (57%) than authors from advanced countries (17%), not because their low scientific quality, but mainly for giving inadequate references to relevant literature, lack of clarity and excessive length of papers. This indicates the low level of awareness of current literature possessed by LDCs researchers, the lack of experience in gaining access to scientific information, and lack of document availability. On the other hand, it has been noticed that journals of developed countries mostly reject papers from Third World institutions (3), and even when those are published, a manifest tendency exists to refuse their citation or at least those papers are cited less frequently than their colleagues in the developed countries (4,5).

For these reasons, bibliometric evaluations when applied to LDCs, without proper modifications, often lead to inaccurate judgements, since it may appear that the scientific productivity of small countries is lower than it actually is, due to the current international communication and information systems which are strongly biased against less developed countries.

The Science Citation Index (SCI) database, owing to its multidisciplinarity, is commonly used as a unique data source for evaluating scientific literature in both production and diffusion aspects. So it has become a "classic" when conducting bibliometric studies.

It is the purpose of this paper to prove that scientific indicators obtained from specialized international databases, other than SCI, reveal the scientific development of each country more accurately, owing to their more comprehensive worldwide coverage, and the inclusion of a larger selection of local journals.

Specially the cooperative database AGRIS (International Information System for Agricultural Sciences and Technology) of FAO, for Agriculture, should be taken into consideration. It offers a quite comprehensive coverage of primary sources, both formal and informal, from peripheral countries since it belongs to a cooperative network between countries. One remarkable limitation is the tremendous delay in updating, at least for LDCs data (6,7).

At the same time national databases, when they exist, covering local journals only, are essential to achieve comprehensive data in bibliometric studies, since a high proportion of local documents does not achieve international diffusion.

1. USE OF THE SCIENCE CITATION INDEX AS EVALUATIVE SOURCE

Even though for impact measurements of scientific works, the SCI is the only worldwide source, as it provides citation frequency of all cited articles in its source journals, it is however inappropriate for the assessment of scientific production, mainly due to the following points: 1) In spite of its multidisciplinarity it includes only about 3200 "core" journals as source journals regarded as covering the most significant research papers in the world ("mainstream" of world research). Each core journal issue is indexed comprehensively (cover to cover), 2) Usually developing countries' journals are excluded from the SCI, which covers less than 2% of the all LDCs journals, 3) SCI is strongly biased in favour of Anglosaxon journals, mainly from the USA, neglecting a great number of relevant periodicals from other countries and non English languages, 4) A great number of these journals belong to the biomedical field, disregarding other important areas, i.e. applied science and technology, 5) The SCI based evaluations ignore the works that are not published by conventional and formal journal channels (reports, patents, workshops, notes etc), which may be heavily used in transmitting scientific research among scientists from LDCs, and could be significant in research, particularly in applied sciences.

2. CONTRIBUTION OF LDC's TO THE "MAINSTREAM" OF SCIENCE.

In any case, the use of SCI as a bibliometric indicator will only be suitable for evaluating the contribution of each country to the "mainstream" of world science, and not to find out the total scientific production of countries (8). As a matter of fact, the underdeveloped countries' contribution to the "mainstream" of science is almost negligible (9), as is shown in the following data.

According to Garfield (10) and Frame (11) in 1973 (data from SCI) 90% of the world "mainstream" scientific papers came from Europe, USA, USSR and Japan, whereas the Indian contribution was 2%, Argentina 0,4% and Brazil 0,23%. In 1978, the scientific production of Argentina, Mexico, Chile, and Venezuela, altogether represented only about 1% of all published articles in SCI (12), whereas the USA generates 40% of all international scientific literature, obtains 60% of all citations, and the 80% of the world scientific literature was written in English (10).

These figures, based on SCI data, have remained without significant variations. In a more recent study carried on by Schubert (13) in 1981-85 period, it is deduced that almost 85% of all world scientific production is generated in the USA, Europe, USSR and Japan. In the said period, the contribution of Brazil to the "mainstream" of world science was 0,36%, Argentina 0,28%, Mexico 0,17%, Venezuela 0,07, India 2,64%, Taiwan 0,13% and Singapore 0,05%.

In spite of the above points about awkwardness, shortcomings and lack of adequacy for evaluating Third World science, SCI is widely used even in the less developed countries as a bibliographic database for publication counting to quantify their own scientific production (4,8,14,15,16,17,18,19,20,21). This method when used without supplementary information derived from other sources, supplies mistaken and false results.

Many bibliometric studies based in SCI database indicate that papers from peripheral countries covered by SCI have certain characteristics in common, which are:

1) Much of the research in developing countries pertains to the biomedical area (4,17,22,23,24).

2) Almost all the papers done in LDCs and covered by SCI are written in English and published in periodicals in the Western World (often in low impact journals) (4,23,24).

3) Most foreign journals come from the USA, UK or Netherlands, except in the case of Cuba, where journals from GDR and USSR are highly used (6).

4) A great number of papers from LDCs are rarely cited even if many of them have appeared in journals having impact factors greater than one (4,24). However, papers published in UK and USA journals have better citation records than those publised elsewhere.

3. INCONSISTENCIES IN THE USE OF SCI AS AN EVALUATION SOURCE.

Some inconsistencies can been observed when using SCI as an evaluative resource. For instance: much of the work done in areas such as tropical medicine and agriculture, public health, parasitology, soils (fertilizing and microbiology), tropical fishes biology, etc. is underrepresented in SCI (17,25). However, when using the French bibliographic database Pascal to establish the world bibliographic production in tropical soil sciences during 1983 (22), a considerable percentage (65%) of the 2040 retrieved references corresponds to research made in peripheral countries, showing that scientists from those countries play an important role in Agricultural Sciences as a whole, and in Tropical Agriculture in particular.

The analysis of 258 papers published from Singapore institutions and covered in SCI (1979-1980) (4), indicates than most of the research made belongs to the Medical field (48%), whereas Engineering reports only 11%. That research output does not match the Singapore national priorities in view of the Goverment's investment promotion and Economic Planning Organization that has choosen 11 industrial fields for prioritary promotion, among them: automotive components, machine tools, computers, electronic instrumentation, optical equipment, etc. Also Singapore has the world third largest petroleum refining centre and the second largest oil rig construction. Other major industries include ship building also.

These kinds of scientific and technical priorities agree with data given by the National Development Research Centre from Canada (NDRC) about research in small countries (26), which reports that, in 1987, the 72% of Singapore government funding was assigned to Engineering and Technology, whereas the Medical Sciences funding was of 13% and Natural Sciences 10%. It seems that the research made in Engineering and Technology does not reach international diffusion through SCI as it originates internal reports or is published in domestic sources or in international ones not covered by SCI.

The same can be said about Agricultural Science, which as Engineering and Technology, does not fit in the concept of mainstream proposed by SCI, being a subject of more local than international interest. According to SCI none of the 25 journals of higher impact factor belong to Agriculture and none of the most cited papers from LDCs authors deal with Agriculture (25). That agrees with Velho (27) who shows that 85% of all Brazilian papers in Agriculture are published in local journals, and with our previous paper about Cuban productivity (6), where we demonstrate that the great majority of Agricultural subject papers are written in domestic journals.

A bibliometric analysis of papers published over a two year period (1979-1980) from the five ASEAN countries (Indonesia, Malaysia, Philippines, Singapore and Thailand), and covered by SCI (24), reveal than those countries have the largest number of papers published in medical journals. In Philippines, Medicine comes on second place very close to Agriculture. Taking into account that the International Rice Research Institute (IRRI) is located in Manila, it seems quite probable that the number of agricultural research publications were greater than those supplied by SCI. It would be useful to verify this feature in local or specialized databases.

In a study by Schubert (13), data from 45 different developed and underdeveloped countries having at least 50 papers published in SCI in five major fields (Life Sciences, Chemistry, Physics, Engineering and Mathematics) during 1981-1985 period were presented. It was revealed that the scientific effort of the great majority of countries was conducted mainly in the Life Sciences field: 27 countries have published more than 50% of papers in the said field; 11 of them have devoted the greatest percentage of research to Life Sciences (between 35% and 50% of all papers), and only 6 countries afforded a greater percentage of publications in any other fields as Chemistry, Physics, etc. These figures certify the lack of data provide by SCI for analysing any matter not included in Life Sciences field.

The use of SCI as bibliographic database for publication counting might produce misleading results mainly for LDCs where an increasing amount of their research is dedicated to national needs, and its results are disseminated in non conventional ways (other than those used in developed countries). For that reason a high proportion of local documents fail to become part of the science mainstream and do not gain international acknowledgement at all, so they remain as "grey literature".

4.SCIENTIFIC EVALUATION USING DIFFERENT DATABASES: COMPARISON OF RESULTS

A large percentage of LDCs research results are published in relevant international journals, not covered by SCI, but by other prestigious specialized or multidisciplinary databases. Those results will achieve international visibility.

With the aim of obtaining information about the possible differences in scientific productivity of each country by counting retrieved references from SCI in comparison with other databases, searches in SCI, Chemical Abstracts (CA), BIOSIS, INSPEC, CAB and EXCERPTA MEDICA during the period 1985-1989 were made, in order to find the scientific productivity of a total of 8 countries, chosen at random between those considered as less developed (Table 1).

Table 1. Papers from eigh LDCs retrieved from different databases (1985-1989)

	SCI	CA	BIOSIS	INSPEC	CAB	EXCERPTA
Singapore	2370	1131	2116	1054	316	1328
Taiwan	6994	7008	5692	4099	2282	3042
Perú	509	102	455	20	421	151
Brazil	13469	8323	4289	3788	9081	4785
Nigeria	4610	1910	4645	639	3762	2377
Kuwait	1711	674	1177	390	193	972
Malaysia	1279	455	1506	272	644	574
Cuba	534	1265	2117	205	2529	551

SCI covers papers in any scientific field which have been published in about 3200 journals of considerable scientific standing. CA, BIOSIS, INSPEC, CAB and EXCERPTA, all more specific in subject (dealing with chemistry, biology, physics, agriculture and medicine respectively), are, however, more comprehensive in journal coverage than SCI (CA covers 13.000 journals, Biosis 9000, Inspec 4000, CAB 10.000 and Excerpta 3500 journals), although not all original papers in those journals are processed, since a previous selection of their papers is made by each database.

The SCI search was performed in the SCI CD-ROM version, hence nearly 3000 journals of Current Contents, which are added to the SCI online databases, were excluded. All other databases searches were performed on-line through Data-Star and ESA/IRS hosts. All on-line and CD-ROM searches were performed according to the same strategy by locating the country name in the field "corporate source", and limiting that set to the studied years.

In spite of its specific subject area, CA gives much more bibliographic information than SCI at least for Cuba, and quite similar for Taiwan. BIOSIS gives more information in the case of Malaysia and Cuba, and quite similar in the case of Singapore, Nigeria and Peru. CAB provides more references in the case of Malaysia and Cuba and similar number in case of Nigeria. EXCERPTA offers more documents in the case of Cuba.

In a bibliometric study promoted to establish the worldwide scientific productivity in the field of sugar cane by products, (1983-87) (7), it was proved that Cuba is the world leader according to number of scientific publications in that subject (128 papers), followed by Brazil (115 papers) and US (93 papers). The results agree with those mentioned by Ubell (28): "In some applied areas; for example, sugar cane by products research, Cuba has jumped to world leadership". To obtain these figures eight international databases had to be used, due to the multidisciplinarity of the subject (CA, BIOSIS, PASCAL, COMPENDEX, FSTA, AGRIS and SCI) as shown in Table 2. 1) CA, BIOSIS and AGRIS, give more information than SCI; 2) all databases other than SCI produce references in any other document types, being remarkable CA in patents and AGRIS in dissertations, congresses and reports, etc. 3) all SCI references were overlapped among other databases. In this report it was also revealed that the Spanish language is the second most widely used (16%), after English (65%), to publish this kind of research.

Table 2. Sugar cane by products (1983-1987). Pertinent references according to data bases and document type

Database	J.	C.	B.	R.	P.	D.	Total
AGRIS	90	34	2	44	-	27	197
BIOSIS	165	14	2	-	-	-	181
CA	272	6	1	5	36	4	324
CAB	109	13	5	16	-	3	146
COMPEN DEX	90	2	3	-	-	-	95
FSTA	37	6	2	-	3	-	48
PASCAL	121	21	2	2	1	1	148
SCI	173	-	-	-	-	-	173

J = journal; C = congress; B= book; R = report; P = patent; D = dissertation.

5. SCIENTIFIC EVALUATION USING SPECIALIZED DATABASES

The specialized international databases when used for evaluative purposes, can lead to more deep inquiries and accurate conclusions, since they reveal a great deal of data and features of the field that could not be possibly obtained by using SCI as a unique data source, as it is presented in the following examples related to Chemical Abstracts database.

According to the Cuban Chemical literature it is shown (6) that the Cuban papers retrieved in CA, 33% correspond to Biochemistry sections, followed by Macromolecular Chemistry (23%), Physical Chemistry (20%) and Applied Chemistry (19%). The limited extent of Cuban research published in Organic Chemistry (4,5%) is also to be noted.

In another bibliometric study (29), Cuban research in Chemistry through Chemical Abstracts database, during 1985-87, was reported. 737 references were retrieved. It was shown that Cuba is making its research effort in the subjects related to the following CA sections: Industrial Carbohydrates (sect. 44), Cellulose, Lignin, Paper and other Wood products (sect. 43) and Food and Animal Nutrition (Sect. 17 and 18). The percentage of Cuban papers covered by CA in said sections is very much higher than the world average. So Cuban Activity Indexes are: in Industrial Carbohydrates subfield 147,5; in Cellulose, Lignin and Paper subfield 13,3 and in Animal and Human Food 3,9. (Table 3).

Table 3. Cuban scientific production in CA (1985-1987)
Most studied CA subjects

CA Section	N. Papers	% Cuba (85-87)	% World (85)	AI*
Industrial Carbohydrates	132	17,7	0,12	14,5
Cellulose Lignin, Paper	60	8,0	0,6	13,3
Animal & Human Food	76	10,2	2,6	3,9
Industrial Biochemistry	35	4,7	2,7	1,7

* Activity Index = The given field's share in the publication output/ The given share in world publication output

6. SCIENTIFIC EVALUATION USING LOCAL DATABASES

In the case of Cuba its own database, a multidisciplinary publication (Revista de Información Científica y Técnica Cubana, RICTC), which encloses the most relevant Cuban journals, has been taken into consideration with the purpose of detecting the Cuban scientific production published in national journals. 9319 papers were retrieved (Table 4). None of those papers could be retrieved by SCI, since no Cuban journal is included as source journal in the said repertory, however, most of those papers are able to be retrieved from CA, BIOSIS, INSPEC, etc. since some Cuban journals are included in said databases. As seen in Table IV, 60% of all Cuban papers published in local journals corresponds to Medicine and Agriculture .

Table 4. Subject and chronological distribution of Cuban papers retrieved from RICTC

	1985	1986	1987	1988	1989	Total	%
Medicine	577	337	544	713	735	2906	31
Agriculture	395	309	617	756	606	2647	28
Engineering	437	215	265	365	295	1577	17
Chemistry	196	125	191	427	118	1057	11
Biology	39	72	55	369	208	743	8
Geology	3	3	12	74	74	166	2
Mathematics	56	24	15	17	6	188	1
Physics	15	20	14	24	26	99	1
Total						9319	

7. SUMMARY

In summary of the above said, to accomplish evaluative assesments of LDCs scientific activity dealing with publication based indicators, the following points must been taken into consideration:

1- The use of SCI multidisciplinary database for publication counting, will supply data only about the contribution of each country to the "mainstream" of world science (often insignificant data in LDCs)

2- The use of other specialized or multidisciplinary international databases will give a bigger amount of publication data coming either from international or local sources not covered by SCI. At the same time further aspects of each specialized field have been analysed.

3- The use of national databases providing access to local literature, will retrieve documents that otherwise would remain unknown (grey literature).

As an example, by comparing SCI Cuban papers by subjects (Table 5), with Cuban data from CA and BIOSIS (5), it has been noticed that: 1) The 74 and 123 references retrieved by SCI in Chemistry and Biology represent the Cuban contribution to the mainstream of world science in those two fields; 2) CA and BIOSIS provide fifteen and seventeen times more information than their equivalent chemical and biology SCI subjects, in the same period; 3) CA and Biosis provide more information about Cuban research than RICTC itself. This fact evidences that Cuban scientists in these fields publish more papers in international journals than in Cuban ones.

On the other hand, total overlapping is produced between SCI and CA and BIOSIS (no more than 74 and 123, of course), some is produced between CA and RICTC and Biosis and RICTC, and no overlapping at all is produced between RICTC and SCI since no Cuban journal is covered by SCI.

Table 5. Cuban scientific production (1985-1989) Number of references retrieved in Chemistry and Biology fields using different databases

Fields	Databases			
	SCI	CA	BIOSIS	RICTC
Chemistry	74	1265		1057
Biology	123		2177	743

CONCLUSION

The scientific productivity of the LDCs is considerably higher than the estimated by conventional ways. A great amount of their scientific literature remains unknown (grey literature) to the rest of the scientific community, because it is not covered by international databases, since the greatest research effort in LDCs is dedicated to local necessities, and its results are published mainly in domestic sources. That kind of significant research will never be detected since it is at no time promulgated outside of the narrow circle of local scientists.

For the above reasons, the following points are recommended:

1. The creation of national databases where all local literature is collected.
2. The promotion of cooperative databases like AGRIS for Agriculture or LILACS for Biomedicine.
3. The use of databases other than SCI to obtain references to LDCs publications.
4. The formation of information networks between peripheral countries and between peripheral and central ones, in order to avoid the "island effect", and to improve the sharing of resources within regions.
5. The development of new reliable scientific indicators capable of reflecting the real scientific effort of the Third World countries more in accordance with their special characteristics.

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COMMUNICATIONS PATTERNS IN AGRICULTURAL RESEARCH IN CAMEROON

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ABSTRACT

Agricultural research is unique in its total reliance on an effective communications mechanism. Research results obtained at an experimental station are of no value unless they can be disseminated to the end user of agricultural technology - the farmer. Furthermore, in common with other research disciplines, a national agricultural research system does not exist in a vacuum. To grow and evolve effectively, it must share its results and experiences with other systems, particularly those in countries with similar social and ecological conditions. It must contribute to the international pool of agricultural knowledge, on which it must also draw to feed its own information needs. In many countries, particularly those in the developing world, there are severe restraints which complicate and hinder such communication. We can think immediately of problems such as the lack of communications infrastructure, the lack of trained personnel, financial constraints and cultural differences. In order to promote the development of effective communications mechanisms, we must study the complex communications patterns of research workers in the national system. We must ask how research results are disseminated to users - farmers, extension workers, decision makers. We must look at where results are published - in research reports, in national and international journals, and ask how these publications are distributed. We must critically examine current publication and dissemination methods and explore more appropriate alternatives. We must examine any national bibliographic tools or collections and see how far these are available to both national researchers and researchers abroad. This paper attempts to answer some of these questions and to promote the development of a national agricultural research information system in Cameroon. The role of a national agricultural database in providing more reliable indicators of national research activity is also examined.

RESUME

La dépendance totale de la recherche en agriculture d'un mecanisme efficace de communications est unique. Les résultats de recherche obtenus au niveau d'une station expérimentale n'ont aucune valeur tant qu'ils ne sont pas transmis à l'utilisateur final des technologies agricoles: l'exploitant agricole. De plus, comme les autres disciplines scientifiques, un système national de recherche agronomique, ne peut pas exister tout seul. Pour se développer, il doit partager ses résultats et expériences avec d'autres systèmes, particulièrement ceux des pays ayant les mêmes conditions sociales et *écologiques. Il doit contribuer au système international de connaissances agricoles, dans lequel il doit également puiser pour satisfaire ses propres besoins en information. Dans beaucoup de pays, particulièrement ceux du monde en développement, il existe des contraintes qui compliquent et rendent impossible une telle communication. Il s'agit parexemple du manque d'infrastructures pour les communications, du manque de personnel formé, de contraintes financières et de différences culturelles. Afin de promouvoir le développement de mécanismes de communications efficaces, il est nécessaire d'étudier la complexité des modes de communications des travailleurs scientifiques au sein du système national. Il faut comprendre comment les résultats de recherche sont transférés aux utilisateurs (agriculteurs, vulgarisateurs, décideurs). Il est également nécessaire de répertorier les différents supports de publication et leur diffusion. Il faut procéder à un examen critique des moyens de publication et de diffusion et expérimenter des moyens alternatifs plus appropriés. Il faut examiner les outils et collections bibliographiques nationaux pour vérifier dans quelle mesure ils sont accessibles à la fois aux chercheurs nationaux et étrangers. Cette communication se propose de répondre à quelques unes de ces questions et de promouvoir le développement d'un système national d'information sur la recherche agronomique au Cameroun. Elle examine également la possibilité d'utiliser une base nationale de données agricoles pour fournir des indicateurs plus fiables sur les activités de recherche nationale.*

INTRODUCTION

Agricultural research has a comparatively strong tradition in Cameroon compared with other francophone African countries. Before independence in 1960, most research in Cameroon was carried out by expatriate researchers on an *ad hoc* basis. In 1965, when there were only two Cameroonian and 61 expatriate researchers, the law establishing the Office National de la Recherche Scientifique et Technique (ONAREST) was passed. After several structural changes ONAREST began functioning in 1974. It was reorganized in 1976 and was replaced in 1979 by the Délégation Générale à la Recherche Scientifique et Technique (DGRST), which became operational in 1980. In 1984, higher education and scientific research were regrouped in one ministry, MESRES, to which computer science was added in 1989. It is this ministry, the Ministère de l'Enseignement Supérieur, de l'Informatique et de la Recherche Scientifique (MESIRES), which is currently responsible for agricultural research in Cameroon.

Until 1973 research activities were still dominated by the French research institutes, notably those now combined in the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM) and the Institut Pasteur. ORSTOM was charged with the more basic research and the CIRAD institutes were given responsibility for research on crops, animal production and forestry. In 1973, ONAREST created its own national agricultural research institutes, which have now become the

Institut de la Recherche Agronomique (IRA) and the Institut de Recherches Zootechniques (IRZ), and took direct charge of research, with the French institutes continuing to play an important role in providing expatriate research staff as well as training opportunities for Cameroonians abroad. This participation still exists.

Agricultural research is unique in its total reliance on an effective communications mechanism. Research results obtained at an experimental station are of no value unless they can be disseminated to the end user of agricultural technology - the farmer. Furthermore, in common with other research disciplines, a national agricultural research system does not exist in a vacuum. To grow and evolve effectively, it must share its results and experiences with other systems, particularly those in countries with similar social and ecological conditions. It must contribute to the international pool of agricultural knowledge, on which it must also draw to feed its own information needs.

Publications are the single most important means by which scientific links can be forged between researchers within one country or region, and by which they, in turn, can be linked to the international scientific community. Publications also form the raw material for the extension service, which must select appropriate information and repackage it for presentation in an appropriate way, if sophisticated technological advances are ever to achieve their desired impact on farmers' fields[1]. If publications are ever to provide a solid basis for the evaluation of scientific research activity, then considerable work will have to take place in the developing countries themselves to ensure that the information required for the construction of such indicators is in fact available.

This paper examines the development of agricultural research communications in Cameroon, discusses current activities in this area and makes suggestions for further improvements in the system.

Constraints in the production of scientific literature

A national medium for the dissemination of research findings has existed in Cameroon since 1978 with the introduction of the quarterly publication *Cahiers de l'ONAREST/ONAREST Scientific Papers*, which was replaced in 1980 by *Revue Science et Technique/Science and Technology Review.* These journals attempted to provide a forum for all activities carried out by the various research institutes in the country. Although they were reasonably successful, it was considered that their scope was too broad to attract a specialized readership. Consequently, the *Revue* ceased publication in this form at the end of 1982 and was split into four specialized series covering medicine, agriculture and animal husbandry, social sciences and earth sciences. The *Revue Science et Technique. Série Sciences Agronomiques et Zootechniques/Science and Technology Review. Agronomic and Animal Sciences Series* is now the major national forum for reporting agricultural research findings.

We have previously drawn attention to the precarious position of many African journals. In 1973, crop science articles reported in the CAB Abstracts database were published in some 20 Africa-based scientific journals, but by 1982 the number of journals had fallen to less than 10, and these were concentrated in just three or four countries (including Cameroon)[2]. In common with most African publications, the *Revue* has experienced many difficulties during its brief lifetime. The publication is intended to be quarterly, but since the first issue dated December 1984 only seven further issues have so far been produced, containing a total of 84 papers. Responses to a questionnaire survey of IRA/IRZ researchers' publication habits over the period 1988-1990, which is currently being carried out, have so far indicated that 50 papers were submitted to the *Revue* during this time. 25 have been accepted and so are regarded as being "in press", 24 are still being considered; 1 has been rejected; none has yet been published.

Faced with problems of this kind many researchers may be tempted to submit manuscripts abroad, particularly to the more prestigious journals of the industrialised world. However, publication in such journals is often fraught with difficulties for the developing country researcher, unused to the rigid rules of presentation and language required[3]. Given the current financial constraints on journal subscriptions, foreign publication can also easily lead to the ironic situation of information from developing country researchers being more easily accessible to researchers in the industrialized countries than to other researchers in the original country.

Even though it is acknowledged that in many parts of the developing world publication in a prestigious American or European journal is considered to be the ideal, there is evidence to show that in those countries where adequate outlets for papers in national journals do exist, then agricultural researchers do use them to report their findings. In two surveys of researchers' publication habits in Brazil and India[4], local journals accounted for over 90% of the researchers' published output, whereas in Nigeria only 25% of papers were published in local journals[5]. An earlier study of Asian rice researchers (45% of whom were in India) also indicated that only 25% of papers were actually published abroad, though 65% of the researchers said they would *like* to publish in the more prestigious international journals[6].

In our current survey of IRA/IRZ researchers, 40% of the papers submitted for publication during 1988-1990 were sent to foreign journals. Of these, over 50% were produced by expatriate researchers or were jointly authored by expatriate and Cameroonian researchers. No papers with expatriate author involvement were submitted to the *Revue* during this period.

What can be done to improve this situation? How can research workers at centres and stations around the country keep abreast of activities at other research sites, given such problems in publication? What other methods exist for the dissemination of research information around the country? How can we expect international databases to include more developing country information if the publications are not being produced?

Alternate/appropriate publication procedures

We know that the non-conventional literature, that is material not distributed through conventional commercial channels, (such as research reports; consultants' reports; experimental data; land and soil surveys; conference papers; and theses or dissertations), plays a particularly important role in the literature of tropical agricultural development[7]. Estimates of the volume of non-conventional material in the literature of tropical agriculture or in developing countries in general varies from 20% to as high as 75%[8]. Table 1 presents the latest figures available from our current survey of IRA/IRZ researchers' publication habits.

Table 1. Documents generated by IRA/IRZ Cameroon researchers (1988-1990)

TYPE OF DOCUMENT	%
Internal reports	29
Conference papers	25
Submitted to the Revue	24
Submitted to other Cameroonian journals	3
Submitted to foreign journals	19

Source: Questionnaire survey, June 1990 (based on 54 responses naming 351 documents).

As can be seen non-conventional documents made up 54% of the researchers' total publications output during the period 1988-1990. Much of the non-conventional literature is never published and consequently is never disseminated effectively to researchers in other parts of the country and certainly never succeeds in being included in international databases. A partial solution to our current problems may be to tackle the non-conventional literature itself. This is after all the source material on which most conventional publications, in the *Revue* or elsewhere, are based.

There are several ways by which we could approach the problem.. Most non-conventional documents are produced in very limited numbers and have a restricted distribution. We could try to improve the dissemination of the documents themselves with only slight changes in presentation. Naturally, this applies only to certain documents which it is felt are in an appropriate form and could usefully be brought to the attention of a wider audience. We could also introduce new forms of publication, such as newsletters, bulletins and report series, which have proved their effectiveness elsewhere[9]. They can be produced at low cost, even using an office duplicator, if necessary. In particular annual reports of research activities must not be delayed simply because the facilities or the finance are not available to produce a high quality, glossy publication. It is essential for the successful planning and monitoring of agricultural research that research results are made available to other researchers on a timely and coordinated basis. These options are currently being examined by the ODA scientific editor on the Cameroon World Bank project.

Another approach would be to ensure that as many non-conventional documents as possible are included in the national agricultural database. They could then be included in bibliographic publications, such as new accessions lists and library catalogues, together with details of where they could be obtained, and also transmitted to international cooperative databases, such as the FAO's Agris (International Information System for the Agricultural Sciences and Technology). Another related possibility would be the inclusion of abstracts or even synopses of non-conventional literature in either bibliographic publications or in a more conventional publication such as the *Revue*. This is the approach taken in the Netherlands with the creation of the Netherlands Agricultural Report Depositary[10].

We could even try to intercept the information before it actually reaches the non-conventional document stage, by the establishment of a research project information system using FAO's CARIS (Current Agricultural Research Information System) methodology. If a bulletin or newsletter on current project activities, including details of any non-conventional or conventional publications coming from the project, could be produced and disseminated this would also serve to keep researchers up-to-date with developments elsewhere in the country.

In our previous study of crop science publications from sub-Saharan Africa, using the CAB Abstracts database, we noted a five-fold increase in the books/conference proceedings category between 1973 and 1982[11]. This trend was observed to have begun in anglophone Africa (this type of document accounting for 70% of total publications for those countries in 1982), but we are now seeing signs that it has spread into francophone Africa too. The increase is attributed to the publication of conference proceedings by the international agricultural research centres, the International Development Research Centre (IDRC) and other similar organizations concerned with the promotion of agricultural research in sub-Saharan Africa. Looking again at Table 1, we can see that 25% of our IRA/IRZ researchers' output over the period 1988-1990 consisted of conference papers (not necessarily published), and within the past year at least three volumes of proceedings have been published of international agricultural research conferences held in Cameroon[12]. Thus with the decline in national and regional journal publications, these meetings are fulfilling an important role in ensuring the dissemination in published form of research findings. Even though they can provide only a limited outlet, researchers should be encouraged to make presentations at such meetings whenever possible, and to attend them, even if not presenting a paper.

Role of national databases

Most of these alternatives, of course, presuppose that the library or documentation centre is in a position to collect, process and store the documents, effectively prepare and disseminate bibliographic publications, and to transmit relevant references to the appropriate international databases. The library, documentation and publications services at IRA and IRZ are currently being reorganised within the framework of two development projects. The Cameroon National Agricultural Research Project (Projet de Recherche Agricole National, PRAN) supported by a World Bank loan with ODA and GTZ co-financing, aims to strengthen IRA and IRZ by improving the infrastructures and the capacity of the research and support staff. The library and documentation component of the project includes the establishment of a joint IRA/IRZ library and documentation centre at the Nkolbisson site (which is the headquarters of both institutes), the development of a national database on agricultural research and a network linking the regional centres and stations to the headquarters. This project also provides for an expatriate scientific editor to assist in the development of more effective agricultural research publications. Another project signed between MESIRES and ORSTOM includes the promotion of database compilation in the various MESIRES research institute libraries and the development of a common database at the ministry library. Both projects are progressing steadily. ORSTOM and CIRAD have provided considerable input to the systems involved by the development of a standardised input format, BABINAT (Bases de Données Bibliographiques Nationales), and the provision of equipment and technical assistance.

The BABINAT format represents an essential prerequisite for the development of a national, cooperative database. It is being implemented in the MESIRES research institute libraries, at the Centre Universitaire de Dschang (the main centre for graduate-level agricultural training in the country) and in some units of the Ministère de l'Agriculture (MINAGRI). A simplified version of the format, known as Basic BABINAT, has been developed for use in the regional centre and station libraries of IRA and IRZ. This version requires less staff training and enables the production of simple bibliographic listings relatively quickly[13].

The databases created at both IRA and IRZ cover all library accessions, published and unpublished --books, reports, theses and conference papers, plus some journal articles-- and include both national and foreign sources. Turning now to the IRA and IRZ databases themselves, Tables 2 and 3 present the basic characteristics of these two databases.

There are two inter-related points of interest in this context: the relative proportion of non-conventional documents and the proportion of material originating in Cameroon as opposed to that produced abroad. At present these ratios are not quite as high as we would like them to be, particularly in the IRZ database. This could be for several reasons. The databases are both relatively new, IRA's began in 1987 and IRZ only began working on theirs in 1989,

neither yet contains records of all the library holdings. IRZ's database, with less than 650 records, represents only the major library holdings. We can expect these two ratios to increase as more material is added.
Within the framework of the MESIRES/ORSTOM project, ORSTOM has prepared a database on Cameroon consisting of references to all documents produced by ORSTOM or prepared by authors working for ORSTOM over the period 1947-1984. This database has been published as a printed bibliography[14] and the documents themselves are all available on microfiche. Table 4 presents the basic characteristics of this database. It is instructive to compare this table with Tables 2 and 3 referring to the IRA and IRZ databases. In the ORSTOM database 45% of the documents are classified as non-conventional and 43% of the material is produced in Cameroon. Of this Cameroonian material, the vast majority (90%) consists of monographs and of these 83% are classed as non-conventional.

Table 2. Characteristics of the source material in the IRA database

SOURCE	%
Cameroon	30
Other franc. Africa	6
Anglophone Africa	7
France	20
Other W. Europe	17
N.America	10
Latin America	6
Asia	4

NUMBER OF RECORDS	4889

LANGUAGE	%
English	50
French	49
Spanish	1

TYPE OF DOCUMENT	%
Monograph	95
Serial article	5
Conference paper	20
Non-conventional	50
Thesis	2

Table 3. Characteristics of the source material in the IRZ database

SOURCE	%
Cameroon	16
Other franc. Africa	3
Anglophone Africa	9
France	20
UK	20
Other W. Europe	14
N.America	16
Other ind. countries	2
Other dev. countries	<1

NUMBER OF RECORDS	641

LANGUAGE	%
English	70
French	30

TYPE OF DOCUMENT	%
Monograph	75
Serial article	25
Conference paper	10
Non-conventional	30
Thesis	10

If the IRA and IRZ databases are to serve as a means of disseminating information about research activities in Cameroon and of generating the bibliographic indicators needed, then we must ensure that the national system strives to collect and process as much of the non-conventional material as possible. The development of an information network around the country will promote this process by shifting responsibility for collection from the headquarters library and documentation centre to the units in the regional centres and stations, who will usually be closer to the researchers generating this information.

Table 4. Characteristics of the source material in the ORSTOM Cameroon database

SOURCE	%
Cameroon	43
France	46
Chad	3
Other countries	8

NUMBER OF RECORDS	2740

LANGUAGE	%
English	97
French	3

TYPE OF DOCUMENT	%
Monograph	70
Serial article	30
Conference paper	12
Non-conventional	45
Thesis	2

Linkages with the international community

How do we ensure that research carried out in Cameroon is communicated to the international research community? More specifically, how do we report our findings to researchers in other developing countries, who may well be working on similar problems? We know that developing country material, particularly in the agricultural sciences, is usually not well covered by the general international databases[15], so how do we ensure that meaningful indicators are generated?

In an early survey of national contributions to three selected abstracting journals (*Plant Breeding Abstracts, Dairy Science Abstracts* and *Biological Abstracts*), only 28 articles were reported from Cameroon over the period 1948 to 1973[16]. Over a similar time period, we find that the ORSTOM Cameroon bibliography contains 58 references to conventional journal articles and 83 references to conventional monographs published in Cameroon between 1947 and 1973. Of course, these documents cover all aspects of research and only a few of the monographs were found to be strictly relevant to agriculture, the majority dealing with hydrology, medicine and linguistics. However, the 58 journal articles were nearly all of interest, the majority drawn from the three Cameroonian titles *Recherches et Etudes Camerounaises, Revue de la Chambre de l'Agriculture, de l'Elevage et des Forêts du Cameroun* and *Le Cameroun*

Agricole, Pastoral et Forestier. We can safely assume that the abstract journals studied by Boyce and Evenson did not cover these titles at that time.

Our own work on crop science publications from sub-Saharan Africa using the entire CAB Abstracts database produced rather higher figures for Cameroon[17]. Table 5 presents the gross annual crop science publications output from government researchers in Cameroon over the period 1973 to 1982. These figures may be rather inflated since they are taken directly from online searches on the database (they do not allow for irrelevant documents nor for duplication, a particularly serious problem with the CAB database in the earlier years).

Table 5. Gross crop science publications from government researchers in Cameroon, 1973-1982

Year	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
No.	24	16	11	29	24	16	19	12	15	19

Source: Bennell and Thorpe[2].

Actual abstracts were only examined for three years during this period (1973, 1978 and 1982); the results of this evaluation are presented in Table 6.

Table 6. Evaluated crop science publications from government researchers in Cameroon, 1973-1982

Year	Type of publication			Authorship		
	Nat./Reg.	Int./Non Afric	Books/Proc.	Expat.	Nat.	Jnt.
1973	-	23	-	23	-	-
1978	-	9	1	7	2	1
1982	4	5	3	4	7	1

Source: Bennell and Thorpe[2].

We can conclude from these data that publications output from Cameroon (in common with the majority of sub-Saharan Africa) has decreased markedly over the period 1973 to 1982. There was a concomitant marked changed from 100% expatriate authorship in 1973 to 60% national authorship in 1982. We can also note a move from 100% publication in international/non-African journals in 1973 to 40% in 1982, with 35% in national or regional journals, and 25% in books or conference proceedings.

The most appropriate international database for agricultural research information from developing countries is the FAO's Agris. IRA is the national Agris centre, responsible for the contribution of bibliographic records from Cameroon to the international database. We are therefore working to increase the input of Cameroonian material, both published and non-conventional, to our own national database and hence to Agris. Other regional databases, such as

RESADOC (Réseau sahélien de documentation et d'information scientifiques et techniques), may serve a similar purpose[18]. An interesting variation on this theme is presented by SESAME, a cooperative database of francophone tropical agricultural literature, which is distributed on CD-ROM (compact disc, read only memory)[19]. The first release contains some 50,000 records contributed by four French organizations, including CIRAD and ORSTOM, plus the Faculté des Sciences Agronomiques at Gembloux (Belgium) and the Institut Sénégalais de Recherches Agricoles (ISRA). Material contributed from the IRA and IRZ databases is scheduled to be included in the next release.

CONCLUSION

It is essential that agricultural research results are effectively disseminated to all clients of the research system --other researchers, both in country and abroad, extension workers, agro-industrialists, political decision-makers, etc. Publications, whether conventionally produced or not, are the prime means of achieving this aim. We must critically examine our publication and dissemination procedures, and explore new avenues which may be more appropriate in the present situation. In whatever form the information is disseminated, whatever medium is used as the information carrier, we must ensure that it is brought under adequate bibliographic control. To guarantee that our research results reach workers outside the country, we must ensure that our national database is constructed in accordance with international standards and that we can effectively participate in international cooperative systems. Only if we succeed in all these areas can we hope to produce truly meaningful indicators of agricultural research activity in developing countries. This is the path we are progressing down, albeit slowly, in Cameroon, and I believe that it is the right one.

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USE OF PUBLICATION LISTS TO STUDY SCIENTIFIC PRODUCTION AND STRATEGIES OF SCIENTISTS IN DEVELOPING COUNTRIES

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ABSTRACT

A bibliometric study using the lists of publications and work of 207 scientists working in Asia, Latin America and Africa was conducted. A certain number of authored and co-authored articles published in scientific journals and bulletins, conference papers, books, chapters of books, reports were taken into consideration to measure the total scientific output. Local vs. international production was also determined by scientific fields, geographic areas, sexe and language of publication. Co-authorship studies were also used to particularly measure the degree of collaboration and dependance of Developing Countries'(DC) scientists on foreign co-authors. An analysis of the references used (age, origins) was also made. Conclusions drawn concern the comparatively specific nature of science produced by DC's researcher. Partly given the importance of the scientific production published in local journals, the inadequacy of international databases to study DC science is confirmed. Most of the DC scientists publish in both national and international journals. They often cite their colleagues from the developed countries but their own work being less "visible" is seldom cited.

RESUME

Une étude bibliométrique utilisant les listes des travaux et publications de 213 chercheurs travaillant en Asie, en Amérique Latine et en Afrique a été effectuée. La production scientifique totale de ces chercheurs a été mesurée en prenant en compte le nombre d'articles en tant qu'auteur et co-auteur publiés dans des journaux scientifiques et bulletins, les contributions à des conférences, les livres et chapitres de livres ainsi que les rapports. La répartition de leur production entre science locale et internationale a également été déterminée par domaines scientifiques et géographiques, par sexe et langue de publication. La qualité des co-auteurs a également été examinée pour déterminer en particulier le degré de collaboration et de dépendance des chercheurs des Pays en Développement (PED) par rapport aux chercheurs étrangers. Les conclusions mettent en évidence les caractéristiques spécifiques de la production scientifique des chercheurs des PED. Compte tenu de la relative importance de la production scientifique publiée dans les journaux locaux, l'inadéquation des bases de données internationales pour étudier la science des PED est confirmée. La plupart des chercheurs des PED publient à la fois *dans des revues nationales et internationales. Ils citent beaucoup les travaux de leurs collègues des pays développés, mais leurs propres travaux étant moins "visibles" sont rarement cités.*

INTRODUCTION

To measure the relative scientific output from the Developing Countries (DC) most authors have so far been using international databases, especially the one from the Institute for Scientific Information (ISI) in the United States (Garfield 1983, Frame et al. 1977, Blickenstaff and Moravcsik 1982). The work done by Davis (1983) in 36 sub-Saharan African countries for the period 1970-1979 is interesting because it concerns a relatively homogeneous group of countries. The scientific output of groups of countries (Arunalachalam and Markanday 1981; Krauskopf, Pessot and Vicuna, 1986) and individual countries (Krauskopf and Pessot 1983, Martinez-Palomo and Arechiga 1979, Morel and Morel 1978) has also been analysed using ISI and other international databases. These studies provide interesting information on the position of the various countries on the mainstream science supplier list and their impact on world science, but the description of how science is constructed in these countries, the researchers' scientific strategy, and their participation in national and international science is incomplete and often inaccurate.

We propose to use a different approach. This paper examines the scientific written output of 207 African, Asian and Latin American scientists who have been awarded one or several research grant(s) from the International Foundation for Science (IFS) in the agricultural and biological sciences and related technology. These scientists are working in 54 countries (23 African, 13 Latino American and 18 Asian Countries). Their scientific written output represents close to 5000 references produced during the 70's and the early 80's. The most significant individual feature of the population stems from the fact that the researchers who constitute it are the products of an internationally directed selection procedure. In other words, we could hypothesize that they are among the best researchers in DCs.

1. Local science and mainstream science

Although there is no database that is anywhere near complete, the DCs were recently credited with approximately 5% of the world's scientific production. Many databases are highly specialized. This is not the case for ISI which covers some 4500 journals from very diverse fields of science. But ISI is very selective and only screens the world's most popular scientific journals, the ones that publish the most frequently cited articles. Its Science Citation Index (SCI), developed by the ISI mapmakers, mainly focuses on what has become known as "mainstream science", the most internationally visible science carried in 3100 scientific journals. Considering that there are not far from 70 000 scientific journals in the world (Turner 1984), the ISI database is really selective. Thus ISI represents about 6.5% of the scientific journals published throughout the world. Bibliometric work is often based on ISI data. Therefore, even if it covers the mainstream, it only bears on a small proportion of the world's science. Further, the DC scientific reviews are rated as "backwood cousins" in the ISI database which includes hardly more than 2% of them. French publications, together with all the other publications that are not in English, are at a disadvantage. The scanty number of DC journals, per country and per discipline, to be found in the ISI database illustrates how severely DC science is underrepresented.

The question of adequately representing science produced in the DCs in international databases was the main point at issue at a 1985 conference organised at ISI, in Philadelphia. The title of the final conference report, "Strengthening the Coverage of Third World Science" pointed to a glaring gap (Moravcsik 1986). It is difficult to define the precise amount of DC science omitted from the international databases, especially at ISI. The final conference report noted that "the workshop participants estimated that only about half of the scientific output of the third world which meets international standards of excellence is included in the SCI" (Moravcsik 1986, p. 3). ISI explains that DC scientific production published in national journals is not included in the SCI for reasons of quality. The national scientific journals are accused of not passing articles through a screening committee and publishing poor and even dubious quality work[1] (Packer and Murdoch 1974). This criticism is often addressed to India, the Third World's leading producer of science...by Indian scientists themselves (Arunachalam 1979a, 1979b, Arunachalam and Manorama 1988). The explanation often goes back to a cultural tradition that virtually bans criticism, especially in Asia. "No one wants to hurt the other. Politeness, a virtue of drawing room conversation, is extended to mean that no one criticises the other. In such an atmosphere, genuine criticism of someone's work is taken as a personal insult and leads to sentimental and emotional reactions, rather than rational defense" (Arunachalam 1979a, p. 8).

The work published in DC scientific journals is not excluded from international science and more specifically from the SCI for reasons of quality alone. The citation criterion, which is the basis of the system, works against scientific communities at the periphery because, as we will see in greater detail below, much of the work is published in local reviews only circulated within the

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[1]The editorial practise of certain mainstream journals, including some of the leading ones, is not always very selective. Packer and Murdoch asserted that during the 1963-1973 period, The Bulletin of Entomological Society of America, by principle, and insofar as possible, printed all the articles it received. During that decade only 4% of the articles submitted submitted to the Journal of 'Economic Entomology', The 'Annals of the Entomological Society of America' and 'Environmental Entomology' were rejected.

country. The scientists of these communities are caught in an especially vicious circle, because even when their findings are published in highly influential, prestigious scientific journals in the centre, they are, all told, far less often cited than writings by their colleagues from the centre, (Arunachalam and Garg 1985) which explains the very ambivalent feelings of scientific communities in the periphery concerning the significance of citation. Recent work on referencing within the Brazilian scientific community showed that, "citation patterns are significantly influenced by factors 'external' to the scientific realm and, thus, reflect neither simply the quality, influence, nor even the impact of the research work referred to" (Vehlo 1986). Brazilian scientists feel that the place of publication strongly influences the number of times a publication is cited. This was borne out by S. M. Lawani (1977) who showed that out of a representative sample of 100 entomology articles written by Nigerian authors, articles published in foreign journals were cited 1.74 times more often than articles published in local scientific journals[2].

Actually as J. D. Frame so correctly said, it all depends on what you are trying to assess. "If the purpose of the bibliometric indicators is to help in the building of a national scientific inventory, telling us what kind of research is being performed at different institutions, then coverage of local as well as mainstream publications would seem important. On the other hand, if one is primarily interested in investigating third world contributions to world science, then publication counts taken from a restrictive journal set would seem most appropriate" (Frame 1985, p. 121).

There is also a marked tendancy to assign research scientists of the peripheral scientific communities to two distinct categories; scientists who "really count", in other words are known to the international scientific community since they publish overseas in influential international journals and, the others, whose "local" science lacks originality and, at best, is published in low circulation local journals (Arunachalam, 1988).

Several recent studies justify a revision of this exaggerated - but largely held - caricature of science production in the periphery. Arvanitis & Chatelin (1988) Chatelin & Arvanitis, 1988) made a bibliometric study on soil sciences and agriculture which pointed to great differences in the national and individual publication strategies in the DCs, and showed that local science was not synonymous to poor science. It is not for reasons of scientific quality that the vast majority of studies on soils and agriculture are not "mainstream". Many dynamic DC scientists actually partake of the international scientific life but publish most of their findings in national journals. Studying a scientific generation's original work in this field so vital to development brought out the

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[2]In this publication Lawani also provides a per country rundown of the 829 journals that have an above-average impact according to the SCI. The USA is the leader (60% of the titles), followed by Great Britain and the Netherlands. There is only one DC journal (Revista Mexicana de Astronomia, published in Mexico) on the list.

importance of the time needed to develop a scientific thrust. A close look at the history of scientific production at a Mexican biomedical research institute showed that research scientists had changed their publication strategies in the score of years between 1959 and 1979 (Lomnitz, Rees and Cameo, 1987). By 1979 half of their output was published in international journals. Yuthavong, (1986) reporting on Thai scientific institutions, found a strong correlation between the number of articles the scientists from these institutions published in international journals and in the Journal of the Science Society of Thailand[3]. Eisemon and Davis (1988) showed that a sizeable proportion of the more dynamic scientists from four peripheral scientific communities of Asia (South Korea, Taiwan, Malaysia, and Singapore) published both in local and in international journals. They said that "the decision to publish locally is not merely the reflex of a second rate scientist, or the result of rejection elsewhere." It is the result of choice rather than necessity. These four countries have developed important local scientific literature that is not mainstream and, according to these authors, the local science will probably not be eliminated as the scientific communities gain clout in the international scientific community.

All these recent findings substantiate the thesis that the bibliometric indicators, especially the SCI, do not accurately assess the scientific output from the periphery, especially from the DCs and that local science far from being synonym of poor science, is at least as important as international science in the context of a developing country, and should thus be taken into account.

2. Total scientific output: sizeable local production, especially in Asia and in Latin America

In our sample, each scientist is producing on average 0.6 publication per year as sole author, and 0.7 as co-author (Table 1).

Table 1. Production per scientist per year.

Articles in scientific journals	1.3
Conference papers	0.5
Books or chapters in books	0.07
Bulletins and reports	0.3

This is slightly more than half that of American researchers in agricultural sciences, according to Busch and Lacy who reported 0.9 and 1.3 respectively.

[3] The Journal of the Science Society of Thailand is also indexed in the SCI of the ISI. A weaker correlation was noted between the number of publications appearing in the latter's journal and the number of abstracts presented at the annual symposium of the Science Society of Thailand by the various scientific institutes of Thailand.

Further we have been able to estimate that more than half (55%) of the total scientific production of the scientists was published or available locally. The remaining 45% which was published abroad can be divided into articles published in scientific journals in industrialised countries (37%) and in other developing countries (8%).

These global statistics camouflage significant variations between geographical and scientific areas (cf. Table 2). The field in which the scientists are publishing most (1.6 publications per grantee per year) is Natural Products. This is also the field in which they publish most abroad (1.1 publications per grantee per year). Food Sciences is almost the opposite. There are more local (1.0) publications than foreign (0.4) publications. These results can be traced to the nature of the related research. The fields in which there are the fewest publications, i.e., Forestry (0.7) and Rural Technology (0.8) are probably also the fields with the most practical applications, whose results do not always need to be published.

We have also observed that Asian scientists publish more than African or Latin American scientists (1.5 as against 1 journal article per grantee per year respectively). Further, Asian scientists publish more locally (60%) than African scientists (41%). In Latin America more was published locally (58%) than overseas. (Table 3). These percentages, in comparison with figures for developed countries, are exceptionally high. Scientists in France publish 20% of their scientific production in foreign journals. For West Europe as a whole, the figure is 12%, and for Japan 25% (Garfield 1977, 1978, 1983).

Table 2. Number of journal articles (per scientist per year) by discipline.

Discipline	Published locally	Published abroad	Total
Aquaculture	0.6	0.7	1.3
Animal Production	0.8	0.4	1.2
Crop Science	0.5	0.6	1.1
Forestry	0.4	0.3	0.7
Food Sciences	1.0	0.4	1.4
Natural Products	0.5	1.1	1.6
Rural Technology	0.4	0.4	0.8
Total Mean	0.64	0.66	1.3

It should be made clear that this covers the scientists' total scientific production, not only journal articles which are published in equal proportions in local and foreign journals. When consulting Table 3 one should also remember that there are many more local journals in Asia and in Latin America than in Africa. We have also observed a relatively significant difference in productivity by gender; men publish more than women. This difference is all the more

Science and Natural Products and less active in fields such as Rural Technology where little is published. Women tend to publish more locally than men.

Table 3 . Place of publication per geographical area (%).

Geographical area	Locallly	In another developing country	In an industrialised country
Africa	41	10	49
Latin America	58	9	33
Asia	60	6	34
Total	55	8	37

Research is becoming increasingly collective, and scientists work together not only to bring their research to a successful conclusion but also to be able to publish their results as a joint venture. This holds for scientists who publish about two-thirds of their work with co-authors, as is shown in Table 4. Table 4 establishes that as a general rule the fields in which scientists work together most are the fields in which most is published.

Table 4. Number of publications (including bulletins, books, internal reports, conference papers) per scientist and per year as sole author and as co-author.

Research area	As sole author	As co-author	Total
Aquaculture	0.9	1.3	2.2
Animal Production	0.4	1.6	2.1
Forestry	0.7	1.2	1.9
Food Science	0.9	1.7	2.6
Natural Products	0.4	1.9	2.3
Rural Technology	0.7	0.9	1.6
Total	0.7	1.4	2.1

This confirms earlier findings by Price and Beaver (1966) and by Beaver and Rosen (1978, 1979a, 1979b) who observed that collaborative research enhanced productivity[4]. Results also show that there is significant difference between disciplines. Fields that have the largest number of authors per publication, such as Natural Products, are fields that require inputs from a variety of disciplines e.g., taxonomy, botany, chemistry, and pharmacology. If the right specialists are not locally available, foreign cooperation is required, which explains the higher number of foreign co-authors per publication (0.53) for a field such as Natural Products (Table 5). Although the difference in average numbers of co-authors in terms of geographical distribution is not significant, we have noted that Asia has the highest number (2.4), followed by Latin America (2.2) and then Africa (2.1).

The mean number of authors per publication gives an interesting indication of the degree of association among researchers who publish, and the origin (local or foreign co-authors) gives an indication of the openness and/or dependence of the researchers. Table 5, for instance, confirms that National Products is the field for which the publication rate is the highest. It is also the field that brings DC scientists and foreign scientists together most. Actually, the more the scientists publish abroad, the more they work with foreign scientists.

Table 5. Average number of authors and co-authors (local and foreign) per publication.

Research area	No. of authors	No. of local authors	No. of foreign co-authors	Total no. of publications per scientist/year
Aquaculture	1.87	0.75	0.12	2.2
Animal Production	2.12	0.98	0.14	2.6
Crop Science	1.95	0.72	0.23	2.1
Forestry	1.98	0.67	0.31	1.9
Food Science	2.12	0.98	0.14	2.6
Natural Products	2.85	1.32	0.53	2.3
Rural Technology	2.20	0.80	0.40	1.6
Total	2.25	0.96	0.29	2.1

Thus we found that there were no researchers who had published more than 12 articles abroad without a foreign co-author. Garfield (1983) has shown that articles by researchers in DCs have a greater impact (on the international scientific community, measured in terms of number of citations per article) when they are

[4]Three reports by Beaver and Rosen published as a series in 'Scientometrics' in 1978 and 1979 are based on a study of collaboration between scientists throughout time since the 17th century. This study showed that collaboration in scientific research was a sign of professionalism within the scientific community and made the scientists more mobile and "visible".

co-authored by researchers from industrialised countries. Here we come up against the dilemma of the strategic scientific choices that researchers in DCs, in common with most researchers in peripheral scientific communities, have to make between participation in mainstream science (the most used, most visible, and most frequently cited science) and the resolution of local problems through "inward looking" research which some call "domestic" or "in-breeding" science.

It is worth observing that co-authoring with foreign scientists is most prevalent among scientists who studied, or went on post-doctorate study tours abroad. In most cases, however, these publications are produced in the years immediately following the stay abroad; sustained active collaboration is rare. Other associations develop when a foreign professor is on assignment in the scientist's home laboratory, or when expertise, not locally available, is brought in as part of a programme financed by a foreign institution or subsequent to an international conference.

The choice of language of publication is also central to the scientific strategy. A look at the lists of references consulted in preparing this study confirms the hypothesis that the different linguistic worlds are almost "language-proof", especially between the English and French languages. Spanish- and Portuguese-speakers often cite literature in English; this is rarely the case for French-speakers. And references by English-language scientists are drawn for all intent and purposes exclusively from literature written in English (Table 6). To one degree or another, these four languages dominate the world's scientific literature. In a few Asian countries, science is published in national local languages.

Table 6. Language of publication by linguistic area (%).

Linguistic area	Local	English	French	Spanish & Portuguese	Total
French-speaking countries	1	17	82	-	100
English-speaking countries	8	92	-	-	100
Spanish- & Port. speaking countries	-	36	1	63	100
Total	6	76	8	10	100

The percentages in Table 6 refer to approximately 5000 publications produced by 40 Latin American researchers (mainly Spanish speaking), 29 French-speaking African researchers and 138 English-speaking researchers. These results confirm the prime importance of English and the resulting subordination of the other languages. Out of 3678 publications by English-speaking scientists, 2 were in French, 1 in German, 4 in Russian and none in either Spanish or Portuguese. On the other hand, more than one-third (36%) of the publications by Latin American and almost one-fifth (17%) by French-speaking scientists were in English. Our case study in Senegal indicated that English was increasingly used in French-speaking countries. The percentage of articles published in English by scientists working in Senegal, for instance, rose from 15% in 1975 to some 30% in the early 1980s (Gaillard, 1989).

The other conclusions that can be drawn concern the relatively significant use (8%) of local languages in certain Asian countries, e.g., Indonesia where more than half (52%) of the scientists' published works appear in Indonesian, Thailand (28% in Thai), and South Korea (18% in Korean). These percentages would be considerably higher if our figures only applied to the language of publication used in the national journals. Eisemon and Davis (1989) reported that over half (57.1%) of the articles in six South Korean journals were published in Korean[5]. Publication strategies differ greatly, depending on both the country and the discipline. Unlike South Korea, in Singapore all the scientific journals are in English.

As a general rule researchers will tend to publish in local languages, in national publications if their subject of research is for direct application. Except, perhaps, for a few Thai scientists, who find it difficult to write in English, the decision to publish in a national language and in a national publication is usually a question of strategy, as can be seen in interviews with scientists who say things like, "I submitted this paper to a local journal because the contents essentially bear on a local problem. This should make it easier for me to make the authorities aware of the problem and help them find the right solutions for our national development." Or, as concerned Korean and Thai, "I published in my national language so that I could use it in teaching." Another scientist said that he had decided to publish in a new local journal to contribute to its development because "...I feel that it is essential for our countries to have good quality scientific publications."

A few scientists admitted that it was "easier" and "faster" to publish in national journals. Using a national language also means reaching readers that do not receive international journals, and, furthermore gaining repute amongst peers and students in the home institutions. Most published both in national and international journals. Only about 20% published exclusively in the national journals; these were mainly young scientists working in agronomic research (Animal Production, Crop Science, Forestry) and Aquaculture. There were no

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[5]The fields covered by these journals, viz., biology, biochemistry, computer sciences, electronics and physics, are however more directly related to international science.

scientists from Natural Products who published exclusively in the national journals.

An analysis of the references used in articles provides precious information on the scientific output and research practices. We saw, for instance, there was far more intra-linguistic than inter-linguistic transfer. We also obtained information on the relative use of local and international science and the relative age of the work cited in the scientists' publications. Some authors found that scientists from the peripheral countries tended to ignore - or did not have access to - older publications, and thus concluded that the use of more recent references was characteristic of science in these countries (Rabkin and Inhaber 1979) The opposite was also alleged, i.e., that scientists in the peripheral countries cite references that are much older than those cited in articles published in international journals by colleagues from industrialised countries (Aranuchalam and Markanday 1981, Velho 1985, pp. 244-256).

Now let us look at our study population. For purposes of comparison with scientists from developed countries working in similar fields we referred to Lea Velho's thesis (1985, p. 247) to find a sample of articles published by - mainly American - scientists in scientific journals of centre countries. The results (Tables 7, 8, 9 and 10) show that DC scientists generally refer to articles more that 10 years old. Close to half (45%) of the references date back to over 10 years, while for authors from centre countries the figure is under one-third (29%).

Table 7. Breakdown according to age of reference cited, per continent of scientists' work.

Years	Africa	Asia	Lat. Am.	Total DC	Centre countries
0-5	180 (22)	195 (22)	126 (25)	519 (23)	340 (42)
6-10	312 (38)	240 (27)	180 (32)	732 (32)	239 (29)
> 10	327 (39)	456 (51)	240 (42)	1023 (45)	232 (29)
Total	819	891	564	2274	811

N.B. Figures between brackets show rounded percentages of the total.

On the other hand, scientists from centre countries often (42%) use references under five years old, while for DC scientists the figure drops to 23%. Table 7 showed us that there was no great difference between geographical areas for the three main continents although there was, as has been shown in other studies[6] (Crane 1972) and in Table 8 below, between disciplines.

Table 8. Breakdown of age of reference cited according to scientific discipline.

Discipline	0-5 (%)	6-10 (%)	> 10 (%)	Total
Aquaculture	132 (23)	138 (24)	303 (52)	573
Animal Prod.	42 (17)	96 (38)	114 (45)	252
Crop Science	102 (18)	171 (31)	285 (51)	558
Forestry	51 (26)	75 (37)	75 (37)	201
Food Sciences	48 (21)	108 (47)	75 (32)	231
Nat. Products	144 (31)	144 (31)	171 (38)	459
Total	519 (23)	732 (32)	1023 (45)	2274

The figures indicate that Natural Products, a discipline that draws heavily on organic chemistry and pharmacology, uses the most recent references (31% within the last five years). It is worth remembering that this is the field that generates the most joint publications with foreign researchers. The biological sciences most directly linked to agriculture (Animal Production and Crop Science) and Aquaculture are the disciplines with the most references over ten years old (between 45 and 52%). Thus, biological disciplines, largely based on analytical work, e.g., natural substances and work on mycorrhiza in forestry, tend to use more recent references than the more descriptive research that relies more on experiments with live matter.

As concerns the age controversy with regard to "national vs. international" journals, our results (Table 9) tend to agree with Arunachalam and Markanday (1981). Apparently articles published in national journals cite references that are older that those cited in international journals that belong to mainstream science. A finer analysis would probably reveal significant differences between countries. Eisemon and Davis (1989) showed that one-fifth of the references in articles published in national journals of Malaysia, Thailand, and South Korea dated back

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[6] Brown, cited by Crane (1972), found that the percentage of refernces under 10 years old was the highest in publications on physics, lowest in biology and that physiology and chemistry came in between.

to five years ago at most whilst in Singapore nearly one-third of the non-mainstream science references were of that age.

Table 9. Breakdown per age of reference between publications published abroad and nationally.

Years	Abroad (%)	National (%)	Total (%)
0-5	405 (25)	114 (17)	519 (23)
6-10	537 (34)	195 (29)	732 (32)
>10	660 (41)	363 (54)	1023 (45)
Total	1602	672	2274

It is quite clear that articles printed in national reviews are much more readily assimilated by DC scientists than anything found in foreign journals, as Table 10 indicates.

Table 10. Breakdown per age of reference: foreign vs. national.

Years	Foreign ref. (%)	National ref. (%)	Total (%)
0-5	243 (14)	276 (56)	519 (23)
6-10	606 (34)	126 (26)	732 (32)
>10	936 (52)	87 (18)	1023 (45)
Total	1785	489	2274

Over half (56%) of the references drawn from national scientific literature date back at most five years, while only about one out of seven references (24%) taken from foreign journals are thus dated. Yet the scientific transfer within or between the DCs is not very great (only 22%). In other words references in publications by DC scientists are mainly (78%) taken from mainstream scientific literature, but with some delay since more than half the references date back to at least a decade ago. Several reasons can be suggested for this situation which is largely due to dysfunctioning of scientific practices in the developing countries.

Since most of the DC scientists, unlike their colleagues in developed countries of the centre, do not belong to what is generally called the "invisible college", they do not become familiar with their colleagues' work before it is published. Actually their only access to information is tedious bibliographic research, and even this does not always result in the identification of the most relevant reference work. We also found out that only half the scientists had bibliographic catalogues like "Current Contents", and that less than one-third of them had access to bibliographic databanks. The unavailability of bibliographic references was felt with special acuteness in most African countries. This said, during our missions we saw that, except in several African countries, the libraries in DC universities and institutions had relatively recent scientific journals from countries of the centre that institute scientists rarely consulted. Some of these journals looked as if they had never been opened. Many scientists try to subscribe individually to the most relevant international journals, but scanty financial means that are not regularly available makes this difficult.

The fact that DC scientists often cite articles in journals that are over ten years old can also be related to the time between their training period abroad and the publication of their work. Over 75% of our cohort studied abroad, mainly in the U.S., Great Britain, and France. Quite possibly their references are works they learned about during their education abroad. This is an explanation Lea Velho entertains in reference to Brazilian scientists: "the longer the time since the researchers returned to Brazil from graduate training abroad, the older the foreign literature they tend to cite" (Velho, 1985, p. 253).

Turning to total scientific production we see that English-speaking scientists, mainly in Asia, constitute the most published group (2.37 publications per scientist per year), while French-speaking Africans (1.63) and Latin Americans (1.76) form the least published groups. These figures, of course, only provide a partial indication and cannot be used as a decisive measurement of the quality of a research scientist. Other indicators have to be used. For reasons given above we decided not to use the citations method in measuring the impact and the quality of articles published in international reviews. A full-fledged qualitative evaluation would have required the participation of several specialists with a variety of linguistic capacities for each of the disciplines concerned, which was beyond the means of our study.

CONCLUSION

Several conclusions can be drawn from this study concerning the specific nature of science produced by DC researchers, and the construction of science in their countries.

Science produced in DCs is not adequately represented in international databases not exclusively for reasons of quality. While international databases can be used as a source of information of the relative strengths of various countries in mainstream science, they give an incomplete and often inaccurate picture of total scientific output and how science is constructed in non-mainstream countries.

A look at total scientific production shows that DC scientists often publish (up to 60% in Asia) in national journals, that the leading language is English, a language even used for publishing by close to one-fifth of the French-speaking scientists and over one-third of the Latin American scientists. We also saw that the English-speaking scientists only publish in English or, as is the case in some Asian countries (e.g. Indonesia, Thailand and Korea), often in local languages. Most of the scientists publish in both national and international journals. Although publication strategies differ according to country and to scientific discipline, scientists who decide to publish in a local language or journal most often do so by choice and not by necessity.

DC scientists cite references essentially (78%) from mainstream scientific literature which they seem to receive later than their colleagues in the centre since nearly half the references are over 10 years old, as against 29% of the references cited by scientists from the centre countries. An analysis of the citations indicates that DC scientists use articles from national journals much sooner in time than articles from international journals. Actually citation modes are affected significantly by factors unrelated to science, factors which are social rather than cognitive in nature. Scientists in the DCs need much more time to avail themselves of new scientific data that are pertinent to their research.

In sum, DC scientists often cite their colleagues from the developed countries, but their own work being relatively "invisible" is seldom cited. They often feel caught in a dilemma: either adopt the habit of scientists from developed countries and publish in international journals to become more "visible" and gain international standing, or else seek national recognition by publishing in local journals, and sometimes in local languages, thus being condemned to non-existence or, at best, marginal existence in mainstream science. The general trend is to adopt the two strategies together.

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BRAZILIAN PRODUCTION IN BIOCHEMISTRY INTERNATIONAL VERSUS DOMESTIC PUBLICATION

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ABSTRACT

This work describes a bibliometric survey on scientific production in biochemistry originated from 19 Brazilian institutions , which comprised 487 staff investigators, 70-80% of active investigators biochemists. These investigators published about 3000 papers in international journals in the period 1970-1985, which generated about 17000 citations from 1983 to 1987, according to the Institute for Scientific Information data base. In this survey we distinguished what we called endogenous articles (produced in Brazil) from exogenous articles (produced abroad by Brazilian biochemists), in terms of the spectrum of journals in which they were published and the number of citations generated per article. A comparison was also performed for the two groups in terms of the impact factor generated by Brazilian articles in a given journal versus the expected impact factor for all articles published in that journal. In all cases we detected a certain disadvantage for endogenous articles, the possible reason of which is discussed. Biochemistry is one of the scientific areas in Brazil in which the investigators make a large effort to publish in international journals. We observed differences in the impact generated by these international papers, when biochemistry was compared with other areas which exhibit the same tendency towards an international output. From these observations we discuss the pertinence of publishing for an international audience as opposed to publishing in domestic journals.

RESUME

Cet article décrit une étude bibliométrique sur la production en biochimie issues de 19 institutions au Brésil, regroupant 487 chercheurs, soit environ 70-80% de la population totale de chercheurs en biochimie du pays. Ces chercheurs ont publié environ 3.000 articles qui ont généré 17.000 références de 1983 à 1987, selon la base de donnée de l'Institute of Scientific Information. Cette enquête distingue les articles endogènes (publiés localement) et articles exogènes (publiés à l'étranger) en fonction de l'éventail des revues de publication et du nombre de citations reçues. Une comparaison est effectuée entre les deux groupes sur le facteur d'impact généré par des articles brésiliens dans une revue donnée par rapport à l'ensemble des articles publiés par cette même revue. Dans tous les cas on note un désavantage pour les articles endogènes dont les causes possible sont présentées ici. La biochimie est un domaine au Brésil où les chercheurs font le plus d'effort pour publier dans des revues internationales. Nous comparons l'impact des articles internationaux avec ceux d'autres domaines qui font le *même effort de publication internationale. A partir de ces observations nous discutons la pertinence de la publication locale par opposition à la publication internationale.*

INTRODUCTION

In Brazil different scientific fields present rather distinct trends in terms of the audiences to which the publications are aimed. If we consider the database generated by CAPES (a federal agency that deals with graduate studies) we see that in 1982 Brazilian scientists published 7,968 journal articles, 5,995 in national journals (1). Therefore only one quarter of Brazilian science is aimed at an international audience, while three quarters is published in national journals, presumably for national consumption only (1). Although this database refers only to graduate programmes, in practice it covers most of the Brazilian scientific publications, 85% according to Castro (2). If any attempt is made to interpret these results it should be considered that the ratio between international and total publications varies substantially from one area to another. Thus, in social sciences this ratio in 1982 was 7.2 %, in agricultural sciences it was 14.3% and in basic areas (biology, chemistry, physics, geology, astronomy and mathematics) international publication reached 46.9% (1). Each sub-area exhibits its own profile: in biology the ratio was 40.7 % and in physical, chemical and earth science international publications comprised 53.2%. In the period 1983-1986, 73 % of the 1,012 Brazilian articles in chemistry were published in international journals, and 92% of the latter were included in the ISI database (3).

Why these different areas present different patterns of publications is a matter of study and debate. Certainly, history and strategy are part of the explanation. However a more comprehensive analysis is required in order to have a better understanding of this phenomenon. An effort in this direction seems to be necessary because the results may have implications in science policy.

BIOCHEMISTRY IN BRAZIL

Biochemistry in Brazil is a relatively developed scientific area. Although it is difficult to delimit its boundaries we know that there are at least 700 active professional investigators registered at the Brazilian Biochemical Society, corresponding to 3 to 4 percent of the total number of scientists in Brazil. Most of them were trained in North American or European Institutions, either as graduate students or as post-doctoral fellows, supported by Brazilian governmental programmes. They brought with them the spirit of competitiveness and the awareness of the international character of biochemistry as a basic area of sciences. Because of that a desire to report the scientific findings in the best international journals is common in most of the biochemistry departments, there is a pressure by grant and promotion committees for good scores of international publications. Given the relatively fragile infrastructure of sciences in Brazil this trend poses a strain over the members of this community which is not common in many other Brazilian scientific areas where publishing is a much less painful task. In fact, virtually all of the about 400 Brazilian scientific journals have either lenient or no editorial policy at all. From these considerations several questions may be raised: (i) to what extent the effort of Brazilian investigators to address an international audience is rewarded ? (ii) does this endeavor pay off in terms of progress of a specific scientific area as compared to areas in which the tendency is publishing in domestic journals. To start addressing these questions an assessment of the pattern of publication and international repercussion of the articles of each area is required. In the present work we describe a survey of publications of Brazilian biochemists in the period 197G-1985 and the impact they produced in terms of citations scanned by *Science Citation Index* (SCI)

SURVEY

We chose to cover 19 departments and/or institutions involved in biochemistry/molecular biology investigation, which are known to represent the best in this area in Brazil. These institutions comprised 487 staff members in 1985, which represented about 70 % of the professional Brazilian biochemists but that in terms of production represented about 90 % of the publications in this area. Eight of these 19 institutions are located in the state of Sao Paulo and 5 in the state of Rio de Janeiro, the remaining being spread over 6 other states. From the publication lists of these 487 investigators we compiled a total of 3301 papers published between 1970 and 1985.

Table 1. Publications in biochemisty in the period 1970-1985

1-Total of publications	3,301
2-International publications*	2,997
3-Publications in Portuguese	304
4-Endogenous international publications **	2,218
5-Exogenous international publications **	779

* Written in a foreign language. Over 95% of these publications were in English. ** See text .

Table 1 shows that 92 % of these papers were addressed to an international audience, the vast majority written in English. However many of these international papers were not in fact generated in Brazil since most of the Brazilian biochemists spent a doctoral or postdoctoral tenure abroad. Therefore each of these 487 investigators were requested to identify those papers which reported work entirely performed in a foreign institution. These we called **exogenous** publications as opposed to the **endogenous** ones, which were entirely or partially (in collaboration) developed in a Brazilian institution. Twenty-six percent (779) of these international publications were exogenous. Therefore the remaining 2,218 were endogenous international papers, which still represents 87.9 % of the total genuine Brazilian publications (compare lines 3 and 4 of Table 1). The international publications in biochemistry correspond to a much higher percentage than the average 46.9 % of international publications in basic sciences in Brazil (1) and probably meets no parallel in other sub-areas of Brazilian science.

Presently, the best way of detecting the repercussion of international publications is through the rate of citations they earn through the SCI survey. Table 2 shows the citation rates surveied in a 5 year period (1983-1897) of the papers published in the period 1970-1985. The first point that comes to our notice is that exogenous papers had an impact 2.8 fold higher than the endogenous papers. That is, Brazilian biochemists, operating in American and European laboratories achieved with their publications a significantly better score of citations than when operating in Brazil. Among the explanations that can be considered, one is the possibllity that the profile of journals utilized for exogenous publications had been distinct from those utilized for endogenous publications.

Table 2. Citation rates in the 1983-1987 period related to the international publications of the period 1970-1985.

Type of international publication	Number of publications	Number of citations	Citations / publications
Endogenous	2,218	8,687	3.92
Exogenous	779	8,724	11.20
Total	2,997	17,411	5.81

This is in fact the case: The 2997 international papers were published in 698 different journals (Table 3). The great majority (426) were international journals, 33 were Brazilian journals and only 9.6 % of these papers were published in proceedings of congresses (monographs).

Table 3. Distribution of International publications

	No.of journals	No.of publications	No.of citations	Citations / publications
International journals	429	2,280	16,458	7.22
Brazilian journals	33	428	353	0.82
Monographs	228	289	600	2.08
Total	698	2997	17,411	5.81

The patterns of the journals mostly utilized for endogenous and exogenous publications were rather distinct, as can be seen in Tables 4 and 5. Among the journals that most published endogenous papers five were Brazilian journals. The impact factors of the journals appearing in Table 4 were on average significantly lower than those for the journals mostly utilized for exogenous publications, appearing in Table 5. The conclusion can be drawn that when operating abroad Brazilian scientists found it less arduous to have their papers accepted by the

Table 4. Journals that most published endogenous papers

Journals	Publications	Citations	Citations/ Publications	Impact Factor
Acad Bras Cienc *	96	73	0.76	0.115
Biochim. Biophys Acta	87	668	7.91	2.739
Comp Biochem Phys	86	237	2.76	0.784
Braz J Med Biol Res *	75	102	1.36	0.447
Arq Biol Tecnol *	73	18	0.25	0.082
Biochem Biophys Res Co	53	304	5.74	3.785
J Biol Chem	42	615	14.64	6.315
Photochem Photobiol	42	307	7.31	2.413
IRCS-Bioch	39	27	0.69	---
J Protozool	36	229	6.36	1.209
Arch Biochem Biophys	34	188	5.53	2.238
Biochemistry	32	382	11.94	3.829
J Parasitol	32	157	4.91	0.783
Exp Parasitol	29	226	7.79	1.363
Experentia	28	39	1.39	1.003
Carbohyd Res	21	71	3.38	1.462
CR Acad Sci III-vie	21	9	0.43	0.302
Rev Microbiol *	20	9	0.45	0.022
Febs Lett	19	107	5.63	3.315
Cien Cult *	19	9	0.47	---
Biochem Pharmacol	18	65	3.61	2.401
Biochem J	17	69	4.06	4.234
Insect Biochem	17	131	7.71	1.797
Brain Res	16	95	5.94	2.859
J Insect Physiol	16	147	9.19	1.597
J Submicrosc Cytol	16	27	1.69	0.636
Acta Trop	16	80	5.00	1.092
Infect Immun	15	108	7.20	3.023
Res Commun Chem Path	15	10	0.67	0.865

* Refers to Brazilian journals; Impact factors correspond to 1986.

most prestigious journals as compared to when operating domestically. This can be accounted for by the prestige of the laboratory where the work was developed and/or by the fact that this work was on average of a better quality than that evolved in his/her home institution. The knowledge of the real explanation for the trend aforementioned is of great importance in the area of scientific policy but no data are available to draw a definite conclusion.

Table 5. Journals that most published exogenous papers

Journals	Publications	Citations	Citations/ Publications	Impact Factor
Exp Neurol	34	259	7 62	1 224
P Natl Acad Sci USA	31	622	20 06	9 165
Mol Pharmacol	30	429	14.30	2.183
J Biol Chem	25	734	29.36	6.315
J Pharmacol Exp Ther	23	197	8.57	3 547
Biochem Biophys Acta	17	137	8.06	2 739
Febs Lett	17	75	4 41	3 315
Psychopharmacology	14	41	2 93	2 428
J Immunol	13	187	14.38	6.190
J Appl Physiol	13	148	11.38	2 519
Eur J Biochem	12	134	11.17	3 655
J Neurochem	11	36	3.27	3.580
Arch Biochem Biophys	11	82	7.45	2.238
Biochemistry	11	171	15.55	3 829
Carbohyd Res	11	58	5.27	1 462
Blochem Bioph Res Co	10	97	9.70	3.785
J Am Chem Soc	10	144	14.40	4 435
J Mol Biol	10	53	5.30	6 597

Impact factors correspond to 1986.

Table 6. Impact factors of Brazilian articles as compared to overall impact factors of SCI indexed

Journals	Endogenous	Exogenous
Brazilian articles in 1984 and 1985	353	107
Total citations in 1986	451	353
Number of journals utilized	124	59
Average impact factor *	1.278	3.300
Expected impact factor **	1.911	3.716
Number of journals in which the impact factor of Brazi-lian articles was higher than the overall impact factor	26 (21%)	20 (34%)

* Citations in 1986 of the articles published in 1984 and 1985.

** Weight average impact factor of the journals, considering the number of Brazilian articles that each one published in 1984 and 1985.

However, the problem can be more directly addressed by asking the question: once a Brazilian scientist succeeds in publishing a paper in a given international journal does this paper earn, on average, a citation rate comparable to that of the journal ? To answer this question we took as reference for citation survey the year of 1986 and considered the publications of 1984 and 1985. A total of 460 papers were published in ISI indexed journals in -these two years, divided into 353 endogenous papers and 107 exogenous papers (Table 6). The average impact factors were 1.278 and 3.300, for the endogenous and exogenous papers, respectively. This again reflects the trend of publishing the exogenous papers in more prestigious journals. If we now compare these impact factors with those expected if the Brazilian articles had the same citation rates that the overall articles in each of these journals the results are 1.278 versus 1.911 for endogenous papers and 3.300 versus 3.716 for exogenous papers. The difference between the two figures in the latter case is not significant ($p > 0.1$) which would mean that Brazilian biochemists working abroad, and counting on the prestige of the institution and better material facilities, are doing as well as central world biochemists. Back home they keep making a great effort to publish in international journals but have on average to content themselves with less prestigious journals. Moreover, when the endogenous papers are published in international journals their impact (1.278) is lower than the expected from the journals where they were published (1.911) and in this case the difference is significant ($p < 0.05$). If we raise the reasonable hypothesis that the editors of these journals are not lenient and on average accept papers of comparable quality, independently of the geographic origin, then some bias might be occurring in the process of citing science which disfavors less renowned groups from Third World countries. However it should be pointed out that this difference is not exaggerated: on average Brazilian biochemists achieved a citation rate corresponding to 67 % of that achieved by their colleagues from central countries, a figure which is just slightly higher than 0.64, the average ratio of direct citation counts to expected citation rates for all Brazilian papers (4). This figure is not significantly affected by self-citation or "in-house" citation which in the present study corresponded to 18 % , a value which falls in the range found for other specialties (5,6).

DOMESTIC VERSUS INTERNATIONAL PUBLICATION

In a recent survey it was found that a Brazilian chemistry paper in the first three years after publication earns less than one citation in the international literature (3). In this same survey it has been detected that 73 % of the Brazilian chemistry papers were published in international journals, a figure that depicts the effort of the scientists in this area to present their findings to an international audience. Because the outcome of this endeavor was considered to be rather poor, the question was raised by the author as to whether a better policy wouldn't be to strengthen Brazilian journals, making them meet international standards and consequently become more visible abroad. This is a fundamental question in the area of scientific policy and deserves to be addressed from multiple angles.

One idea that permeates this debate is that regardless of the good quality of a scientific work developed in a Third World country, the international recognition it will earn is inevitably poor because First World scientists virtually ignore the work published by Third World scientists. However, this idea does not resist to a more careful analysis . The fact is that large differences can be found in terms of international impact among different areas of Brazilian science and in, a given area, among different investigators. It is certainly not expected that the areas tending to publish in domestic journals achieve any significant citation rate. Among the areas in which a clear effort is identified towards all international output, the results may vary significantly. For instance, the 272 international papers in biochemistry published in 1982 by Brazilian scientists earned 8.8 citations per paper over the period 1983-1987, or 1.76 citation per year per paper. If we consider only the endogenous papers of 1982, the publications were 207 and the citation rate was 1.00 citation per year per paper, or 0.82 if we discount the self-citations. This is a much more expressive figure than the 0.30 value for the average Brazilian chemistry paper (3), another area in which a major effort is conducted towards an international output.

In addition, it should be mentioned that these figures are rather distinct among different institutions (7). In the case of the department of Biochemistry of the University of Rio de Janeiro, for instance, each international publication of 1982 earned 1.6 "real" citations per year, in the period 1983-1987. Finally, 85 endogenous papers (3.9 % of the total) earned 20 or more citations in the period 1982-1985. These most cited papers earned 32 % of all citations for endogenous papers and were published by only 28 senior authors (5.6 % of the total). This denotes a concentration effect whereby a relatively small number of Brazilian biochemists is responsible for most of the impact generated by Brazilian biochemistry papers.

If we try to delineate the general characteristics of these investigators we see that they are all recognized scientific leaders in Brazilian biochemistry, have published a large number of papers, have been responsible for the training of many young scientist and have kept close contact with First World colleagues, participating in meetings as invited speakers, visiting laboratories, etc. In other words, they constitute a group of scientists who have somehow overwhelmed the intrinsic difficulties of doing science in Brazil and would be classified by international standards as important contributors in their areas.

These investigators learned very soon the challenge of publishing in the best international journals. They recognize that to a certain extent Third World scientists have to overcome extra barriers in relation to their First World colleagues when trying to publish or earn credit for their published work. There is in fact some bias and even prejudice in the process. However this is inevitable and tends to diminish as a national community grows stronger and acquires prestige in the performance of science. Meanwhile coordinated action of third world science communities might help to enhance awareness of first world scientists for some inequities.

The alternative to a major effort to publish domestically seems to be fruitless. Brazilian scientists are now publishing about 2000 papers yearly in international journals. To accommodate half these articles in Brazilian journals would require roughly 20 new Brazilian journals. It is not just a matter of adding 20 more to the 400 Brazilian scientific journals already marketed. With perhaps a couple exceptions these latter journals are far from meeting the international standards. To produce really high quality journals, an enormous effort would be required involving a large amount of investment and organization that Brazil is certainly incapable to face. If a policy decision were taken toward this aim the best we could expect is to set up a scientific press organization, commercially oriented (as is the case for the scientific press houses abroad) and keeping no symmetry to the Brazilian science output. It would be run by international editorial boards, publish mainly international articles, bring funds to Brazil and, in terms of scientific benefit, could attenuate to a certain degree the alleged bias towards Brazilian papers that were submitted. This seems to be the situation in the Netherlands, which has a centennial tradition in scientific publication. It does not seem to pay off the effort required for such an enterprise.

If science is to be consumed internationally there seems to be no way other than trying to improve our conditions to compete for the best journals and to struggle to earn credit for the relevant findings of Brazilian science. This means becoming organized in order to lobby influential editors to enforce fairness in the processes of judgment and crediting. It remains that we have to improve our science since this will bring as consequences the rise of fine scientific journals and international recognition.

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PUBLICATIONS OF SCIENTISTS IN DEVELOPING COUNTRIES: NATIONAL AND INTERNATIONAL PRODUCTION OF ARGENTINIAN ECOLOGISTS

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ABSTRACT

The production of articles by Argentine ecologists is examined both in local journals as well as in SCI. A careful analysis of the citation patterns of local and international production shows that argentine ecological sciences are not visible. In particular, local production would have been totally unknown to foreign ecologists if there were no argentine authors writing in international journals.

RESUME

La production d'articles scientifiques des écologistes en Argentine est examinée à travers les revues locales et la production dans des revues internationales identifiées dans le SCI. Une analyse des citations des revues nationales et internationales montre que la production locale est pratiquement inconnue des auteurs étrangers et qu'elle n'aurait jamais été citée si des auteurs Argentins n'avaient pas publié dans des revues internationales.

INTRODUCTION

There are very few studies on the scientific production of Argentina. They usually range from extremely general (Quesada Allué, in press; Velasco, 1983a, 1983b) to extremely specific ones, as a study of scientific production in the area of limnology (Gabellone et. al., 1987). The present paper shows the results of a study of argentine scientists working in one particular field: ecology. The study had a fairly specific objective: to try to evaluate the importance of argentine authors that publish both in national and international journals as a channel for international detection of argentine colleagues that publish only in national journals.

METHODS

The articles that appeared in the last 25 years in 22 argentine periodical journals (see Annex 1), where biologists (and among them ecologists) publish normally, were analyzed individually. As these journals are not specialized in ecology, a careful definition of the criteria for what kind of article would be considered eclogical was in order.

Articles both academic as well as applied were included in the study. Examples of the types of subjects covered in basic ecology are:

- Interactions between one or several abiotic factors with individuals, populations, or communities
- Interactions between individuals, and between populations
- Geographical and/or tempo-spatial distribution of species
- Seasonal cycles, primary productivity, trophic webs
- Migrations and dispersal
- Population dynamics
- Structure and diversity of communities

Examples of the types of subjects covered in applied ecology are:

- Man's impacts on population, communities, and ecosystems
- Renewable natural resources management
- Pest control
- Preservation and conservation of habitats and species
- Public health and medical ecology (vectors of diseases)
- Legal and administrative aspects of some of the above

With these criteria at hand, the stacks of seven University libraries were checked for all numbers of these journals for the last 25 years (1963-1988). However, the first 15 years of most of these journals were very irregular, and many of the results here presented are given for the period 1978-1988. When a larger period was considered it is indicated.

The following information was registered: last name and initials for the first author and all coauthors of an article, institution of first author, province of that institution, name of journal, volume, number and year of publication of journal, title of the article, numbers of first and last page, and a subject and a methodological classification of the article (details of the classification can be provided by the author on request).

Additionally, the Science Citation Index (SCI) data base was consulted; however, due to budgetary constraints, only the 1988 information was available for consultation. Thus the comparisons between international and national rates of publication are limited by this restriction; nevertheless, still many useful relative indicators could be produced. The SCI data base was consulted by searching as cited authors the names and initials of the ecologists that were found to publish in the Argentine journals as first authors.

From the results of the SCI search the following information was registered: last name and initial of cited author, year of publication cited, name, volume and number of journal cited, last names of authors that produced the citation, as well as the name, volume, number and pages of the article source of the citation.

By inspection of the names of people and journals, an additional information was recorded: nationality of the authors that produced the citation, kind of work that produced the citation (article, review, or note, as well as its language), and the relation-ship between the authors cited and the authors source of the citation ("citing" authors); for the latter the following four classes were used: 1) self-citation, 2) citation by argentine colleagues (either of the same institution or not), 3) citation by other Latin-American colleagues, and 4) citation by authors from outside the Latin American region. When the establishment of the relationship was dubious, that record was classified as undetermined, and eliminated from certain analyses.

Finally each citation was classified by ecological subject (plant ecology, animal ecology, aquatic ecology, taxonomy, and a "various" ecology that included more specialized disciplines such as chemical ecology, epidemiology, climatology, paleoecology, and evolutionary ecology).

For determining the relationship between citing and cited authors (apart from the obvious self-citation case) the institution and/or the country of origin of the citing authors had to be established. I resorted to international directories of ecological societies (ESA, 1988; Misra, 1983; BES, 1986; SPE, 1980), if not found or in case of uncertainty the citing article was checked physically. Local and national directories (Prosag, 1986; CERZOS, 1986, 1987; Villar, 1988) were used for the institutional origin of Argentine ecologists; however, the main source for the Argentine ecologists' identification was SPIDER's directory (SPIDER, 1989), with a data bank with over 1,000 people, with personal, institutional and research subject information.

The information was entered as tables in a PARADOX data base for PCs. An AT equipment was used, with extended memory that could be used as a virtual disk, accelerating all the searching procedures, particularly cross-searches between tables.

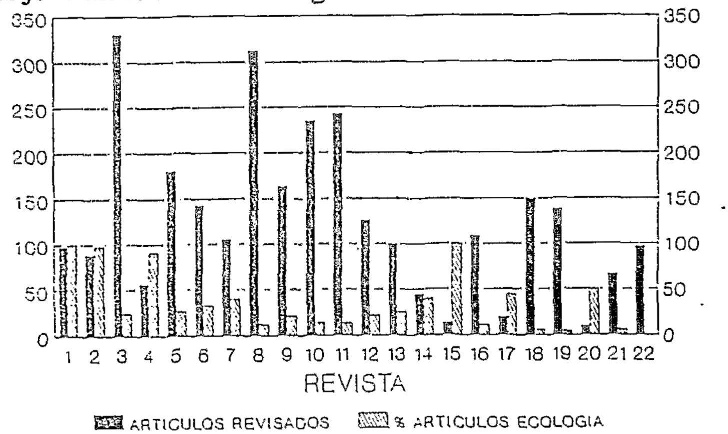
The presentation of results is divided in three parts: the national rates of publications, the international rate of publication as given by the SCI for 1988, and the relationships between national and international production.

RESULTS

1. Scientific production of Argentine ecologists in Argentine journals

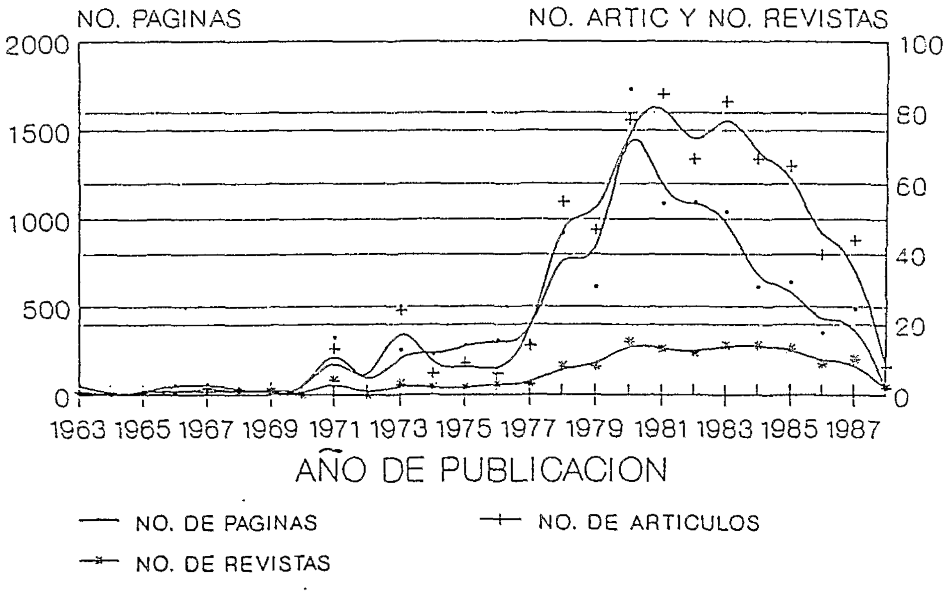
The search in the 22 Argentine journals resulted in a broad and irregular distribution of ecological articles per journal (Fig. 1): from zero to 100% ecological articles. There were a total of 722 articles of an strict ecological nature, that were produced by 404 first authors. All the information was stored in what will be called below the Argentine Ecological Data Base (AEDB). The annual production shows a strong growing tendency up to about 1980 (depending upon if the indicator used is the number of pages or the number of articles), and then a sustained decline (Fig. 2).

Figure 1. Results from the search of ecological scientific articles in 22 argentine periodical journals from 1963 through 1988.



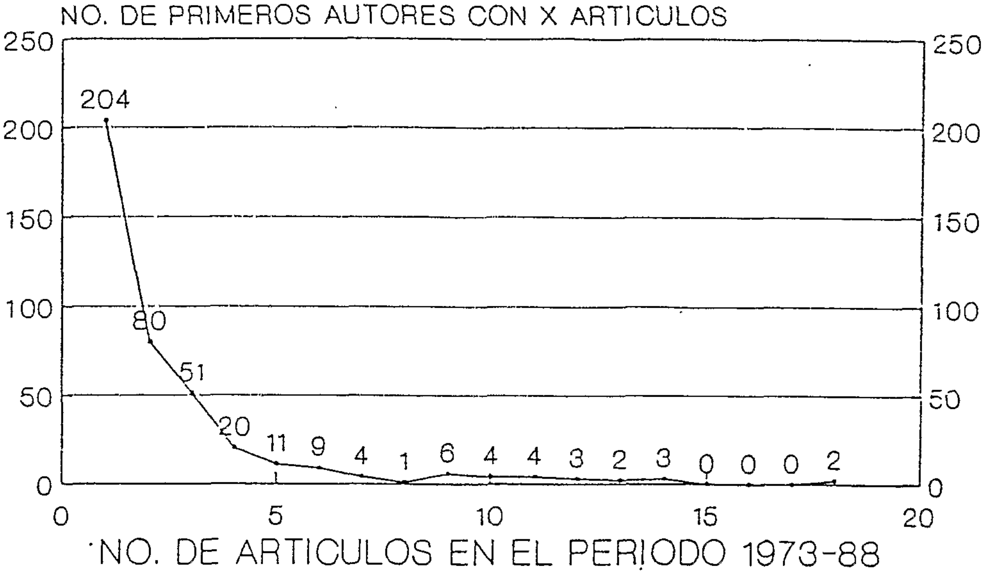
The numbers of the horizontal axis correspond to the name of the journals as they appear numbered in Annex.

Figure 2. Annual variation in the publication rate of ecological scientific articles in 22 argentine periodical journals from 1963 trough 1988.



The *per capita* production rate shows the classical decaying exponential form for larger number of articles per author (Fig. 3).

Figure 3. Per capita productivity of Argentine ecologists between 1973 and 1988, as indicated by the number of articles published by first author.



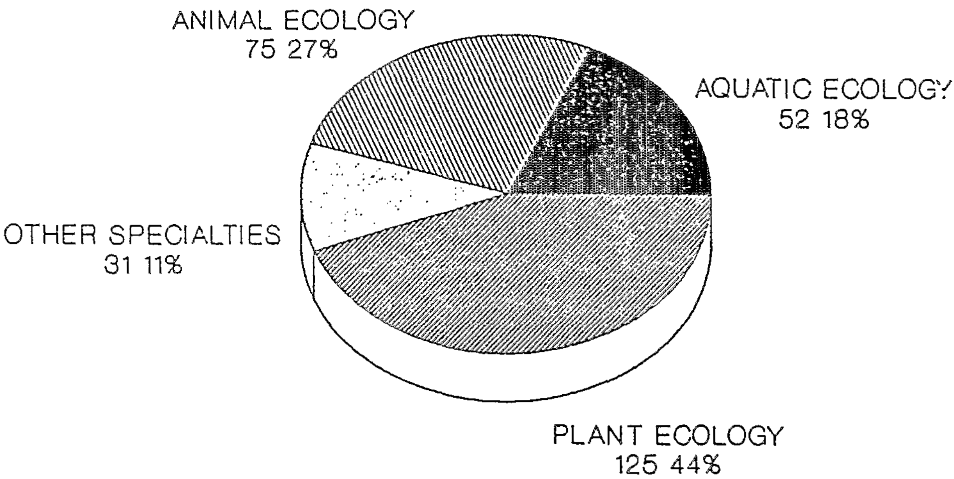
2. Citation of Argentine ecologists in the SCI 1988 Data base

From the 404 first authors of the AEDB that were entered in the 1988 SCI data base, a total of 318 citations were obtained; of these 35 (11%) were articles in plant or animal taxonomy, and were eliminated from the analysis; the remaining 283 citations were dominated by plant ecology works (44%), followed by animal ecology papers (27%), and aquatic ecology (18%); the other specialties amounted for only 11% of the total citations (Fig. 4). These 283 citations of ecological articles were published by 88 different (first) authors, that is, with an average rate of 3 . 22 articles per author.

The annual distribution of the 283 ecological citations found in the 1988 SCI data base shows a peak in 1985 (Fig. S), which coincides with the accepted fact that the mode in the number of citations used in most references lists is usually not older than 2-3 years (Schubert et. al., 1988).

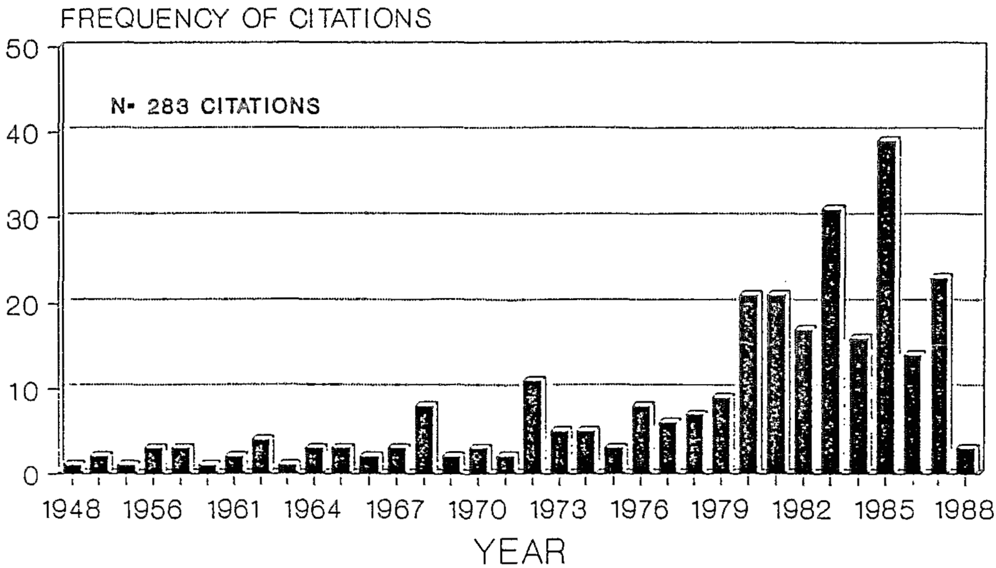
Table 1 (cf annex) shows some of the quantitative results of the frequency of citations grouped by origin of the cited paper, average number of citations per citing article, by nationality of the citing authors, by type of citing article, language of the citing paper, and the cited/citing authors' relationship.

Figure 4. Percent of ecological fields present in the argentine ecology citations in the 1988 SCI data base.



N = 283 (taxonomy excluded.

Figure 5. Annual citation of publications by argentine ecologists from the 1988 SCI data base.

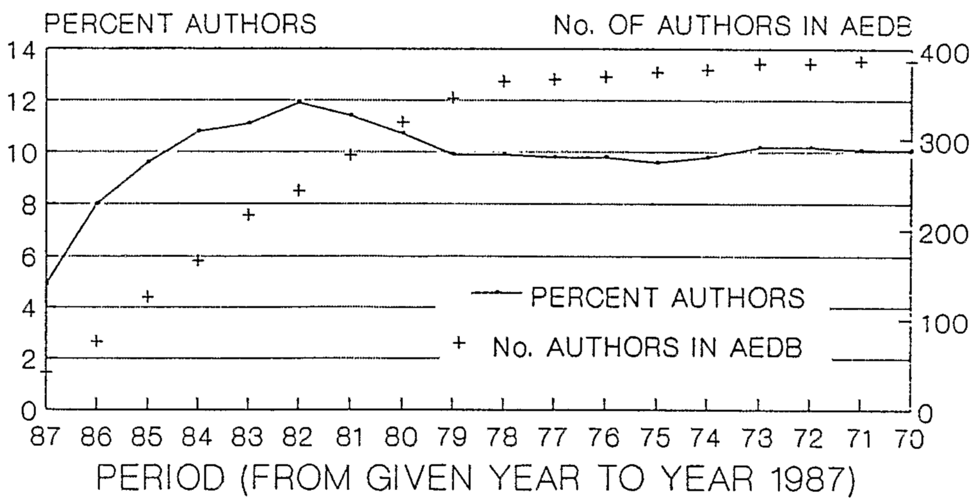


It was of interest to evaluate some cross-tabulations, such as the intersection between origin of the cited paper and relationship between cited/citing authors; the results (Table 2 cf. annex) show that in terms of the number of citations the relationship with colleagues is very close to the one with apparently independent citing authors; self-citations account for a lower number, but is not trivial at all.

3. Relationship between the Argentina Ecology data base and the 1988 SCI

Comparing the number of different authors retrieved from the SCI search (N=88) with the list of first authors of the AEDB, the number of common authors varies depending upon the number of years used in the AEDB; however, the percent of authors of the SCI data base that is found in the AEDB stabilizes at about 10%, after reaching a flat peak of near 12% shown for the period 19821987 (Fig. 6).

Figure 6. Percent of the argentine authors in the 1988 SCI data base that published in the Argentine Ecology Data Base (AEDB) in cumulative periods between 1970 and 1987.



Note: maximum N for SCI = 283; maximum N for AEDB = 404.

When the number of citations of the SCI data base is restricted to argentine journals and compared with the AEDB, I obtained that only 50 first authors of the AEDB (that is, 50/404= 12.4%), represented by 126 articles (that is, 126/722= 17.5%), had been cited in the SCI; however, when a one to one comparison is made between the articles of the AEDB and the ones cited in the SCI, only 16 (that is, 16/722= 2 . 2%) specific articles of the AEDB appeared in the SCI; the other 110 citations were not in the AEDB because: a) it was a "grey publication" and not an argentinean periodical journal, and/or b) it was not an ecological publication (frequently an ecological article cites many taxonomic publications). In terms of authors, only 3.7% (15 out of 404) were cited in the SCI .

When the comparison was made taking into account the relationship between "cited/citing" authors I obtained that, from the 16 publications of the AEDB cited in the SCI, one citation was a self-citation, one was made by a Latin-American colleague, three were made by apparently independent authors, and eleven (68 . 8%) by Argentinean colleagues (generally of the same institution).

DISCUSSION AND CONCLUSIONS

Blickenstaff and Moravcsik (1982) claim that only 31.2% of scientific and technical articles published in the World are detected using the international data bases and the best libraries of the developed countries. Quesada-Allué (in press) found that approximately 50-60% of argentine publications in scientific journals are detected in the international circuits.

Our study shows that about 30-40% (when restricted to the years 1983-1985) of all publications by argentinean ecologists are detected in the SCI; lor those same years, in terms of the number of authors, the proportion detected drops down to less than 12%.

However, considering only argentinean journals, the picture is very different; when the proportion citations of the argentinean publications of the ecological data base (AEDB) was compared one by one with the citations of argentinean ecologists that appeared only in argentine journals in the 1988 SCI, only a 2.2% was found. When the source of the citations was analyzed almost 70% of that 2.2% figure originated in argentinean colleagues.

If we evaluate the representation of the three citations made by apparently independent authors the figure drops down to 0.4% (3/722). Thus, it is concluded that the detection of argentinean publications in the international circuit is very low, and that if it would not be for a relatively small number of argentinean colleagues that publish in international journals, their detection in the international arena would have been nil. If this is also true in other fields of argentinean science or in other developing countries cannot be at this time asserted.

Acknowledgements

To Helga Hoenecken, as well as Néstor Benchaya, who patiently helped me to collect the argentinean data, and to Daniel Spina, Raúl Spina, and Fernando García who very kindly helped with the 1988 SCI data base, I am very grateful. Many thanks to Fundación Antorchas who provided the funds for the an agreement with ISI that allowed the availability of the SCI data base.

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ANNEX

Table 1. Frequency analysis of 283 citations of argentine ecologists cited in the 1988 Science Citation Index, grouped by different parameters (percent in parenthesis)

Origin of the journal in which the article was cited	No. of citations with that origin		No. of cit. of a given author that was found in one citing article	No. of cases with that Nb. of citations	
International	152	(53.7)	1	160	(56.5)
Argentinean	99	(35.0)	2	58	(20.5)
Local manuscript	25	(8.8)	3	34	(12.0)
Lat. Amer. Journal	7	(2.5)	4	12	(4.2)
			5	5	(1.8)
			6	7	(2.5)
			7	7	(2.5)

Country where the citing article was produced	No. of cit. with that origin		Type of citing publication	No. of citations	
Argentina	145	(51.2)	Article	246	(86.9)
Other	109	(38.5)	Note	27	(9.5)
Latin American	18	(6.4)	Review	11	(3.9)
Undetermined	11	(3.9)			

Language of the cited article	No. of citations		Relationship between cited and citing authors	No. of Citations	
English	256	(90.5)	Argentine colleague	112	(39.6)
Spanish	14	(5.0)	No apparent relation	106	(37.5)
German	11	(3.9)	Self-citation	42	(14.8)
French	2	(0.6)	Latin-American colleague	18	(6.4)
			Undetermined	5	(1.7)

Table 2. Number of cited authors and number of citations (in parenthesis) cross-tabulated by origin of the cited article and cited/citing authors' relationship.

	RELATIONSHIP									
ORIGIN	self-citation		Argentine colleague		Latin American colleague		Apparently independant		TOTALS	
Local manuscript	4	(6)	13	(15)	1	(1)	3	(3)	21	(25)
Argentine journal	3	(8)	39	(59)	6	(6)	15	(23)	63	(96)
L-American journal	O	(0)	2	(4)	2	(2)	1	(1)	5	(7)
SCI journal	12	(28)	15	(34)	3	(9)	32	(79)	62	(150)
TOTALS	19	(42)	69	(112)	12	(18)	51	(106)	151	(278)

(Five cases of undetermined relationship were left out of the analysis).

Names of the argentine periodical journals revisited

1. ECOSUR
2. ECOLOGIA
3. PHYSIS
4. DESERTA
5. REVISTA DE LA FACULTAD DE AGRONOMIA, UNIV. BUENOS AIRES
6. REVISTA DE INVESTIGACIONES AGROPECUARIAS
7. LIMNOBIOS
8. NEOTROPICA
9. EL HORNERO
10. REVISTA DE LA SOCIEDAD ENTOMOLOGICA ARGENTINA
11. HISTORIA NATURAL
12. AMBIENTE Y RECURSOS NATURALES
13. ACTA ZOOLOGICA LILLOANA
14. REVISTA DEL MUESEO DE LA PLATA (SERIE ZOOLOGIA Y BOTANICA)
15. REVISTA DEL MUSEO DE CIENCIAS NATURALES "BERNARDINO RIVADAVIA" (SERIE ECOLOGIA)
16. CIENCIA DEL SUELO
17. ANALES DE PARQUES NACIONALES
18. DARWINIANA
19. MEDIO AMBIENTE Y URBANIZACION
20. IADIZA (CUADERNOS TECNICOS)
21. LILLOA
22. REVISTA ARGENTINA DE PRODUCCION ANIMAL

PARTIAL ASSESSMENT OF MEXICAN HEALTH SCIENCES RESEARCH 1982-1986

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ABSTRACT

The paper provides a picture of Mexican health sciences research for the years 1982-1986, measuring, bibliometrically, the size of its scientific activity. The most widely used bibliometric indicators for research evaluation, publication count and citation analysis, are combined to determine the degree of production, productivity, and impact. The study also highlights the role of leading research institutions.

RESUME

Cette communication propose un panorama de la recherche médicale Méxicaine pour les années 1982-1986 à partir de l'analyse bibliométrique de sa production scientifique. Les indicateurs bibliométriques les plus communément utilisés pour évaluer la recherche (nombre de publications, analyse des citations) sont combinés pour déterminer le niveau de production, de productivité et d'impact. L'étude met également en lumière le rôle des institutions de recherche leaders.

INTRODUCTION

Mexico, with its pathologies of 'poverty' in which nutritional and infectious diseases predominate among a comparatively young population and its intense epidemiologic transition, characterised by a further decline in the incidence of infectious diseases and a rapid increase in the incidence of chronic illnesses and accidents, expects that research should bridge the gap between imbalances and development. Therefore, health sciences research, i.e. research that covers not only biomedical and clinical research, but also research in the social, environmental, and alimentary sciences that is associated with health, should be intimately related to the society of which it is part and an essential component of the development process.

Although it has been said that health sciences research is in a 'healthy' condition because '. . . health sciences research account for 40% of the articles published by Mexicans in foreign journals' (1), policy makers and science planners need reliable indicators for science planning. However, since Mexico has a research infrastructure (institutions, manpower, and limited investment to acquire equipment) there are some questions to be asked: what is the size of the research effort? What type of research is being attacked? We attempted in this paper to shed some light on the condition of Mexican health sciences research for the years 1982-1986.

MATERIALS AND METHODS

In order to evaluate Mexican health sciences research performance, we assembled data on research activity in the Mexican health sciences research by counting the items retrieved from four major online databases covering the field and counting citations retrieved from printed citation indexes. The following steps were taken:

1. We searched on: a) 'Mexico' in the address field of BIOSIS PREVIEWS, CAB ABSTRACTS, EMBASE, and MEDLINE; b) CODEN or ISSN numbers of Mexican journals scanned by the databases; c) titles of Mexican journals indexed by each database; d) Mexican states; e) Mexican institutions acronyms; f) relevant subject areas, or descriptors; g) specific type of documents; and h) year of publication. For convenience, in our study, institutional affiliation was equated with Mexican nationality. Also, our searches were confined to primary research articles, and review articles, which are the most common forms of communication in the health sciences. A total of 8,124 journal articles was retrieved across the four databases, using MEDLINE as the point of reference for weeding. A total of 5,060 unique articles authored by Mexicans was identified.

2. The journals in which Mexican authors had published were classified into field, using the JOURNAL ASSIGNMENTS & INFLUENCE MEASURES list compiled by Computer Horizons, Inc. (CHI) (2), into field. The list was used to overcome variations in the quality of journals where Mexican authors publish, which are indexed regularly or randomly by the four online databases. The list permitted a total of 1,720 articles to be classified. The list also facilitated the identification of mainstream journals indexed by the Institute for Scientific Information (ISI).

3. To further refine our population of papers we matched the 1,720 articles against both the Science Citation Index (SCI) and Social Sciences Citation Index (SSCI) for the period 1982-1987, and a subset of 1,062 articles which had been cited at least once was identified. Although only one Mexican journals was indexed by ISI, the identification of mainstream research which have had some impact was considered essential.

4. An Activity Index (AI) (3) was used to give a graphic picture of the activity profile of leading institutions characterising, at the same time, the relative activity of two fields. An Attractivity Index (AAI) (4) was also used to distinguish the relative impact of Mexican papers produced by the most active institutions in seven fields as reflected in the citations they attracted.

RESULTS

A comprehensive coverage of the output produced by Mexican health sciences researchers was obtained by searching four online databases: BIOSIS PREVIEWS, CAB ABSTRACTS, EMBASE, and MEDLINE. Using MEDLINE as the bench-mark, 5,060 unique articles were recognised. Over the five year period (1982-1986) there is little apparent variation in the level of research activity among Mexican health researchers, with an annual average of approximately 1,000 papers. The distribution of articles across the year of publication and the breakdown in terms of Mexican and non-Mexican source journals showed that 36.8% were published in foreign journals (5).

On the assumption that it is in general terms more difficult to publish in a foreign than a domestic journal because of language barriers, larger pool of candidate authors, higher rejection rates for authors from less developed nations (6), we might expect penetration of foreign journals by Mexican authors to decrease as cut-backs in the science and technology budget begin to take their toll. However, on the basis of the present figures, there is not yet evidence to support this view, though the competition for space in prestigious journals is such that authors may be forced to lower their sights and accept publication in less highly ranked journals. Our figures seem to suggest that Mexican authors prefer to publish in mother-tongue journals which include Latin American and Spanish journal titles.

Although the number of articles published in foreign vs. domestic journal titles could be used as an indicator of the progress or decline in the quality of research, our findings suggested that Mexican authors tend to publish in Mexican journals because:

1. Mexican journals, in general, do not conform to the standards of most foreign journals, hence, there are better chances to have papers accepted.
2. Language barrier does not exist.
3. Domestic journals are conveniently located for being reached.

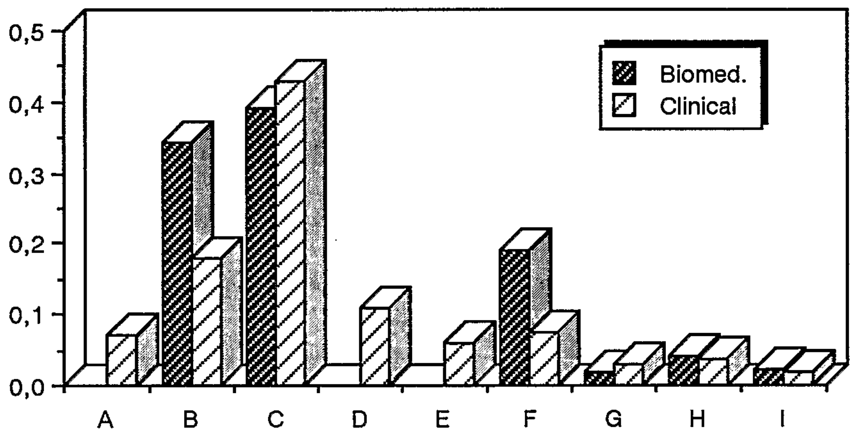
However, it could also mean an excessive degree of self-centredness. Mexican authors published in a wide range of journals. A total of 649 unique journal titles were identified. Of these, 621 were foreign and twenty-eight were domestic. Thirty two percent of the foreign journals carried three or more articles. When we looked at the institutions where research was carried out, we found that research in the area is performed mainly by the government. Public health institutions carried out 65.64% of the research followed by public institutions of higher education (26.8%). The residual 7.56% was spread across private institutions of higher education, international organisations, private sector companies, public sector agencies, decentralised agencies, and a miscellany of other organisations.

The country's research output was produced in the Federal District, also known as Mexico City, and six states (Jalisco, Nuevo Leon, Puebla, Morelos, San Luis Potosi, and Yucatan), while 16 states out of 27 producer states originated 20 or fewer papers not counting the five zero producers (7). It is evident that Mexico needs a policy towards decentralisation. Science planners have undertaken some actions during the last 20 years to prevent centralisation, however, the Federal District is still the centre of all aspects of political, economic and cultural activity in the country. Concentration of research has positive aspects: the possibility to share equipment as well as the possibilty to enhance collaboration among researchers or institutions, thus reducing costs, in particular, the high costs of original biomedical research. The geographical distribution of researh topics, neverthless, requires attention since there are some types of research which can only be effectively carried out in those areas where the research may be expected to be of benefit.

The use of different data sources to gather Mexican health sciences research output was necessary. Items retrieved from the online databases accessed (BIOSIS PREVIEWS, CAB ABSTRACTS, EMBASE, and MEDLINE) gave an approximation of the total Mexican output in the health sciences, but as the quality of the nation's research effort cannot be gauged accurately using unweighted output measures, we matched data obtained from online searches against mainstream journals in order to identify Mexican mainstream research. We used the CHI's list to distinguish mainstream from peripheral journals. We found that a small proportion of papers (1,720, i.e. 33.99%) of the unique articles retrieved form the online databases (5,060) were published in mainstream journals listed by CHI. Source journals were classified using the CHI's list to obtain overall country activity by field.

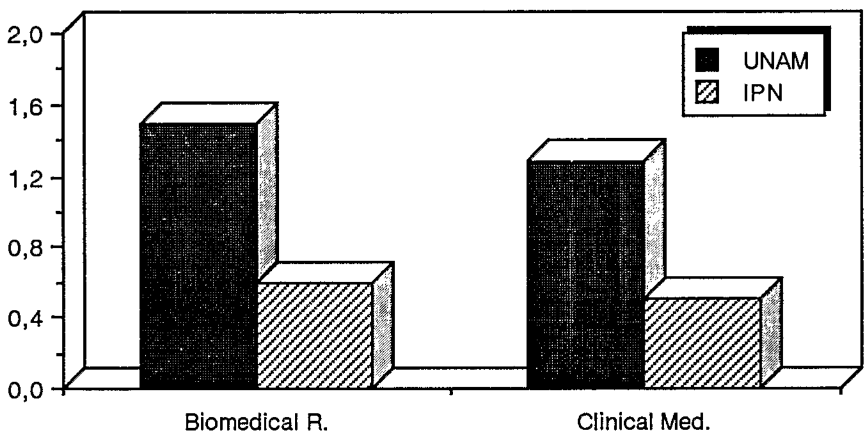
Both strong and weak areas were identified, on the basis of the number of papers published in each field. The fields were, in descending rank order: Clinical Medicine, Biomedical Research, Biology, Psychology, Chemistry, Engineering & Technology, Mathematics, and Physics. Since estimating the level of scientific activity in research institutions is not an entirely straightforward matter because of variations in the size of subject fields and the resource base of institutions, we used the Activity Index (AI) formula developed by CHI to distinguish the relative research effort in Biomedical Research and Clinical Medicine of two groups of comparable institutions (Figs. 1-2). We found that the research effort at the National institutes of Health is lower-than-average in both fields, while the research effort at two of the most prestigious higher education institutions showed that research activity at the National University of Mexico (UNAM) is higher-than-average in both fields. The National Polytechic Institute (IPN) was lower-than-average, also in both fields (8).

Fig. 1 Activity Index of the National Institute of Health



A = Children's Hospital; B= Institute of Cardiology; C= Institute of Nutrition; D = Institute of Neurology and Neurosurgery; E = Institute of Respiratory Diseases; F = Institute of Paediatrics; G = Institute of Perinatology; H = Institute of Psychiatry; I = Institute of Cancerology.

Fig. 2 Activity Index of two higher Education Institutions in Biomedical Research and Clinical Medicine



Publication counts say something about activity and quality, but should be combined, ideally, with other partial indicators such as citation counts. Therefore, we attempted, through citation counts to describe the impact of Mexican health sciences research. To further refine our population of papers, the 1,720 articles that were published in the journals included in the list compiled by CHI, were matched, manually, against both the SCI and SSCI, and a subset of 1,062 papers which had been cited at least once was identified.

Cited papers attracted a total of 5,292 citations. Since it was considered essential to identify the relative impact of cited papers published by the six most active institutions (UNAM, IPN, Social Security Institute (IMSS), national institutes of Cardiology, Neurology, and Nutrition) we calculated their Attractivity Index (AAI). We found that the UNAM's AAI was higher than average in six fields: Biomedical Research, Psychology, Chemistry, Biology, Mathematics, and Engineering & Technology, while in Clinical Medicine it was lower-than-average. The IMSS was higher-than-average only in two fields: Clinical Medicine, and Psychology. The IMSS was lower-than-average in three fields: Biomedical Research, Biology, and Chemistry.

Our findings suggested that the impact of Mexican research groups is closely associated with the quality of their research. From a research policy viewpoint it is not only required that researchers produce scientific results of some quality, but also that they generate impact, though factors such as the visibility of journals, visibility of authors, and the pertinence of the research topics influence the impact.

DISCUSSION

The use of bibliometric data, publication and citation counts as tools for the evaluation of Mexican health sciences research performance was the central issue of this paper. In undertaking this assessment, we developed a number of 'informatory' indicators (9) of research performance. The indicators gave a picture of scientific research in Mexican health sciences, although the small numbers make interpretation difficult and generalisation almost impossible. The publication and citation 'informatory" indicators which we developed suggested that they are straightforward measures of research performance, and they are not susceptible to ambiguities although, it is difficult to know exactly what a citation measures. With regard to the relevance of the construction of indicators based on publication counts and citation analysis through bibliographic and citation sources, it was apparent that at face value there are marked differences among bibliographic and citation sources, mainly because the latter register what is called 'mainstream' research. We could not argue that Mexico was underrepresented in the citation databases but only say that research results were not reported in the world's most central journals.

Mainstream journals are quality output measures, because of the criteria for selection of journals by ISI. Although selection criteria are also applied to bibliographic databases, the choice of journals for inclusion in these databases is based on the fact that included journals are not necessarily superior to those not included.

Our findings suggested that there are marked differences among bibliographic databases and citation sources. It became clear that data sources for bibliometric analysis have different objectives. Publication counts may say something about the scientific effort of entities being assessed, but citations highlight mainstream research, hence the need to combine publication counts with other partial indicators such as citation counts (10). Our results confirmed that publication counts do not provide an assessment of the quality of research. On the other hand, citation analysis revealed the extent to which Mexican research is used. From the research policy viewpoint, citations constituted the proof that Mexican researchers are carrying out, though modest, mainstream research published in core journals. Acceptance of a paper by a prestigious journal is usually an indication that the article has fulfilled certain standards: quality, significance of results, originality, readability (11). Nevertheless about 38% of the papers published in mainstream journals 'died', i.e. they were not cited. Although the great bulk of 'live' papers (70.35%) were cited less than five times, the principle of 'publish or perish' may be assumed to apply in Mexico, since institutions appear to place considerable emphasis on publishing activity and citations. Institutional policies encourage and even require publication in foreign journals, probably as a way to improve the quality of research, or to gain institutional prestige and visibility. However, our results showed that as far as quantity and impact measures are concerned, these are modest.

Yet, if researchers are forced to publish their best work in foreign journals, it follows that what appears in Mexican journals has lower standards. Mexican journals then should overcome their deficiencies and become valid publications in order to guarantee that quality research is published in them. In our analysis, we found that publication and citation practices differed from field to field, partly because of the institutional research size. Clinical Medicine, the field that addresses most directly human health, accounted for the largest number of papers and citations, while Biomedical Research, the field that indirectly addresses health, was behind. Fields such as Biology, Chemistry, Engineering & Technology, Mathematics, Physics, and Psychology did not show high activity. Our results, although limited in scope and limited by the size of the research effort might, if combined with other indicators such as input measures and peer assessment, give an approximation to the real condition of Mexican health sciences research.

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ACCESS TO NATIONAL AND INTERNATIONAL SCIENTIFIC INFORMATION AS REVEALED BY SCIENTIFIC ACTIVITIES IN THREE PERIPHERAL COUNTRIES

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ABSTRACT

Scientific activities in five developing countries (Egypt, Kenya, Nigeria, Saudi Arabia and Uganda are examined using mainly three indicators: number of publishing scientists, journal used and citation received. The number of publishing scientists do correlate with the number of publications from the journals covered by SCI. However most papers receive no citation and the few that do are published in journals in developing countries. The reasons for the low citability rate are discussed.

RESUME

Les activités scientifiques de cinq pays en développement sont examinées en utilisant trois indicateurs: le nombre de chercheurs qui publient, les journaux utilisés et les citations obtenues. Le nombre de chercheurs qui publient corrèle avec le nombre de publications dans les journaux indexés par SCI. Cependant, à l'exception de quelques publications publiées dans des journaux de pays développés, la plupart des publications ne font pas l'objet de citations. Les raisons de ce faible taux de citation sont discutées.

INTRODUCTION

Nations can be categorized on the basis of the contributions they make to world's science. Countries fall in three categories: central, middle and peripheral levels. Rabkin and Inhaber, when studying three less developed countries (Argentina, Brazil and Norway) applied this categorization (Rabkin and Inhaber, 1979). According to them, the central scientific powers are U.S.A, U.K, USSR and Federal Republic of Germany (now the United Germany). Arunachalam and Markanday (1981) include France and Japan on the list; to make six leading countries. These six countries contribute more than 80% of the world's scientific literature. In Who Is Publishing In Science (WIPIS) these central countries rank in the first seven positions including Canada, in the number of publishing scientists from 1971 to 1978. Countries falling in the middle level category are Australia, Canada, India, Israel and a few European countries. These countries have moderate number of publishing scientists and also produce a considerable number of publications. Though these middle level coutries do not contribute as much to scientific literature as the central scientific powers, their share is still not inconsequantial. The rest of the world falls in the peripheral category. Scientific contribution from these countries is very little and is insignificant compared to that from the first two categories.

The scientific gap between developed and developing countries is very much broader than the economic gap. Much of the literature on science in the world produced by the central and middle scientific powers is not accessible by the developing countries because of this economic gap. Lack of foreign currency prevents developing countries from obtaining most of the international journals. The few journals that are obtained by developing countries are not accessible to scientists of these countries because the journals are put in unorganised, manually searched information systems without professional information scientists. Therefore scientists of developing countries when they struggle to contribute to the world science, their work suffers delayed publication due to manual search of data; and in most cases the work comes out to be a duplicate of the already published research. This happens because of lack of information tools such as Research in progress, current contents and the like. Therefore their work does not contribute much to the world science and does not win much citations.

In the study, two indicators were combined. One is publication count and the other is citation count. Publication indications measure the efforts of individuals who are actively engaged in the pursuit of research. As de Solla Price put it, "whenever a man labours, produces something new and the result is a publication; then he has been doing what I call science" (Price, 1969). It is only in rare cases that one labours to produce something new, but does not publish it in the scientific literature. In such cases publication indicators ignore the research efforts of such individuals. In developing countries it is more likely for such research scientists to publish in local journals rather than failing to publish at all. In the ranking of number of publications and number of Nobel prizes won for the ten countries which contribute more than 80% of world's scientific literature, a correlation has been observed between the two (Frame and al, 1977). Thus there is reason to guess that publication count does not only indicate the quantity of science but also roughly the quality of science.

The citation count as the next Indicator, was used as a weighing factor to the publication count Indicator. A few papers produced and cited carry more scientific quality than a lot of papers produced but not cited. Scientific growth is similar to that of living organisms. In a living organism growth between two points of time A and B can only be measured basing on the orginal mass of the organism at point A. In other words growth is relative and not discrete. Similarly science grows by building on the old ideas already contributed by scientists. A scientist with a new idea cites or refers to the contributor of the old idea which led to the growth of the new idea. For these very reasons one would like to see to what extent the ideas generated from science in the peripheral countries are cited in world science.

If one produces a paper, and it wins no citations, there are several reasons for this. One may be that the paper has not been accessible to those who would have found it relevant and necessary to cite. The second reason may be that the content of the paper has no direct relevance to current science and therefore it is not cited. If the former is true, then the journal in which the paper appeared is local or has little accessibility. If the latter is true, this has several meanings. This can mean that the author's field of research is isolated from the rest of the world's scientific literature. Also it can be due to the fact that the work produced is a duplicate of that already in literature.

METHOLOLOGY

From eight annual volumes of WIPIS, the number of publishing scientists from the three countries under study was obtained from 1971 to 1978. For the year 1978, in addition, the number of publishing scientists from other African countries was collected and compared with the three leading African countries. Similarly the number of publishing scientists in 1978 from USA, England, USSR and Federal Republic of Germany was also collected for the purpose of comparison. From 1971 to 1978, USA, England, USSR and Federal Republic of Germany rank in the first four positions respectively in the number of publishing scientists. The data have been compared as shown in Tables 1 and 2.

The next source of data was SCI Corporate source Index 1979. This index lists all the publications in one calendar year, countrywise. It was searched by hand to find details on institutions, authors, journal, volume, starting page and year for each one of the papers published, from these three countries; and the details were recorded on work sheets. All duplicates noted were removed and the total counts from each country were noted.

Counting of citations of each and every publication contributed by the three countries was done from the annual editions of SCI of 1979, 1980 and 1981. Limitation to this method is that a period of three years is not long enough to cover a considerable number of citations expected on any publication. Most publications, especially those from developing countries, win citations after a considerable lapse of time. Due to the fact that other indicators mentioned above were not affected, this limitation was borne with. All citations to these papers were noted on the worksheets. For every citation noted, the citing journal with details of volume, starting page, and year were recorded. The citing author in every case was cross-checked with cited author on the worksheet. In case the two were the same, a note of self-citation was made on the worksheet. After citation count, the analysis of the data was done as follows. All papers not cited at all in a period of three years were counted and noted. Then papers with one to "n" number of citations were counted and a table of citedness was made (table 3).

The second phase of analysis was on the journals used. All journals noted on the worksheet were tabulated (table 4). Papers published in each of the journals were counted and tabulated (table 5). The International Serial Catalogue was used to check the journal title abbreviations and the country codes, showing where the journals were published. The country codes were used to identify how many journals originating from developed countries are used by each of the three countries. For the journals not covered by ISC, or those covered but country codes are not given; Ulrich's International Periodical Directory was used as an alternative. International Standard codes for the represantation of names of countries (ISC 3166) was used to know the countries represented by the codes. Impact factor was added for journals under, study. The data was collected from journal citation reports, JCR. How often, on average each item published in a journal is cited, is considered to be the impact factor of that journal. The total number of items published by the journal influences the number of times it is cited. The more the journal publishes the greater the number of opportunities it has for it to be cited. Therefore, impact factor indicates whether the journals used by the three countries under study are of good quality or not.

RESULTS

Using WIPIS as a source, data on number of publishing scientists were tabulated (table 1 and 2). This was to show the comparative strength of publishing scientists from these countries. Data collected from SCI corporate Index 1979 were subjected to several analysis. First, journals used were listed to find out preferred journals based on the number of papers published in them. Using codes from ISC, the countries of origin of journals used were determined. Journals published from USA, UK and the Netherlands, used by each country, were counted because these journals were more often used than journals originating from other countries. Data on journals from USA, UK and the Netherlands were tabulated on table 4 and table 5. Table 4 was to show the percentage of journals used from USA, UK and the Netherlands, the percentage of journals used with impact factor of one or more; and the percentage of journals used from other countries.

Table 1 : Number of publishing scientists

Years	1971	1972	1973	1974	1975	1976	1977	1978	Av. of 8
Egypt	436	442	547	559	648	738	731	666	595.8
Nigeria	195	242	288	340	473	521	643	650	419.0
Kenya	119	100	130	113	178	202	174	166	147.7

Source: WIPIS, ISI different editions)

Table 2 : Number of publishing scientists in 1978

USA	141,1398
England	25 407
USSR	23,581
FRG	19 467
Total of Africa without S.A = A	2 531
Total of Egypt, Kenya and Nigeria = B	1482
B as % of A	58.5%
Total of Africa as % of USA	1.78%

Source WIPIS 1978

Table 5 was to show the percentage of papers published in the journals originating from the three developed countries, the percentage of papers published in journals with impact factor of one or more and the percentage of papers published in journals originating from other countries.

Citations of the papers from the three countries were counted and table 3 of citability was made. This was to show the percentage of papers not cited at all, cited one to four times and cited five more times. In addition to this the table showed the total citations won in the period of three years and the percentage of self citations to the total citations.

From the number of publishing scientists originating from the three countries (table 1), the following can be deduced. Egypt had the highest number of publishing scientists in the eight years followed by Nigeria and Kenya the least. Nigeria unlike the other two countries, Egypt and Kenya, her number of publishing scientists increased steadily in the eight year period. The three above countries were the lending countries in the number of publishing scientists and accounted for more than 50% of the total number of publishing scientists from African countries: (in all comparisons with Africa, white ruled South Africa is excluded). To place Africa science in perspective, one notes that the number of publishing scientists in African countries is just 1.78% of the number of publishing scientists from USA in 1978.

The choice of journals made by scientists to publish their work has a direct relevance to the quality of scientific papers. Through well defined editorial processes and refereeing systems, journals maintain a certain level of quality. Therefore when a good quality journals is used, papers are also likely to be of good quality. The standards of quality differ from journal to journal. And in fact a paper that is accepted and published in one journal need not necessarily be good enough to be found acceptable by a higher quality journal.

Table 3 : Citability

COUNTRY	EGYPT		KENYA		NIGERIA	
Total papers	1119	100.0%	283	100.0%	709	100.0%
Papers not cited	758	67.7%	155	54.7%	424	59.8%
Papers cited	361	32.3%	128	45.3%	285	40.2%
Papers cited 1 to 4	337	30.0%	94	33.2%	256	36.1%
Papers cited 5 or >5	24	2.2%	34	12.1%	29	4.1%
Total citations	697		491		672	
Self citations	199	28.5%	47	10.0%	167	24.8%

Table 4 : Journal use

COUNTRY	EGYPT		KENYA		NIGERIA	
Total journal used	413	100.0%	120	100.0%	343	100.0%
Journal with IMPF=1	103	24.9%	34	28.3%	94	27.4%
USA journal used	109	26.4%	39	32.5%	86	25.5%
UK journal used	73	17.6%	42	35.0%	77	22.4%
NLD journal used	24	5.8%	11	9.2%	23	6.7%
USA+UK+NLD	206	49.8%	83	76.7%	186	54.1%
Other countries	207	50.2%	37	23.3%	157	45.9%

Table 5 : Journals in which papers are published

COUNTRY	EGYPT		KENYA		NIGERIA	
Total papers in SCI*	1119	100.0%	283	100.0%	709	100.0%
Papers in journal with IMPF=1	202	18.1%	57	20.1%	202	28.4%
Papers in USA journals	119	10.6%	54	19.1%	123	17.3%
Papers in UK journals	158	14.1%	89	31.4%	177	24.9%
Papers in NLD journals	34	3.0%	20	7.1%	47	6.6%
USA+UK+NLD	311	27.7%	163	57.6%	347	48.8%
Other journals	808	72.3%	120	42.4%	362	51.2%

*during 1979

Egypt used 49.8% of journals originating from USA, UK and NLD of her total journals used; and published 27.7% papers in these journals out of her total papers published. Journals with one or more impact factor used by Egypt were 24.9% of her total journals used; and published 18.1% papers out of her total papers published. Kenya used 76.7% journals originating from USA, UK and NLD of her total journals used; and published 57 . 6% papers in these journals out of her total papers published. Journals with one or more impact factor used by Kenya were 28. 3% of her total journals used; and published 20.1% papers out of her total papers published. Nigeria used 54.1% journals originating from USA, UK and NLD of her total journals used ; and published 48.8% papers out of her total papers published. Journals with one or more impact factor used by Nigeria were 27.4% of her total journals used; and published 28.4% papers out of her total papers published.

The total papers counted for Egypt, Nigeria and Kenya were respectively 1119, 709 and 283. Out of 1119 papers Egypt had 32.3% of the papers cited; and of these 30% papers were cited one to four times while 2.3% papers were cited five or more time. The 32.3% papers of Egypt cited, won a total of 697 citations and out of these citations 28.5% were self citations . Out of 709 papers Nigeria had 40.2% of the papers cited and of these 36.1% papers were cited one to four times while 4.1% papers were cited five or more times. The 40.2% papers of Nigeria cited, won a total of 672 citations and out of these citations, 24.8% were self citations. Out of 283 papers, Kenya had 45.3% of the papers cited and of these 33.2% papers were cited one to four times while 12.1% papers were cited five or more times. The 45.3% papers of Kenya cited, won a total of 491 citations and out of these citations, 10% were self citations .

DISCUSSION

From the results of tables 1 and 2, the three countries rank in the order of Egypt, Nigeria and Kenya (according to their quantity of science produced in the eight year period). From the results of table 3, the three countries rank in the order of Kenya, Nigeria and Egypt (according to their quality of science revealed from citedness of their papers). From the results of tables 4 and 5 of journal use, the three countries rank in the order of Kenya, Nigeria and Egypt (according to 1) the number of journals originating from USA, UK and NLD used, 2) the number of papers published in journals originating from the above three developed countries; and 3) the number of journals used and papers published respectively in journals with impact factor of one or more). The order of quality of scientific work from these three countries under study, correlates significantly with the order of journal use of journal originating from the three developed countries and also with the order of journal use of journals with one or more impact factor.

Therefore one would think that scientific work accepted in international journals such as those originating from developed countries; or accepted in journals with impact factor of one or more must be of good quality. In addition to the good quality, publication of this scientific work in such journals disseminates it and makes it accessible to most of the scientists. Therefore this work wins more citations than scientific work published in journals of low impact factor and in journals originating from developing countries.

CONCLUSION

The bibliometric study has revealed that science contribution from the three countries is still of a peripheral nature. It's size and quality compared to those of world science are still minimal. This may be mainly due to inaccessibility to International Scientific information carried mainly in the journals of developed countries by the third world countries countries; as revealed with low percentage of journal use from developed countries. However the little scientic work that overcomes the barriers of communication and gets accessibility to international scientic information contributes fairly well with the rest of world science.

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MEASUREMENT OF THE SCIENTIFIC PRODUCTION IN BRAZIL: THE CASE OF ECONOMICS

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ABSTRACT

This study is an attempt to measure and analyze the Brazilian scientific production in the field of economics as reflected in Brazilian journals in the period 1980-1988. Twelve Brazilian journals were selected by fourteen specialists. On the basis of the articles published and patterns of scientific production it is shown that individual authorship is characteristic of the area. In contrast to this general situation, elite authors adopt more frequently a multiple authorship pattern. Another important finding is the strong North American influence on Brazilian economic thought.

RESUME

Cet article se propose de mesurer et d'analyser la production scientifique brésilienne dans le domaine de l'économie au cours de la période 1980-1988. A cet effet, douze journaux brésiliens ont été sélectionnés par quatorze spécialistes. Sur la base des articles publiés et des modes de production scientifique, les auteurs montrent que les articles signés par un seul auteur sont caractéristiques de ce domaine. A contrario, les chercheurs 'élites' les plus productifs signent plus fréquemment leurs articles avec d'autres auteurs. La forte influence nord-américaine sur la pensée économique brésilienne est également mise en évidence.

INTRODUCTION

The study aims to analyze the productivity of the authors in economics in the period 1980-1988, the adopted work practices and the existence of a pattern of authorship, seeking to see if the multiparadigmatic nature of the social sciences influences the standards of scientific communication in the area. Studies of the academic activity in economics show that it is a highly stratified system, in which productivity and prestige are concentrated in a small, yet dominant, elite of authors and institutions (Bensman, 1982) Thus, in a scenario of growing

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[1]Advisor of the dissertation from which this article originates.

scientific production which manifests itself principally in articles, evaluation of the Journal and of the research community is today a demand of the very process of the development of Science in the country (see also Goncalves & David, 1982).

1- METHODOLOGICAL OBSERVATIONS

Various procedures were used in order to select the periodicals and articles. A preliminary list were generated for examination by specialists in the field; a basic list was then created applying criteria derived by the operational definition and from the consultation of fourteen economists; this list was then consolidated by the titles' occurrences on authorized lists (of CAPES: Coordination for the Improvement of Profressional Level Personnel, and of *"Literatura Economlca"*) and in secondary sources of information (bibliographies, indices, etc... see annex)

A total of 2,225 contributions have been extracted from this list of journals for which author's name, volume, number, month and year of edition, and the institution to which the author belongs were coded.

Journals and authors productivity was computed. Upon considering the productivity of each author, as well as his/her way of producing articles (individual, collective, or both), it was decided to isolate the more productive authors (elite) given their importance in the selection of articles (Peters & Cecy, 1982). An important finding of previous research was the correlation between the elite authors' institutions and that of the editors evaluators. Our objective was to verify the level of "'endogeny" and the existence of schools of thought ("ideological inclinations") on the process of evaluation by peers.

"Endogeny" refers to the incidence of authors from one institution who write in the Journal which is published by that same institution. It can be noted that endogeny occurs both for authors and evaluators: the author can publish his/her article in his own institution, and an evaluator can write in the same journal for which he/she is part of the editorial board.

2. ANALYSIS OF THE RESULTS

2.1 Endogeny and the Pattern of Authorship

Articles written by authors who hold positions in Brazilian institutions were distinguished from authors with foreign affiliation, in order to locate the existence of an "endogeny" phenomenon. GONCALVES and DAVID (1982) also detected it, referring to "intramurally originated contributions". The pattern of authorship illustrates the level of cooperation through co-authorship.

The institutional origin of the authors is illustrated in Table 1. 85% of articles were written by authors who hold positions in domestic institutions. The 16% articles witten by authors in foreign institutions includes foreign as well as Brazilian authors abroad.

TABLE 1. GENERAL DISTRIBUTION OF ARTICLES PUBLISHED IN THE PERIOD1980-1988 ACCORDING TO ORIGIN OF THE AUTHORS

TYPE	JOURNAL	YEAR FOUNDED	DOMESTIC ARTICLES	FOREIGN ARTICLES	TOTAL
LEARNING	AN.ECON.	1983	50	5	55
AND/OR	EST.ECON.	1970	218	49	267
RESEARCH	RBE	1947	171	25	196
INSTI-	RBMEC	1975	148	9	157
TUTIONS	ENS. FEE.	1980	149	22	171
	LIT.ECON.	1976	84	48	132
	PPE	1971	244	56	300
	RBCEX	1985	86	10	96
	REN	1969	151	16	167
SUBTOTAL			1,301 58%	240 11%	1,541 69%
SCIENTIFIC	RE	1981	65	19	84
SOCIETIES	REP	1981	224	62	286
	RER	1962	301	13	314
SUBTOTAL			590 27%	94 4%	684 31%
TOTAL			1,891 85%	334 15%	2,225 100%

Regarding submissions by foreigners, GONCALVES and DAVID found 21% for the period 1970-1980 in three journals (RBE, PPE, EST.ECON). Here a proportional reduction should be noted. In some journals (EST.ECON, LIT ECON, PPE, RPE) foreign articles prevail[1]. These journals account for 65% of the total production.

Endogenous authorship can be observed In Table 2, which shows the portion of articles written by local faculty in their institution's journal.

Endogeny represents 25% of the total production in all type of journals. If we isolate articles published by LRIs we find a higher proportion (35%). This figure

[1]LIT. ECON., which shows a rather high figure, publishes regularly translations of foreign articles.

is significantly less than that found by Goncalves & David (one out of two articles were endogenous; while we find one out of three).

TABLE 2. ENDOGENOUS AUTHORSHIP OF ARTIGLES PUBLISHED BY LRI

JOURNAL	INSTITU-TION	TOTAL ARTICLES	ENDOGENOUS ARTICLES	
			abs.	%
AN. ECO.	UFRGS	55	35	63
EST.ECON	USP	267	99	37
RBE	EGV/RJ	196	58	31
RBMEC	IBMEC	157	83	53
ENS. FEE.	FEE	171	84	49
ECON	IPEA	132	22	17
PPE	IPEA	300	74	25
RBCEX	FUNCEX	96	44	46
REN	BNB	167	48	29
TOTAL		1541	547	100

2.1.2 Authorship Pattern of the Articles

The pattern of authorship practiced in the area of Economics can be observed in Table 3, which shows that 77% of articles were written individually. This pattern of individual writing was, curiously, even stronger in journals published by LRIs. Given the nature of LRI journals, more interaction among the researchers was expected but in fact did not occur. Individual authorship in the LRI journals is distributed among indices that range from 93% (AN. ECON.) to 78% (PPE). In the SS Journals the situatlon is slightly different (77%). It should be noted that one journal had a significant effect on this percentage: the RER -an interdisciplinary journal involving economy and rural sociology-, which has a 42% index., instead of the 82% for RE or 88% of REP.

2.1.3 Institutional Origin vs. Authorship Pattern

Combining the institutional affiliation with the pattern of authorship in LRI journals, we find an elevated index of endogenous and individually authored articles (30% of the articles published by the LRI journals). However, if the comparison is based on the overall total of articles studied (2,225), the index reaches 25%. Even more surprising is the index of individual authorship within the group of endogenous articles: 84%.

This seems to indicate a tendency of isolation of ideas and implies the absence of formal communication among peers. This isolation is also evidenced by the fact that 75% of non-endogenous articles are co-authored.

TABLE 3. DISTRIBUTION OF ARTICLES ACCORDING TO PATTERN OF AUTHORSHIP

TYPE	JOURNAL	AUTHORSHIP		
		Individual - %	In Collaboration - %	Total
LEARNING	AN. ECON.	51-93	4-7	55
AND/OR	EST. ECON.	218-82	49-18	267
RESEARCH	RBE	157-80	39-20	196
INSTI-	RBMEC	125-80	32-20	157
TUTIONS	ENS. FEE.	153-89	18-11	171
	LIT. ECON.	115-87	17-13	132
	PPE	234-78	66-22	300
	RBCEX	86-90	10-10	96
	REN	133-80	34-20	167
SUBTOTAL		1,272 82,5%	269 17,5%	1,541 100%
SCIENTIFIC	RE	69-82	15-18	84
SOCIETIES	REP	251-88	35-12	286
	RER	132-42	182-58	314
SUBTOTAL		452 66%	232 34%	684 100%
TOTAL		1,724 77%	501 23%	2,225 100%

2.1.4 The Influence of Individual Authorship on the Productivity of the Authors

We found a total of 1466 authors in the total list of 2225 articles. The number of articles written per author varies from one to 41 (Table 4). While 945 authors (64%) wrote only one article over the nine year period, a single author produced individually and/or in collaboration 41 articles (1.39%).

Considering the above, for this study it is necessary to apply the Law of Elitism (Price, 1972), which states that a population N (be it articles, journals, or authors) contains an effective "elite" group whose number is equal to the square root of N. Upon applying this formula to the absolute number of authors in the study (1466), the resulting elite is made up of 38 authors. When this number of authors is isolated , it is found that a total of 44 authors produced from seven to

41 articles - a substantially higher number than the formula indicates. Reducing the nucleus of elite authors to the line immediately below - line 13- a total of 37 authors are found to produce from eight to 41 articles, a valid number to represent the elite. Thus, the elite group of more productive authors represents 2.5% of the total number of authors, that produced 16.5% of articles.

Comparing the productivity of the elite to the non-elite, we find that:

- The non-elite (1,429 authors) represent 97.5% of the total number of authors and are responsible for 83.5% of the articles (2,458). The average number of articles per author is 1.7.
- The elite (37 authors) represent 2.5% of the total number of authors and are responsible for 16.5% of the articles (484). The average number of articles per author is 13.

TABLE 4. BIBLIOGRAPHIC PRODUCTIVITY OF THE AUTHORS 1980 -1988

Authors (A)	Sub-missions (S)	A	%A	%A Cumul	SxA	SA	%SA	%SA Cumul
1	41	1	0.06	0.06	41	41	1.40	1.40
1	24	2	0.06	0.12	24	65	0.90	2.30
2	22	4	0.14	0.26	44	109	1.50	3.80
1	21	5	0.06	0.32	21	130	0.80	4.60
2	20	7	0.14	0.46	40	170	1.40	6.00
1	16	8	0.06	0.52	16	186	0.50	6.50
3	15	11	0.20	0.72	45	231	1.50	8.00
1	14	13	0.14	0.86	28	259	0.90	8.90
3	12	16	0.20	1.06	36	295	1.30	10.20
2	11	18	0.14	1.20	22	317	0.80	11.00
5	10	23	0.30	1.50	50	367	1.50	12.50
5	9	28	0.30	1.80	45	412	1.50	14.00
9	8	37	0.70	2.50	72	484	2.50	16.50
19	7	56	1.20	3.70	133	617	4.50	21.00
25	6	81	1.70	5.40	150	767	5.00	26.00
39	5	120	2.60	8.00	195	962	7.00	33.00
66	4	186	4.50	12.50	264	1226	9.00	42.00
101	3	287	7.00	1.50	303	1529	10.00	52.00
234	2	521	16.00	35.50	468	1997	16.00	68.00
945	1	1466	64.50	100.0	945	2942	32.00	100.0

Moving on to the subject of individual authorship's influence on the authors' productivity, we find that a large number of authors usually write alone. 671

authors (45%), adopting the practice of markedly individual academic production. In contrast, a larger proportion of the authors (795, 55%) produce individual as well as collective works The general pattern that emerges is that those who write individually, write less. In collaboration with their colleagues, they tend to produce more.

In the elite group that produces more articles, we find that only 5 authors (14%) adopt an individual authorship pattern, and these are responsible for 9% of the production of the elite group. The other 32 authors, who write both individually and collectivelly are responsible for 91% of the production.

One of the greatest changes in scientific literature over the last decades has been the increase in multiple authorship (Price, 1963). In respect with the social and behavioral sciences, Psychiatry and Psychology, almost half of the literature has been written by research groups, while in the social sciences and sociology only one-fourth of the literature is individually authored (Lindsey, 1968).

In a total of 795 authors who did not adopt an individual pattern of authorship, we found that 234 authors wrote published individually and collectivelly while the remainig 561 (38%) wrote exclusively co-authored papers. In the elite the figure of both collectively and individual authorship is of 29 authors. Only three authors wrote exclusively as co-authors. These observations demonstrate that the elite authors behaved differently from the majority.

2.2 Elite Authors, their Institutions and the Degree of Endogeny

Once the elite group of authors was singled out, they were compared to the group of editors and evaluators in order to verify the degree of endogeny among them. In the same manner, the institutions that granted the elite authors academic degrees were compared to those of the editorial board members in order to observe any correlation between them and the possible influence on receptivity of articles submitted for publication.

We found that the elite show afiliations distributed among 19 institutions: 11 universities, five research centers, two companies and one professional association. Five institutions were responsible for 57.5% (283) of the articles, published by 48% (86) of authors. They are:

USP (Universidade de Sao Paulo) with 15% of the articles (75); PUC-RJ (Pontificia Unlversidade Catolica do Rio de Janelro) with 15% of articles; UFRJ (Unlversidade Federal do Rio de Janeiro) with 11%; UFV (Universidade Federal de Vicosa) with 8.5%; and FGV/RJ (Fundacao Getulio Vargas- Rio de Janeiro) with 8%. These are all higher education institutions, leading to the conclusion that in the area of Economy in Brazil, the strongest scientific production is generated in Univesrities.

It should be also noted that in the "institutional elite", five institutions produced six research journals. These institutions were represented by 13 economists who produced 36% of the articles. Five of them were also editors of three research journals. Furthermore, 150 economists were found in the editorial boards of the journals. From these, 12 were in the elite group identified earlier. Endogeny is thus further emphasized. Additionally we must mention that three foreign institutions appear in the affiliations of authors from the elite. These are the Boston University, The World Bank, and Massachussets Institute of Technology.

Table 5 was drawn up in an attempt to measure the index of endogeny among the authors in the elite group. It represents 12 authors of the elite in five institutions that publish six journals. We find here a high endogeny number of 43%. Examination of each case revealed that the highest indices are those of RBMEC (83%) and ENS. FEE (83%). Excluding these two publications lowers the endogeny index to 28%, meaning that one out of every four articles originates from within the publishing institution.

TABLE 5. ENDOGENOUS AUTHORSHIP AMONG THE ELITE AUTHORS

No. AUTHORS	INSTI-TUTION	JOURNAL	ARTICLS OF AUTHORS IN JOURNALS	TOTAL NB OF ARTICLES OF AUTHORS	%
4	USP	EST.ECON	14	75	19
2	FGV/RJ	RBE	11	29	38
2	IBMEC	RBMEC	19	18	83
2	FEE	ENS.FEE	15	18	83
2	IPEA	PPE/LIT.ECON	12	25	48
12	5	6	71	166	43

2.3 Elite Authors vs. Evaluators: the Influence of Institution from which Academic Degree was earned

The academic degrees of the more productive elite authors, the distribution of articles among the primary journals, and the number of authors granted degrees by each institution were examined jointly in detail. 29 authors had been granted doctorate degrees, only two had a masters degree, and six had not indicated their degree level.

American universities were the principal institutions granting degrees (19 authors). English, Canadian, and French universities accounted for 5 authors, and four Brazilian universities granted degrees to seven authors. The majority of the published articles were written by authors who earned degrees from American universities: that is, 257 articles were written by 19 authors. The journals that published a high number of articles are of a general nature: PPE, with 70; RBE and REP, with 38 each: and EST. ECON., with 25. Only one primary journal dedicated to a specific sub-area, that of rural economy, with 42 articles (RER).

The degree of endogeny and possible "ideological inclinations" of those specialists who edit and evaluate the articles submitted for publication in the journals is obtained by comparing the academic degrees of the elite authors with the academic degrees of specialists that form the editorial boards of the Journals. Survey of these specialists' degrees showed the presence of 13 American universities and one English University, out of 22 different universities.

In a more detailed analysis, table 6 shows that some of the most productive authors are members of editorial boards. Moreover the author's affiliation seems to be an important factor when judging the articles. Finally, authors associated to the same institution that granted the degrees to the members of the board seem to be privileged.

TABLE 6. ELITE AUTHORS PARTICIPATION ON EDITORIAL BOARDS OF THE PRIMARY JOURNALS

AUTHORS	INSTITUTIONS	JOURNALS	ARTICLES
A*	FGV/SP	REP	20
B*	FGV/SP	REP	9
C*	FGV/SP	REP	8
D*	IPEA	PPE	10
E	IBMEC	RBMEC	11
F	UFRJ	RBCEX	14
G	USP/ESALQ	RER	24
H	USP	EST.ECON.	21
I*	FGV/RJ	RBE	15
J	PUC/RJ	RBE	12
K	USP	EST.ECON.	22
L	USP/ESALQ	EST.EGON.	8

* Editors.

3. FINAL CONSIDERATIONS

The research results allow some overall observations to be made. We found a high index of endogenous production and high individual rates of publication, which seem to indicate a lack of interaction within the scientific community of economics. Individual authorship is characteristic of the area. It may be the multi-paradigmatic nature of the social sciences that explains these authorship practices Also individual productivity is lower for those who write individually. In contrast to this general situation, the elite of authors adopt a multiple authorship pattern more frequently, confirming what is known from the sociology of science: collective authorship improves the productivity of the authors.

Finally, another important finding was the indisputable north american influence on Brazilian economic thought, verified by the academic degrees earned by the more productive authors, as well as the editors of journals in the field.

It is hoped that the results of this study will open the debate about the subject, contributing to a better understanding of the communication patterns inside the scientific community.

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ANNEX

JOURNALS PUBLISHED BY LEARNING AND/OR RESEARCH INSTITUTIONS (LRI)

-Analise Economica (AN. ECON.) Faculdade de Ciencias Economicas - Unlversidade Federal do Rio Grande do Sul - (UFRGS)
-Ensaios FEE (ENS. FEE) Fundacao de Economia e Estatistica Siegfried Emanuel Heuser (FEE)
-Estudos Economicos (EST. ECON.) Instituto de Pesquisas Economicas da Universidade de Sao Paulo - (USP)
-Literatura Economica (LIT. ECON.) Instituto de Pesquisas do Instituto de Planejamento Economico e Social - (IPEA)
-Pesquisa e Planejamento Economico (PPE) Instituto de Pesquisas do Instituto de Planejamento Economico e Social - CIPEA)
-Revista Brasileira de Comercio Exterior (RBCEX) Fundacao Centro de Estudos do Comercio Exterior (FUNCEX)
-Revista Brasileira de Economia (RBE)
Escola de Pos-Graduacao em Economia da Fundacao Getulio Vargas - (FGV)
-Revista Brasileira de Mercados de Capitais (RBMEC)
Instituto Brasileiro de Mercado de Capitals - (IBMEC)
-Revista Economica do Nordeste (REN)
Escritorio Tecnico de Estudos Economicos do Nordeste do Banco do Nordeste do Brasil - (BNB)

JOURNALS PUBLISHED BY SCIENTIFIC SOCIETIES (SS)

-Revista de Econometria (RE),
Sociedade Brasileira de Econometria - (SBE)
-Revista de Economia Politica (REP)
Centro de Economia Poiltica em co-edicao com a Editora Brasiliense - (CEP)
-Revista de Economia e Sociologia Rural (RER)
Sociedade Brasileira de Economia Rural - (SOBER)

CINQUIEME PARTIE

LE ROLE
DES REVUES SCIENTIFIQUES

BIBLIOGRAPHIC CONTROL AND INTERNATIONAL VISIBILITY OF LATIN AMERICAN PERIODICAL PUBLICATIONS

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ABSTRACT

Bibliometric research can provide science policy makers with indicators of the capacity of a country's national scientific system to produce printed information. The capacity of a scientific system to produce printed information, particularly periodical publications reflects the availability of local outlets for the dissemination of scientific findings. The availability, visibility and ease of access to outlets for the dissemination of scientific findings are factors of particular importance to science policy makers in developing countries (DC). These factors can reduce the insularity of the scientific output of a DC. The present research attempts to evaluate the level of bibliographic control, and the international visibility of the periodical publications of Latin American countries. A search was performed on the 1990 CD-ROM version of THE SERIALS DIRECTORY, a commercially produced international reference source on periodical publications. The periodical publication's output per Latin American country with the addition of Spain and Portugal was recorded. Publications were sorted thematically and indicators of bibliographic control, and of international visibility were recorded. Suggestions for the improvement of the international visibility and bibliographic control of periodicals from DC are presented.

RESUME

Les études bibliométriques sont en mesure de fournir aux décideurs politiques des indicateurs sur la capacité d'un système scientifique national à produire des informations imprimées. Cette capacité, et en particulier l'existence de publications périodiques, reflète l'existence locale de moyens de dissémination des résultats de la recherche. La facilité d'accès, La disponibilité et la visibilité de ces moyens de dissémination sont des facteurs d'une importance particulière pour les décideurs politiques dans les pays en développement (PED). Ces facteurs peuvent réduire l'insularité de la production scientifique d'un PED.
Le présent travail a pour but d'évaluer le niveau de contrôle bibliographique, et la visibilité internationale de publications périodiques Latino Américaines. Une recherche a été effectuée à partir de la version CD-ROM d'un répertoire (THE SERIALS DIRECTORY), source internationale de référence sur les publications

périodiques. Nous avons enregistré la production de publications périodiques par pays Latino Américain ainsi que pour l'Espagne et le Portugal. Nous avons trié les publications par thème et nous avons produit des indicateurs de contrôle bibliographique et de visibilité internationale. Nous proposons en conclusion des suggestions pour améliorer la visibilité internationale et le contrôle bibliographique des périodiques des PED.

INTRODUCTION

Bibliometric research can provide science policy makers with indicators of the capacity of a country to produce printed information. Printed information can take the form of monographs, journals, conference proceedings and "grey literature". Each of these media fulfills a specific role in the communication of scientific results. The availability of publication media indicates the level of maturity of the indigenous publishing industry. A mature publishing infrastructure provides sufficient local outlets for scientists to disseminate findings about locally produced research.

The traditional outlet for the dissemination of research results in the sciences and social sciences is the scientific journal. However, its role as primary element in the diffusion and exchange of scientific ideas has been seriously contested in favour of a perspective that links publication practices with the present evaluation and reward systems of science (1). Indeed, since the evaluation of scientific work can be influenced to some extent by the visibility and reputation of the journals in which the work is published, the choice of highly visible, prestigious scientific journals as publication outlets has become a crucial element in the career of scientists (2).

The choice of publication outlet affects not only the visibility and recognition of the work of a scientist as an individual, but also plays a role in the visibility and recognition of the efforts of any country as a contributor to scientific knowledge. The publishing infrastructure of any country plays a key role in introducing and making available journals which publish the results of local science.

The mechanisms by which scientific journals become academically recognized, visible and commercially viable ventures are worth considering. However, the role of the publishing industry as an intermediary in the dissemination and visibility of scientific journals has not so far been presently researched in the area of scientometrics (3).

The present paper examines the effect of the publisher in the visibility of the periodical publications of a group of developing countries, DC in Iberoamerica. The concepts of international visibility, bibliographic control and academic recognition shall be discussed from the viewpoint of a mature publishing infrastructure in the first section of this paper. This viewpoint shall be contrasted to the problems of publishing in developing countries in section 1.3. The database selected for the study shall be described in the second section. The methodology for sample selection is presented in the third section, the results are presented in the fourth section, and finally a discussion of the findings and their implications to future research in bibliographic control is presented in the last section.

1.1. VISIBILITY OF PERIODICAL PUBLICATIONS

The concept of visibility implies the state or fact of being visible. For the purposes of this research a periodical publication becomes "visible" the moment it can be uniquely identified and obtained by its potential readers.

The visibility of scientific journals can be seen as the result of a composite process involving objective and subjective elements. A traceable bibliographic record per scientific journal constitutes a countable item which can be used to produce bibliographies. In turn, the bibliographies can be analyzed to picture the publication structure of individual scientists or the total yearly publication output of a research group or field. In as much as the bibliographic records are countable, they present an objective picture of research output.

The subjective element involves the evaluation of the intrinsic value of the information published in the journal. This academic recognition is usually related to the existence of an internationally recognized editorial board, and an enforceable peer review processes. Both objective and subjective elements shall be further examined in the next two sections.

1.2. BIBLIOGRAPHIC PRODUCTION AND CONTROL

The bibliographic production of periodical publications of a country has been related to the number of items listed in periodically updated reference sources (4). Bibliographic control over serials is achieved in the sense that every item in the national bibliographic production satisfies the following criteria:

- every item is uniquely described
- every item can be traced back by its publisher
- every item can be easily obtained

The unique description of a journal deals with the normalized application of standard bibliographic elements to produce a standard bibliographic record that will facilitate its physical description and its access. Examples of such bibliographic elements are: the title of a journal, its ISSN number, its country of publication, its frequency, its publisher etc. These elements have been traditionally used by libraries to produce cataloguing cards. These elements also have been used by commercial database producers to produce computer searchable automated cataloguing records which can be accessed on-line. In either case the purpose of the bibliographic record is the same, to accurately describe the document in question, and to provide the information necessary for the user to access the document.

A traceable bibliographic control record therefore implies that the publication must have the elements that insure its unique identification, both for descriptive purposes (library catalogues), and for acquisition purposes (subscriptions by institutions or individuals). Publishers usually insure at publication time that the publication's name, editor, publisher, publisher's address, ISSN and country of publication appear. Subsequently, the title is uniquely identified and can be listed in national and international reference sources compiled either by national libraries or commercial institutions.

The ease of availability of a document is therefore related to having its bibliographic record listed in a frequently updated reference source, and to its subsequent mention in printed or on-line versions of major library catalogues and secondary publication data bases. The existence of major bibliographic reference sources such as the National Union Catalogue, the OCLC cataloguing network or the catalogues of The British Library allow for virtually any document produced in industrially developed countries to be obtained with relative ease.

1.3. ACADEMIC RECOGNITION AND COMMERCIAL SUCCESS OF PERIODICAL PUBLICATIONS

The academic recognition of a periodical publication often reflects a subtle interaction between the communication needs of the scientific community, the academic motivation of the editor and its editorial board, and the economic motivation of its publisher. Ideally, all of these motivations coincide to produce a journal that prints academically sound information, that is accepted and recognized by the scientific community it serves, and that is a commercial success.

Since the academic recognition of a journal is a complex mechanism that involves at least the constant interaction of three different groups of people with different motivations, it is important to understand the mechanisms leading to a successful publication both from an academic and an economic perspective. In an academic perspective a journal is the result of the choices of scientists who wish to communicate their research results and to stake a claim of their contribution to knowledge by submitting manuscripts for review to the editorial board of a journal. The members of the editorial board, scientists themselves, act as regulators of self-imposed research standards in the academic community, and make sure that manuscripts get assessed according to the rules of the community. The scientist and the members of the editorial board are both members of the scientific community at large and their aims for publishing are presumably non-commercial.

The publisher on the other hand, is usually a financial investor. Publishing scientific literature is seen as a business enterprise where an adequate return for the original investment is sought. Since an economic return is expected and an investment is at stake, publishers often coordinate and orchestrate the different actors involved in the establishment of a journal in order to ensure as much as possible its financial success. Major science publishers aim to produce quality journals from an academic and a production and distribution perspective.

Major science publishers recognize that quality journals are the result of several factors:

- the need by the scientific community for a new journal
- a good editorial board
- a solid production infrastructure
- sound marketing principles

Considerable research efforts are spent by science publishers on the identification of suitable areas for the launching of a scientific journal (5). The research may include the analysis of the yearly number of conferences on research-front topics, the number of academic societies per topic, and in many cases, the number of yearly post-graduates in the discipline. Ideally, the journal has to attract at least 1 years' worth of manuscripts prior to the publication of the first issue (6) and can continue to attract a substantial number of manuscripts to maintain its publication schedule.

A respectable academic record is achieved by a knowledgeable impartial editorial board to examine the academic content of submitted manuscripts. In fact, major efforts are spent by publishers in locating potential editorial board members that can guarantee academic quality and that can attract by virtue of their reputation sufficient manuscripts to keep the journal viable as an academic and a commercial venture.

A solid production infrastructure is particularly important in the initial stages where the attractiveness and printing quality of the journal will be judged. Although the quality of the information in the journal is the paramount factor to subscribers, consideration is given by the publisher to deliver the information in a durable, attractive package. Issues such as the printing quality, the accurateness of the delivery of the journal, the timeliness of its printing, and the quality of the paper give the periodical an attractive image. Sophisticated science publishers are aware of these considerations and therefore make financial investments in the technical equipment necessary to produce quality printing.

Finally, circulation forecasting figures based on readership levels derived from market research are drawn by publishers wishing to asses the prospective rate of return on their investment. These figures complement feasibility plans with detailed costs of managing, producing, editing, printing, distributing and marketing the journal. The feasibility plans are important because publishers are usually aware that on average a possible return on their investment will not occur before the journal reaches five years (7).

1.4. BIBLIOGRAPHIC PRODUCTION, CONTROL & VISIBILITY

The picture described in the preceding two sections is drastically different, however, in most DC where sources of bibliographic control are generally non-existent or exist only in legislative form with depository libraries lacking resources to maintain up-to-date catalogues of the country's bibliographic production (8).

Estimates of bibliographic production are therefore based on counts of items listed in printers' catalogues or publishers' lists. The shortcoming of this method is that the estimate will be as reliable as the lists are exhaustive, and frequently updated. Some form of bibliographic control and some local visibility can be achieved by word of mouth, or by developing personal knowledge of the particularities of a library collection compared with other collections, however this form of control is highly individualized and cannot be assessed and measured to produce a picture of the degree of control the country has over its bibliographic production.

2. BIBLIOGRAPHIC CONTROL AND THE SERIALS DIRECTORY

Librarians have long aimed to achieve bibliographic control of their collections, particularly with the advent of automated retrieval bases and the possibilities of interchanging machine readable records of holdings. Bibliographic control of serials is a complex issue because the publishing world of serials is a very dynamic one. Periodical publications emerge as invisible colleges become institutionalized; the scope of a journal may change to reflect a change of membership of the editorial boards; titles die; titles merge etc.

Librarians are increasingly making use of commercially produced reference sources of bibliographic information to keep them abreast of the bibliographic changes in the world of serials. One such reference source is THE SERIALS DIRECTORY produced by EBSCO.

EBSCO, as a multinational subscription agent is an intermediate between editors and publishers of serials, and libraries. It confronts problems of bibliographic control of a much greater magnitude than most libraries since it aims to provide any library in the world with any serial publication in existence regardless of its country of publication.

In order to serve its clients EBSCO maintains an on-line database called EBSCONET that records bibliographic and price information on over 300,000 titles. As a large database, EBSCONET experiences an average of 10,000 changes per month (9). The composition of the database is international and it reflects to a certain extent the acquisition policies of EBSCO's clients. Any EBSCO client worldwide can access the database through telecommunication networks such as Tymnet and Alanet. A subproduct of EBSCONET has been made commercially available in CD-ROM and book format since 1986 as THE SERIALS DIRECTORY.

This reference source is now in its 5th edition and comprises information on over 150,000 titles produced by 51,000 publishers worldwide. This involves amongst other things the yearly mailing of over 200,000 questionnaires in 5 languages to publishers and editors of serials worldwide.

In addition to the mailing to editors and publishers, THE SERIALS DIRECTORY incorporates bibliographic information from the CONSER Snapshot, Library of Congress, including the MARC-S and the unauthenticated CONSER Updates.

THE SERIALS DIRECTORY is therefore built from three sources, the EBSCONET database provides current subscription information such as the frequency of a title, its price, the name of its publishers and its address and telephone number. The mailings to the publishers are used to verify and corroborate the accuracy of the subscription information as well as to furnish additional information regarding the scope of the journal, its acceptance of book reviews and advertising, its circulation figures, and a descriptive listing of the publication. Finally the CONSER records provide the bibliographic information concerning the title statement, the key title, the dates of publication, the ISSN, the country of publication, the language(s), index and cumulative index availability, and several other bibliographic elements (10).

3. METHODOLOGY

The purpose of this research was to examine the visibility of Iberoamerican serials in THE SERIALS DIRECTORY through indicators of bibliographic control. A computerized search of the database was performed on the CD-ROM disc corresponding to Summer 1990. Iberoamerican publications were selected using their corresponding country codes (11). The search yielded a total of 5,167 publications. Spanish and Portuguese publications were included in the search and merged into the initial result list. This decision was taken because of the major cultural influence of both countries in Latin America and the similarity of problems faced by the publishing sectors of all countries involved.

The 5,167 publications were then grouped into 7 thematic categories. The categories were based on the list of Subject Headings provided in THE SERIALS DIRECTORY. The results of each individual search merged into 7 large thematic categories listed in Table 1.

It was not possible to include the remaining 1798 periodicals as they fell outside the 7 categories contemplated.

Table 1. Iberoamerican publications

Thematic Groups	Number	%
Social Sciences	939	28
Arts and Humanities	862	26
Sciences	487	14
Agricultural Sciences	353	10
Engineering	284	8
Health Sciences	272	8
General Interest	172	5
Total	3369	99

As a comparison point a search on the periodical production of the rest of the world was performed on the same subject categories as those studied in Iberoamerica. The results are presented in Table 2.

Table 2. Geographic ans thematic distribution of periodicals publications

Geographic groups	Iberoamerica		World	
Thematic groups	N	%	N	%
Social Sciences	939	28	18811	24
Arts and Humanities	862	26	13912	18
Sciences	487	14	12638	16
Agricultural Sciences	353	10	6347	8
Engineering	284	8	12405	16
Health Sciences	272	8	6019	8
General Interest	172	5	6019	10
Total	3369	99	78630	100

It is interesting to note that in spite of the huge differences in actual numbers between the world production of periodicals and those of Iberoamerica, there was very little difference in the percentages except for the case of Engineering, where the world's production (16%) contrasts to that of Iberoamerica (8%).

3. INDICATORS OF VISIBILITY

In order to examine the visibility of periodical publications it was necessary to detect bibliographic elements that would ensure that a publication could be easily identified and bought in its country of origin, as well as abroad. An examination of the standard descriptive entries for a periodical publication in The Serials Directory revealed up to 24 items of information, listed in Table 3. The elements marked with an asterisk were those selected for their influence on the visibility of a journal. Although strictly speaking the title is one of the most important bibliographic element in a publication this element was ignored in the present study because very little visibility can be derived from the title of a periodical.

The ISSN was selected as a visibility indicator on the understanding that the ISSN allows for a publication to be uniquely identified and makes it more easily traced back to its publisher. ISSN numbers are assigned under the auspices of the ISDS network. The International Serials Database System, ISDS network was formed in 1971 by the United Nations. It operates in France and is divided into member countries that work from national centres. Each national centre is responsible for assigning an ISSN to each serial published in its country while adhering to the ISDS standards.

Table 3. Standard description. Serials Directory

(1) Subject	(9) Frequency	(17) CODEN
(2) Key Title	(10) Price	(18) Book Review
(3) Title	(11) Publisher *	(19) Advertise
(4) Date/Volume	(12) Index/Abstracts	(20) Circulation *
(5) ISSN *	(13) Telephone	(21) Index Availability *
(6) Serial Type	(14) Editor *	(22) Description (Scope) *
(7) Country	(15) Classifications (NLM, DC, LC, UDC)	(23) Other Formats
(8) Languages (s) *	(16) CONSER	(24) Preceding Title

The Language field was selected as an indicator because multilingual journals, or publications that systematically include abstracts in English, or other languages have more probabilities of being incorporated into major secondary publications and databases. Similarly, the existence of an Index either by Author, Title or Subject simplifies the retrieval of the articles within the journals. This in turn facilitates the journal's entry into major international indexing and abstracting services. The Index/Abstract field was selected because once a publication is selected to be systematically perused for indexing and abstracting purposes by an international abstracting service its eventual visibility and possible commercial success is ensured.

The Editor field was selected since the editor is responsible for the academic integrity of the journal. The existence of an editor generally implies the existence of an editorial board and of a peer review process. All of the above constitute requirements ensuring the academic quality of the publication, and preconditions to the insertion of the journal into to an abstracting service. The Description of Scope was selected because it provides a small section in which the editor describes the scope and general contents of the journal.

The Publisher field was selected because it was felt that its role was crucial to the survival, commercial success and eventual visibility of any periodical publication. Similarly, the Circulation field was selected because it might be an indicator of the commercial success of the periodical and of its ultimate visibility.

4. RESULTS

The analysis of the data pertaining to the availability of bibliographic items in the periodical publications of DC gives evidence of a very loose level of bibliographic control. Indeed, the data pertaining to the number of journals that listed an ISSN number (Table 4) show that only 45% (124) of the 277 journals studied, listed this most important item of bibliographic identification and control. Similarly, only 11% (30) of the journals reported the printing of a periodic index, (Table 5), thus making the retrieval of a particular article within the journal an extremely cumbersome process.

The academic quality of the journals was also in doubt since only 20% of the journals (55) listed an editor or an editorial board (Table 6). The absence of an editor responsible for the academic integrity of the journal as an enforcer of editorial practices, and an overseer of the peer review process reveals a major shortcoming of the publisher. It is possible that there is indeed a person responsible for these important academic activities, and it was simply not reported by the publisher. Nonetheless the frequent omission of a named editor is disturbing.

Similarly, only 22% (61) of the journals presented a description of scope (Table 7). This data is consistent with the data presented in the preceding table in which very few editors were listed, since the description of scope field is the place where the editors or the editorial board, describe the aims of the journal as well as its scope.

Table 4. Distribution of Journals with ISSN

Subject	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
Yes	32	19	18	8	24	23	124	45
No	31	27	25	31	14	25	153	55
Total	63	46	43	39	38	48	277	100

Table 5. Distribution of journals with an index

Subject	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
Yes	7	3	3	4	5	9	30	11
No	56	43	40	36	33	39	247	89
Total	63	46	43	39	38	48	277	100

Table 6. Distribution of Journals with listed editors

Subject	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
Yes	11	5	7	9	12	11	55	20
No	52	41	36	30	26	37	222	80
Total	63	46	43	39	38	48	277	100

Table 7. Distribution of journals with a description of scope

Subject	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
Yes	10	6	8	13	12	12	61	22
No	53	40	35	26	26	36	216	78
Total	63	46	43	39	38	48	277	100

A breakdown into three categories was performed on the Publishers field in order to have a clearer picture of the bodies responsible for the production of periodical publications in Iberoamerica. The breakdown is presented in Table 8 where the major publisher of periodical publications was the academic sector, comprising 34% (95) of the journals in the sample. As a whole the distribution of publisher types is quite even, with commercial publisher providing 32% (89) of the journals.

Table 8 . Publishers type per subject category

Publ. Type *	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
A	34	15	8	6	11	21	95	34
G	8	13	13	5	6	23	68	25
C	17	4	20	27	19	2	89	32
N.A.	4	14	2	1	2	2	25	9
Total	63	46	43	38	38	48	277	100

Legend - Publisher Type. A = Academic Publishers; G = Governmental Publishers; C = Commercial Publishers; N.A.= Non Available

An analysis of the data pertaining to the availability of multilingual periodicals produced in DC shows that only 20% (56) of the journals are either published in more than 1 language or with abstracts in more than 1 language (Table 9). This seems to suggest that the publishers aim towards a local readership, or towards an almost exclusively Spanish-speaking audience.

The circulation data presented in Table 10 shows that circulation data was only available for a quarter of the data. This suggests that publishers did not want to have their circulation data disclosed. For the available data only 8% (23) of the journals achieve a circulation figure between 1000-2999. The breakdown figure is admittedly arbitrary, but it does show that the readership is not extensive.

Table 9. Number of languages used per journal

Lang. used	Arts	Sci.	Eng	Gen.	Med.	Agric.	Total	%
1	53	36	36	36	26	34	221	80
2	4	5	5	3	9	10	35	13
>3	6	5	2	1	3	4	21	7
Total	63	46	43	39	38	48	277	100

Table 10. Circulation data

N	Arts	Sci.	Eng.	Gen.	Med.	Agric.	Total	%
-999	5	5	2	0	0	7	19	7
1000-2999	3	4	2	7	3	4	23	8
3000-4000	2	1	1	1	3	2	10	4
> 5000 *	1	0	3	8	7	0	19	7
N.A.	52	36	35	23	25	35	206	74
Total	63	46	43	39	38	48	277	100

* Journal with Largest Circulation = 36,000

Consistent with the data that suggest only local readership levels, only 20% (84) of the publications are systematically perused and indexed by international secondary publications (Table 11). The data agrees quite well with the data presented in Table 9 where 80% of the journals were published in only 1 language. Due to the fact that most major international indexing and abstracting services are English language based, the publication of only Spanish language abstracts seriously affects the inclusion of Iberoamerican publications into these services.

Table 11. Number of journals retrieved by indexing / abstracting services

	Arts	Sci.	Eng	Gen.	Med.	Agric.	Total	%
0	47	30	28	36	19	33	193	70
1-3	10	10	9	0	10	6	45	16
> 3	6	6	6	3	9	9	39	14
Total	63	46	43	39	38	48	277	100

In order to examine the role of the publisher in the production of journals, four of the visibility indices studied in the preceding section were compared with the respective type of publisher. The results are presented in Table 12.

Table 12. Indicator vs. publisher type

Pub. Type Indicator	Academic %	Government %	Commercial %	N.A. %
No Editor	71	94	74	100
1 Language	67	87	85	88
No Index	83	94	89	100
No ISSN	35	68	64	68

Academic publishers constitute the largest publisher type in the sample studied, although admittedly the distribution of journals amongst publisher type is quite even. Academic publishers are responsible for 34% (95) of the journals studied, see Table 8. However, 71% of those editors printed periodicals without a named editor. Likewise, 83% of the academic editors printed journals without an index at the end of the volume. Commercial publishers are the second largest publisher type. They are responsible for 32% (89) of the journals studied, see Table 8. In this case 74% of the publications were produced without editor and 89% without an index. Governmental publishers produced 25% (68) of the journals in the sample. However, 94% of their publications were without an editor, and without an index.

In the case of the introduction of ISSN numbers, the community of academic publishers fared the best, only allowing 35% of its production to be without an ISSN. However commercial and governmental publishers allowed over 60% of their production to be without the ISSN in spite of considerable efforts to improve the bibliographic control of DC through the International Serials Database System, ISDS.

The conclusions derived from the data presented in this section are somewhat limited because comparable data on the bibliographic control of publications from industrially developed countries was not obtained due to financial constraints.

5. DISCUSSION

Journals with high visibility are seemingly published in countries where the scientific and publishing infrastructure is mature (12). The visibility and international recognition of these publications is the result of numerous factors such as a stringent editorial practice, the visibility and internationality of their editorial board, the commercial savvy of the publisher and the application of publishing standards that facilitate an adequate bibliographic retrieval and control of the journal.

On the basis of the data analyzed in the preceding section, the publication infrastructure of the Iberoamerican countries studied is still in a developmental stage. Publications issued from this infrastructure do not present the minimum levels of bibliographic control necessary to be uniquely identified, read, and subscribed to by an international audience. Periodical publications issued from such an infrastructure are condemned to a ghost-like existence, and the scientists that publish in them are condemned by implication to have their research results unrecognized (13). Both of these factors have grave implications from a science policy perspective in DC.

An immature publishing infrastructure means that there are relatively no valid publication opportunities available locally. In this case, science policy planners can decide to favour either a national or an international publication strategy for their scientists. Both approaches have advantages and disadvantages.

An approach that favours only international publications implies that researchers will not be induced to publish locally. Scientists must publish abroad and adhere to international reviewing and publishing standards. To publish abroad entails a number of choices by scientists working in DC as to the types of problems to be researched, the methodologies to be employed, and the type of outlet in which to present the results (14). These choices have significant repercussions on the scientist's career, and the type of rewards offered by the peer community. Therefore there may be some conflict between the interests of individual scientists and those of DC. To choose to participate in "front-line" science will almost inevitably mean the adoption of scientific problems suited to the prevailing problems and conditions of developed nations. These might not suit the scientific and technological needs of developing countries.

On the other hand, Arvanitis and Chatelin (15) argue in favour of an integrated science policy concerning publication of research results favouring national publications, coupled with increasing interaction and participation of DC in international congresses. The implementation of such a strategy would allow local publications to establish and develop a local scientific press with progressively more sophisticated editorial and refereeing practices. Local journals would develop an indigenous readership base composed of researchers and students. As the publishing and editorial standards improved such a policy would allow scientists and journals from DC to become more visible internationally.

CONCLUSIONS AND RECOMMENDATIONS

The development of a local publishing infrastructure is a long-term investment. Science policy makers can decide to favour financially those publishers that incorporate the bibliographic control elements recommended by the ISDS, and necessary for the unique identification of their journals. Training schemes with successful science publishers can be arranged, and promotional activities of specific journals vis a vis major indexing and abstracting services can be done.

Certain policies, such as the refusal of mailing privileges at advantageous rates could be implemented to discourage publishers that do not adhere to ISDS norms. However, a commitment towards bibliographic control takes more than mere adherence to ISDS norms for political impact.

The participation of a country in international bibliographic networks like the ISDS, working towards the common goal of universal bibliographic control means an array of hidden costs not always fully realized at the outset of the cooperation agreement. More often than not the agreement is done for political reasons without adequate financial and man-power support for full participation. Science policy makers have to realize that a strong publishing infrastructure producing timely documents such as scientific periodicals, directories of scientists, scientific societies, and research institutions is vital in DC. A consequence of a lack of reference/information sources is a diffuse and often imprecise picture of the scientific system. Science policy makers shall continue to make decisions in situations of extreme uncertainty, until adequate information to facilitate decision making about the scientific system becomes available.

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EVALUATION OF THE SECTORIAL PROGRAM OF PUBLICATIONS IN SCIENCE AND TECHNOLOGY FINEP/SCT/BRAZIL

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ABSTRACT

The present study aims to evaluate the programme performance from 1983 to 1989 and its initial proposal of having for each area of knowledge at least one scientific journal with an international pattern of quality. Here are delineated the profile of the financed journals and being verified quality data indicators such as: circulation, periodicity, graphic pattern, standardization, type of publisher, editorial body, content structure, selection of mechanisms and collection of papers indexed and distribution. In this context we also intended to verify the programme goals such as: an upgrade in the level of quality, form and matter of these journals and an increase of its diclosure in the country, and abroad by comparing quality indicators when starting the financing and after five years.

RESUME

Le but de ce travail est d'évaluer un programme d'aide à la publication (1983-1989) et sa proposition initiale d'avoir, au Brésil, pour chacun des domaines de connaissance au moins un journal scientifique de qualité internationale. Les caractéristiques des journaux financés et leur qualité sont passées en revue à l'aide d'indicateurs tels que la circulation, la périodicité, le graphisme, la standardisation, le type d'éditeur, le comité de rédaction, la structure du contenu, les mecanismes de sélection, les modes d'indexation et de distribution. Les objectifs du programme ont également été vérifiés en s'attachant particulièrement à la promotion de la qualité, la forme et le contenu, la circulation à l'intérieur et à l'extérieur du pays à l'aide d'indicateurs de qualité mesurés au début du programme et après cinq années.

INTRODUCTION

The Sectorial Program of Publications in Science and Technology is carried out by FINEP - Studies and Projects Financing Agency, a subordinate of Brazil's Federal Secretary of Science and Technology.

Investment in the development of national scientific/ technical literature is the primary philosophy of this program, considering that publication of research results is part of the process of communicating knowledge and constitutes an integral step in Science and Technology development.[1]

The policy of support for scientific journals was established with the objective that Brazil would shortly have at least one journal with international prestige in each field of study. [2] An estimate of the number of technical/scientific journals existing in 1982 in Brazil is about 1,600.[3]

The objective of the Sectorial Program of Publications in Science and Technology is to improve the form and content of the journals and to broaden the scope of distribution of scientific and technological information in Brazil and abroad. Its aim is to raise the present level of quality and distribution of 50 journals: 20 already known abroad and 30 relatively unknown abroad.

Publications are selected for financing by FINEP based on profile indicators such as: technical/scientific and administrative autonomy, quality of editorial policy, graphic presentation, periodicity, content and distribution.

The objective of the study was to evaluate the Program based on the profile indicators and on a comprehensive analysis aimed at characterizing standards of quality of the financed journals in relation to international standards, their performance in the publishing aspects and dissemination of scientific information, as well as each journal's distribution.

METHODOLOGICAL PROCEDURE

Period of financing and representativity of subject field were the criteria that defined the sample which was composed of 17 journals with at least five years of financing, representing 75% of the subject areas, covering six years from 1983 to 1988 (Appendix I). Classification by area is as follows: CET: Pure Science, including Earth Sciences; E: Engineering; CA: Agricultural Sciences; CB: Biological Sciences; CS: Health Sciences; CH: Human Sciences; CSA: Applied Social Sciences; LLA: Linguistics, Literature, and Fine Arts.

Materials analyzed in this study were forms from FINEP's archives submitted every year by editors applying for financial support from this agency. Active editors during the study period were interviewed, as was FINEP's representative on the Editorial Committee at the time the Program was created. The material analyzed was also complemented by texts of the Sectorial Program of Publications in Science & Technology and documents related to scientific information policy.

RESULTS

Profile of the scientific periodicals

Table 1- General Information - presents the profiles of the journals that belong to the sample, taking into consideration extrinsic data such as: subject field, periodicity, number of copies printed per edition, number of published papers per issue, initial year of publication, place of publication - journal's main office-, publishing institution. Scientific periodicals are mainly concentrated in the areas of CET and CB. The number of printed copies per journal edition averages around 1,800.

Table 1. General information

Area	No. of the Journal	Periodicity	Copies per Edition	Published papers per copy*	Initial year of publication	State	Publishing Institution
CET	08	Quarterly	5,000	8	1971	SP	SOC
CET	04	Quarterly	3,500	9	1971	RJ	SOC
CET	12	Quarterly	3,000	15	1978	SP	SOC
CET	09	3 times/y.	2,000	4	1982	RJ	SOC
CET	07	Bimonthly	700	8	1982	SP	SOC
CS	02	Quarterly	3,000	17	1981	SP	SOC
CS	10	Quarterly	1,400	12	1967	DF	SOC
CB	06	Quarterly	2,000	16	1978	SP	SOC
CB	13	Quarterly	1,600	6	1982	SP	SOC
CB	11	Quarterly	1,100	11	1970	SP	SOC
CB	3	Quarterly	650	15	1954	SP	SOC
CA	16	Bimonthly	2,000	10	1948	MG	EI
CA	05	Quarterly	900	17	1976	DF	SOC
E	15	Bimonthly	1,200	6	1982	RJ	SOC
E	01	Quarterly	1,000	4	1979	SP	SOC
CH	17	3 times/y.	1,300	8	1966	RJ	EI
CH	14	3 times/y.	1,000	5	1975	SP	SOC

SOC: Scientific Society; EI: Educational Institution
*Refers to the average of 1984, 1985, AND 1986

The average number of published papers in the journals is ten articles per issue. The fields with a larger number of published articles belong to Biological Sciences, Health Sciences, and Agrarian Sciences. Periodicity of the majority of the journals is quarterly. Journals have high standards of graphic quality and adhere reasonably well to technical norms of scientific publications such as: experience, summary, abstracts and other references. Some journals provide titles and abstracts in English and half of them indicate in the summary the types of articles contained in the journals. Most of the analyzed journals are edited by Scientific Societies. They are headquartered in the southeastern region (77%), in the states of Sao Paulo and Rio de Janeiro, and were formed in the seventies.

Editorial structure

Practically all the journals have an editor, generally assisted by two associate editors. The editors are not remunerated and they divide their time between the journal and academic functions. In most of the journals the editor is helped by the associate editors with the tasks of pre-selecting the articles, choosing referees and deciding which articles to publish. The editorial board is formed by qualified researchers, serving on a permanent basis or in renewable terms, fulfilling functions that overlap other levels of the editorial structure. They analyze manuscripts, select referees, discuss editorial policy or simply lend prestige to the journal. These functions are aggregated in some journals and they are exclusive in others.

The figurehead function appears exclusively in three periodicals. The referee function appears in three others. For the remaining journals the editorial council assumes the various functions described. The editor and associate editors are familiar with practically the entire scientific community in their respective areas and it is through this knowledge that the referees are selected. The number of referees who judge the articles varies from one to three, depending on each editor's needs.

Nine journals (56%) publish their articles based on the formal opinion of two referees. Four (25%), publish based on three opinions, and three journals (18%) publish based on only one formal opinion.[4]

Quality control

Most of the journals are intended for the community of specialists with a graduate degree or higher. Some journals also try to reach the undergraduate community, reserving page space for undergraduate research.

Scientific journals dedicate an average of 77% of their page space to original articles concerning research results; 5% to theses summaries and communications, and 8% to reviews.

All the periodicals analyzed adopt the evaluation by peers system for at least 80% of the journal, since the other 20% is dedicated to reviews and communications that do not necessarily go through the referees. Seven journals (44%) adopt the quality control by peers system for all the articles. For the other periodicals the control of the review articles, communications, and thesis summaries are done according to the criteria of each editor. An attempt was made to group data related to the academic background and degrees as well as the institutional origin of the consultants, with the objective of verifying the qualification level of the people involved with quality control of the journals.

Results of the analysis of this data should be interpreted as indicators of a tendency of the referees' academic qualifications, since only four gave sufficient information for the intended analysis, relative to the last year of the studied time span.

Academic background (Table 2) includes degrees at the undergraduate, master's or doctorate level or equivalent. 61% of the personnel involved with evaluation of the articles in the CET area have a doctorate.

Table 2. Academic qualification of the specialists involved with evaluation

Area	Journal number	Graduate (%)	MS (%)	PhD (%)	NI (%)	Total
CET	07	-	3 (18)	12 (70)	2 (12)	17
CET	08	7 (17)	9 (21)	26 (62)	-	42
CA	16	8 (6)	56 (36)	91 (54)	-	155
CA	05	11 (15)	15 (20)	48 (65)	-	74
TOTAL (%)		26 (9)	83 (129)	177 (61)	2 (1)	288 (100)

NI: not Indicated. Data from 1988.

High percentages of personnel with master's degrees (21, 36 and 20%) can be explained by the journal's policy that addresses the undergraduate level. In this case undergraduate authors' papers probably would be judged by referees with master's degrees.

Table 3 covers the institutions that granted the degrees to the personnel related to the four journals listed in Table 2 who are involved with evaluation. Table 4 analyzes the institutional origin of personnel involved with evaluation who hold a Ph.D. The data show that 39%, or the majority, of the referee's titles were earned abroad and that 24% were earned at USP - Sao Paulo University. 37% of the titles are distributed among other schools, the majority of which are located in the southeastern region of the country. It was observed in the respondents' data that schools tabulated as "others" are also located in the southeastern region of the country. The concentration of titles earned in the southeastern region of the country coincides with the regional origin of the journals.

Table 3. Origin of personnel involved with evaluation

Area	J. No.	USP	UNESP	UNICAMP	UFRJ	UFF	UFMG	UFV	UREMG	UFRGS	UnB	UFBA	OTHERS	ABROAD	TOTAL
CET	07	8	-			1	4	9	22						
CET	08	19	4	-						4	-	3	3	9	42
CA	16	20	6	1	6	4	39	2	2	3	-	-	5	67	155
CA	05	22	-	3	-	-	-	7	-	2	6	-	4	30	74
Total (%)		69 (24)	10 (4)	4 (1)	6 (2)	4 (1)	39 (14)	9 (3)	2 (0)	9 (3)	6 (0)	4 (1)	16 (6)	115 (39)	293 (100)

Table 4 demonstrates the tendency of utilizing evaluators who belong to the same institution that publishes the journal and houses its headquarters, which characterizes an endogenous system.

Table 4. Institutional origin of Referees with PhD degree*

Area	Journal number	Editor's & Journal's headquarter institution	Other institutions	Foreign institutions	Total
CET	07	8 (66%)	3 (26%)	1 (8%)	12
CET	08	13 (50%)	13 (50%)	-	26
CA	16	23 (25%)	64 (70%)	4 (5%)	91
CA	05	6 (13%)	42 (87%)	-	48

Data from 1988.

Considering that the editorial policy is a group of measures that set the general directions for the journal and constitute an indicator of quality, the manner in which the journals make these indicators explicit was analyzed.

It was found that in general the editorial policy is not presented clearly in the journals. Questioned about the importance of their publication, more than half of the editors think that the editorial policy of their journal is obvious to the scientific community, making its clarification unnecessary.

Journals that mention some indicators do not necessarily publish others. Only one of them clearly explains its editorial policy along with its reference system.

In the majority of these Journals the review articles are generally requested from authors of notable knowledge, with the objective of lending prestige to the periodicals and to stimulate the quality of articles written for the journals, or even to reach the minimum number of articles required to fill the journal.

Dissemination policy

The distribution of the periodicals in the international scientific community is a basic factor in the establishment of editorial policy. The main objective of the scientific journals is to be the channel of distribution for the nation's researchers. This distribution should reach national and international scope. Editorial practices related to the integral elements of a journal's dissemination policy have been demonstrated. They are: the publication's language, indexing, and distribution.

Language and indexing

The periodicals accept articles in Portuguese because this is the official language of the country, but they would rather have and motivate the authors to publish in English because it makes the journal's indexing and circulation abroad easier. Journals in the humanities are an exception. They are published in Portuguese and invest in well-elaborated abstracts to solve the language problem regarding international circulation.

Despite the fact that on one hand English facilitates international circulation, on the other hand it acts as an obstacle to internal circulation, because there is a large group in the community who are not sufficiently fluent in the language to submit articles in English. Language, therefore, constitutes a delicate problem to be faced by the editors.

The editors believe that being listed in international indexes is one of the most significant elements for a journal's visibility abroad, and they consider it a factor of the journal's quality. The indexing process is considered part of the editorial policy regarding distribution of the periodical in the international community. Fifteen (88%) of the seventeen periodicals analyzed are listed in index journals, national and international reviews of current summaries. Two journals, representing 11%, are not indexed. 86%, or thirteen periodicals, are listed in the main index sources of their respective fields of knowledge, all foreign. The majority of the periodicals have, on the average, five listings with a predominance for indexes of North American origin. Current Contents is cited by six editors as the most important index, followed by the specific index for the journal's field of knowledge.

Distribution

The periodicals are distributed through subscriptions, donations and exchanges. Among the journals published by Scientific Societies, about 70% of each edition is distributed among members either free of charge, or by subscription. Half of the Scientific Societies include a journal subscription with payment of annual dues. Societies that do not follow this procedure distribute the journals to their members cost free.

Journals published by educational institutions distribute their issues mainly through donations and have a very low number of subscribers. Journals published by educational institutions end up with the highest level of unsaleable copies in comparison to all other journals. These levels are considered high (44% and 24%) when compared to the average (around 14%). Library subscriptions represent an average of about 2% of a journal's total number of copies printed per edition. Subscriptions by foreign libraries are even lower. The significantly low percentages representing journal subscriptions by libraries reflects the reality: the country's libraries, in general, do not subscribe to national periodicals. When they are interested in the periodical, they request a donated subscription because of the lack of resources.

Periodicity and regularity

The vast majority of scientific journals do not adhere to their own publication deadlines. When regularity is maintained, albeit off schedule, past delays can never be recovered. The editing time for articles was analyzed with the aim of verifying the cause of the journals irregularity. The process takes twelve months on the average. The time between an article's submission and acceptance by the sampled journals averages 5 months and the time between acceptance and publication is seven months. The delay occurs during the production process, involving the journal's infrastructure and graphic techniques. The most frequent problems faced by the editors regarding production time goes back to the matter of resources. The journals depend on outside financing for survival. Frequent delays in liberating funds, aggravated by rising inflation, jeopardize payment of freelancers. As a result there is a general delay in publication and the journal's periodicity is compromised, which in turn compromises its credibility within the community. The editors see referees' delay in evaluating papers as a problem that also delays publication.

The journals with a smaller infrastructure, in general an administrative staff of one or two people, are the same ones that have longer turnaround times in the second phase of the publishing process. The majority of periodicals have, besides a minimal staff, minimal equipment to automate the simplest tasks. Only four journals have adopted the process of electronic publishing and even so, not all of them are completely equipped. Three journals work in a very simple fashion, generally with just the editor and some sporadic freelance work.

CONCLUSIONS

Scientific journals analyzed in the Sectorial Program of Publications in Science and Technology are characterized by being rather young, averaging 15 years in existence. Most have a quarterly periodicity and the average number of copies printed per issue is 1800. They are based primarily in the southeastern region where more than half of the research in the country is concentrated.[5] The majority are published by Scientific Societies (which are also relatively young) that guarantee the technical/scientific autonomy desired by the Program. An average of ten articles are published per issue, with 80% of the articles being original research results and the other 20% being review articles, communications, and thesis summaries. Regarding form, the journals have graphic design, structure, references, and standards appropriate for scientific periodicals. The publishers are aware of the importance of format in keeping with the elements of universal standards.

The scientific journals that were analyzed exhibit an editorial structure similar to the more prestigious international journals, which serve as models for the publishers. The editorial staffs are made up of highly qualified researchers and the editorial council is well diversified and representative, contributing to a journal's quality. The peer evaluation system is adopted by all of the analyzed journals. They are listed in the principal indexes of their fields of study, which presupposes the potential for adequate distribution. It can be concluded that the journals supported by the Program under these criteria are in accord with universal standards of quality in respect to form, structure, and quality control, fulfilling the profile indicators in the Program. The journals reflect the dimension and capacity of production in the scientific community, of which they are a vehicle.

In relation to editorial practices, the journals present characteristics which are slightly divergent from the expected model. If they all boast a diverse editorial council made up of renown researchers, for many this structure is a mere formality. The editorial council avoids its basic functions of discussing the journal's policies and aiding the editors in decision- making, which are built-in mechanisms to guarantee high standards of quality.

The journals have other unique characteristics which are related to their origin. The Scientific Societies that publish the journals are strongly connected to the educational institutions of the editors (all of whom are practicing researchers) through the editors' academic positions at the institutions and through their prestige for having arranged a headquarter site for the journal. The Society and the journal (for those that have headquarters) share the same space in a small room at the university where the editor gives class. The editors, in turn, divide their time between the university and the journal. Although the Scientific Society's structure guarantees the changing of editors resulting from periodic elections, there is in reality a tendency for the editor's permanence once he has been re-elected several times.

The publishers of scientific journals face such adverse conditions that a new editor is generally chosen from the same location as the previous editor. This practice is probably followed to prevent the journal's demise through the deterioration of the established infrastructure, which, however minimal, is the only one that exists. It was observed that the journals that do not make use of permanent headquarters are the ones that have interrupted production with each new editor. The lack of a structure that guarantees discussions by the editorial council, the permanence of editors on reputation, or the continuation of editors from the same institution, in combination with the tendency to use a concentrated group of evaluators, also from the same institution, all add up to characterize the endogenous system which is generally criticized in the journals published by educational institutions. This condition deserves the Program's attention concerning the decentralization of this model.

The dissemination of the periodicals also deserves a careful look. On one hand the scientific journals are the channels of dissemination for national scientific production, publishing the work of a great number of researchers who are not able to publish abroad. On the other hand, they cannot do without researchers of international influence, and they must see that the journals reach the best researchers abroad so that our science can enter the international circie. In this sense it is necessary to reconcile the means to attend to an internal as well as an external public, represented by different levels of development. Some periodicals, according to characteristics determined by certain fields of study, aim to reach a readership at the undergraduate level, further complicating the problem of distribution. Besides the problem of reconciling various levels of qualification within the readership, language constitutes an obstacle to international communication.

Since the official language of the country, Portuguese, is not read in the countries that are ahead in research, the editors prefer to publish articles in English. Articles in Portuguese are accepted, but the authors are encouraged to submit manuscripts in English. This practice is good for distribution abroad, but it is not the best solution for internal distribution because a large section of the scientific community is not fluent in English.

It is also true that the journals publish few articles written by their own country's eminent scientists. These authors generally publish abroad, where their peers are located. When they publish internally, they are usually reviews or articles with a specific motive, written on request from the journal. In reality, national periodicals are not their first choice. Journals that also target the undergraduate level have this problem aggravated if they intend to maintain contact with the international community.

The inclusion of chronograms in the publication is an indicator of quality that permits the journals to enter the international scientific community. However, Brazilian scientific journals face a reality that has not provided the means for them to overcome their difficulties to keep their deadlines. Half of the periodicals analyzed take an average of seven months to publish an article; the other half take 14 months.

The journals depend on governmental resources for survival, but the funds are invariably liberated after delays and losses to inflation. The absence of infrastructure in terms of staff (in general two or three people produce a journal) and the absence of adequate, modern editing equipment complete an amateurish picture; nevertheless, the editors persevere in publishing the journals in the face of all difficulties. The Brazilian scientific society is in its adolescence. At fifteen years of age it still has not matured. It does not possess a sufficient number of qualified researchers to hold on its own before international science. There are a few exceptions: a small group has earned distinction in the more traditional research areas or in new specialties, but nothing more.

The social stratification of Science produces a culture of elites. This culture is reflected in the absence of prestige given to national periodicals by the researchers themselves, with repercussions reaching the organizations that finance research. data concerning distribution and leftover copies confirm the low prestige of periodicals that are provided free of charge to members of the Societies. When they are not published by a Society, copies remain undistributed or are donated to researchers. Data concerning library subscriptions confirms that the general scene has not changed much in the last few years. Resources exist only for subscriptions to periodicals that address the undergraduate level in their policies. Generally speaking, Brazilian researchers do not purchase Brazilian scientific journals.

This situation could probably be changed just by investing the appropriate level of resources for national research. Through the volume of articles produced and the subsequent selection of the best ones, journals would be able to raise the level of published science and compete on an equal level with the prestigious international journals.

This is not to say that the journals should not be published. On the contrary. It is through competition that quality is improved. Despite all their difficulties, journals continue to be the channels for the dissemination of national scientific production. To many publishers, Brazilian scientific journals have an important educational role for the researcher. This role is performed by editors and referees, giving constructive criticism to submitted work, raising the articles' level of quality and consequently improving the opportunity to contribute to Science.

The Sectorial Program of Publications in Science and Technology is part of the combined effort to raise the standards of Brazilian scientific journals. In this first phase its financing represents the survival of the periodicals. The government is making an admirable effort to establish strategies that attempt to overcome this situation by organizing the Sector of Scientific Publications. The goals of the Program are set, but reaching them will mean the adequate investment of human resources and research for the formation of a pool of qualified specialists.

Notes and References

[1] Interview with FINEP's Editorial Committee representative.
[2] CNPq'SEPLAN: *Uma Experiencia de Gestao em Ciencia e 'Tecnologia*, Brasilia, 1985, p.70.
[3] Bastos, S. et al. Apud Furtado, J.S. *Programa de Publicaçoes em Ciencia e Tecnologia;* preliminary proposal/s.e//s.ed./,1982.
[4] The percentage is based on sixteen interviews.
[5] MARTINS, Geraldo e QUEIROZ, Rubens. *Rev. Bras. Tecnol.* Vol. 18 (6), pp.38 - 6, September 1987.

APPENDIX I

LIST OF SCIENTIFIC JOURNALS ANALYZED

Arquivo Brasileiro de Medicina Veterinaria e Zootecnia
Brazilian Journal of Medical and Biological Research
Dados - Revista de Ciencias Sociais
Fitopatologia Brasileira
Psicologia
Ouimica Nova
Revista Brasileira de Ciencias Mecanicas
Revista Brasileira de Engenharia
Revista Brasileira de Entomologia
Revista Brasileira de Fisica
Revista Brasileira de Genetica
Revista Brasileira de Geociencias
Revista Brasileira de Geofisica
Revista Brasileira de Matematica Aplicada e Computacional
Revista Brasileira de Medicina Tropical
Revista de Microbiologia
Revista Brasileira de Zoologia

BREAKING THE INFORMATION BARRIER : A COMPUTERIZED RESEARCH JOURNAL PRODUCED BY AND FOR DEVELOPING COUNTRIES

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ABSTRACT

A computerised research journal was launched in Colombia in late 1989, with the specific aim of promoting communication among scientists and decision makers concerned with the role of livestock technologies in rural development in the Third World. Three numbers have been published and the fourth is ready for distribution. Of the forty papers published or in press, 52.5% are in English, 37.5% in Spanish, 7.5% in French and 2.5% in Portuguese. Papers have been received from 14 countries 11 of which are "developing". There are correspondents in 49 countries and four international agencies participating in the distribution network. From replies received so far, support for the concepts and philosophy of the journal is almost universal. Concern has been expressed about the potential risk from virus-infected diskettes. However, no specific cases have been reported. Some readers have expressed a wish for all papers to be translated into English. It is too soon to draw firm conclusions but it is clear that some of the objectives have certainly been met. The journal is being received enthusiastically by the target audience -- professionals in developing countries. The authors and all the papers have their origins in developing countries. The logistics of preparing and distributing the journal have proved to be simple, effective and inexpensive. The time lag between receipt of a paper and its publication is less than two months. The project has a high degree of self-reliance. The journal was launched and is being sustained without external financial assistance.

RESUME

A la fin de l'année 1989, un journal de recherche sur support informatique a été lancé en Colombie dans le but exclusif de promouvoir la communication entre les scientifiques et les personnes chargées de prendre des décisions touchant à l'impact des technologies d'élevage sur le développement rural du tiers-monde. Trois numéros ont déjà été publiés et le quatrième est prêt pour la distribution. Parmi les 40 articles publiés ou en passe de l'être, 52,5% sont écrits en anglais, 37,5% en espagnol, 7,5% en français et 2,5% en portugais. Ces articles proviennent de 14 pays dont 11 sont des pays en développement. Le réseau de distribution est constitué par des correspondants situés dans 49 pays et par 4 agences internationales. Les réponses reçues à ce jour permettent de dire que les concepts et la philosophie du journal rencontrent un adhésion quasi unanime. Certains

se sont inquiétés du risque potentiel que présenteraient des disquettes infectées par des virus, cependant à ce jour, aucun cas d'infection n'a été rapporté. Quelques lecteurs ont exprimé leur souhait d'une traduction systématique des articles en anglais. L'expérience est trop récente pour tirer des conclusions définitives, cependant, il est clair que certains des objectifs recherchés ont déjà été atteints. Le journal est reçu avec enthousiasme par le public ciblé: les professionnels des pays en développement. Les auteurs de tous les articles sont originaires de pays en développement. La logistique pour la préparation et la distribution du journal s'avère être simple, efficace et peu coûteuse. Le délai entre la réception d'un article et sa publication n'excède pas deux mois. Le projet présente un bon niveau d'indépendance, le journal a été lancé et est maintenu en activité sans soutien financier extérieur.

BACKGROUND

Communication among scientists working in developing countries has always been difficult. There are many reasons for this. International scientific journals are without exception published in the industrialised countries. Their editorial policies reflect the interests of these countries; not those of developing countries. Many of them levy page charges (in hard currency!). They are also highly expensive and beyond the reach of most individual scientists. In libraries and other educational and research institutions in the developing world, budgets are invariably restricted thus it is difficult to subscribe to all, or even a reasonable proportion of, the current journals and research periodicals.

The information published in the scientific journals of developed countries increasingly becomes less relevant to readers in developing countries. This is due to the current agricultural situation in industrial countries where surpluses of agricultural products and concern for human health jointly have had the effect of discouraging applied agricultural research and promoting work on human nutrition.

Scientists from developing countries find it difficult to have their papers published internationally, due often to the impossibility of paying the page charges; or satisfying the editorial requirements.

Finally, there is the delay between finishing a piece of research and having the paper available in print. At least a year on average, and often more, is the lag time. Much of this delay is incurred by time spent in editing and reviewing but in the developing countries, this is compounded by the unreliable postal services.

Fortunately, developments in information technology are rapidly revolutionising the way written material is processed and transmitted. Not only in developed, but also in developing countries, micro-computers and their accessories are becoming commonplace.

CIPAV (Convenio Inter-institucional para la Produccion Agropecuaria en el Valle del Cauca), a Nongovernmental Organization established in 1986 by private sector initiative in the Cauca Valley, Colombia, has as its mandate the development, transfer, training in and and diffusion of, sustainable livestock-based technologies for tropical rural development. A major feature of CIPAV's activities has been to acquire and disseminate appropriate information at all levels. It soon became apparent that conventional procedures for doing this were woefully inadequate and likely to be exorbitantly expensive. The idea of using computer technology to overcome these limitations is not only eminently feasible but is specially suited to the needs of developing countries where information, rather then publications, is (or should) be the first criterion determining the nature of the transmitting medium.

The computerized journal "LIVESTOCK RESEARCH FOR RURAL DEVLOPMENT", the medium for which is the floppy diskette, was conceived and launched in late 1989.

OBJECTIVES

The long term aims of the journal are:

-To promote the development of livestock production and associated technologies which are appropriate and sustainable, and contribute to self-reliant ecologically balanced rural development.

-To take advantage of developments in computer technology in order to promote faster, easier and less costly communication among scientists active in rural development.

The specific aims are:

-To establish an international forum for reporting the results of livestock research as this relates to rural development, the medium for which will be the magnetic disk that can be written and read by a micro-computer.

-To promote the rapid exchange of research and development-orientated data at minimum cost to scientists and institutions in the developing countries.

-To maintain an editorial policy of promoting those technologies which are likely to lead to increased self-reliance and ecologically balanced rural development.

LIVESTOCK RESEARCH FOR RURAL DEVELOPMENT achieves these objectives because:

-It operates and can be read on the most basic IBM compatible microcomputers and printers.

-It does not to require any specialised software or word processing packages.

-It publishes papers as fast as possible, with the minimum of centralised editorial input.

-It is distributed throughout the world, through a network of interested and sympathetic colleagues.

THE POLICY

The title of the journal is LIVESTOCK RESEARCH FOR RURAL DEVELOPMENT. The principal language is English but papers are accepted and published also in French, Spanish and Portuguese. Each paper has a summary and key words in English and in the language in which the paper is written. One volume is published each year, consisting of three or more numbers, each number consisting, on average, of 10 papers together with lists of contents and indices.

THE NECESSARY EQUIPMENT

LIVESTOCK RESEARCH FOR RURAL DEVELOPMENT can be read on any IBM compatible microcomputer with a minimum memory size of 256 Kbytes and one floppy disk drive, either 5.25 or 3.5 inch size. It operates under MS-DOS 2.1 or more. It requires no modification to the CONFIG or AUTOEXEC files, no drivers to be installed and no specialised computer training. It can be viewed on monochrome, non-graphics screens and can be printed out on any printer that can reproduce the standard (USA) ASCII character set. The basic equipment (computer and printer) can be purchased for as little as US$500, before local taxes and duties. The same equipment will run a word processor and spreadsheet/database which are the essential tools of the research worker.

THE SOFTWARE AND TEXT FILES

The journal consists of the articles, written in ASCII format (they can be TYPEd or PRINTed from MS-DOS), and a simple software package that allows the user to view the articles and print them out on any printer. The programme JOURNAL.COM was written in TURBO PASCAL and compiled for efficient operation. It is controlled by the cursor keys, the return key and 6 function keys, with no need for typed commands, except for the initial 'JOURNAL'. A small text file stores the volume details and contents.

Articles can be written using most popular wordprocessors. CIPAV specialises in WORDPERFECT 5 and this can convert files from WORDSTAR, WP 4.2, DISPLAY WRITE and PROFESSIONAL WRITE. The only limitations are to avoid tabulations and indents, which must be replaced with spaces, and font changes and other specialist commands which cannot be reproduced in ASCII. Data are presented in tabular form at present, because of the limitations of some computers, printers and VDUs in handling graphics.

ADMINISTRATION AND EDITING:

The journal is administered through a coordinating editorial centre (CIPAV, Colombia), in close collaboration with the Department of Plant Sciences, Oxford University, UK. There are sub-editorial groups representing each of the four languages and the major continental groupings. The journal is distributed free to sub-editors, to country correspondents and to International Agencies who agree to copy the diskettes to interested participants in their area of influence.

SUBMISSION OF PAPERS

Papers are submitted on disk (either 3.5 or 5.25 inch), to the regional language sub-editor. Authors are required to have their papers refereed, before submission, by at least two scientists who have both post graduate qualifications and proven experience. A signed statement by the referees should accompany the submission. 'When authors have difficulty in locating appropriate referees, they should contact the nearest sub-editor who will provide names of suitable candidates. The papers can be written with the aid of any of the major word processing programmes (eg: Word Perfect, Word Star, Word, Display Write, Professional Write). If other word processing packages are used (eg: FRAMEWORK) the paper should be saved in ASCII. The paper can be in any of the official languages: Spanish, Portuguese, French and English, but the preferred format should be followed (see notes for contributers).

For example, a paper originating from an African researcher and written in French should be submitted to the nearest sub-editor (French), in this case Dr C Kayouli, of the Institut National Agronomique, Tunis, Tunisia. The sub-editor will have the final responsibility for acceptance (or otherwise) of the paper and will then send the disk direct to the coordinating centre in Colombia. Similar procedures will be followed by researchers working in other languages and geographical regions.

In order to ensure that the journal can be printed with the minimum of hardware and software, data presentation is restricted initially to tables. These should be written bearing in mind that the final paper will be prepared in ASCII format, thus the text should be written for standard size paper (65 characters x 54 lines, allowing for margins) and tables should not exceed 23 lines in length, so they can be accommodated on a standard monitor and printer. Graphs and similar illustrations will not be accepted in view of the special requirements these impose on printers.

To save time and money, papers (disks) are not normally returned to authors (unless they so wish and are prepared to pay the costs). Papers that are accepted are published as received with only minor editing.

The disks containing the edited papers are received by the coordinating unit in Colombia. Editing is minimal, mainly to ensure uniformity in style of presentation. As soon as 10 papers are available the particular number of the journal is closed and the table of contents and indices prepared. The journal is copied on both 3.5 and 5.25 inch disks and sent to sub-editors and to institutions and individuals who copy and distribute the disks for individual subscribers.

SUBSCRIBERS TO THE JOURNAL:

Subscriptions to the journal are paid for in the form of one floppy disk (or equivalent) for each number. To receive the journal the potential subscriber simply sends TWO blank disks (3.5 or 5.25 inch) with a return stamped and addressed envelope, to the nearest collaborator. The journal will be copied onto one of the disks which will be returned to the subscriber. The second disk will be retained as payment. Alternatively, payment can be made by cheque or international money order to OXFORD COMPUTER JOURNALS Ltd, 31 Northmoor Road, Oxford OX2 6UR, UK). The yearly subscription is US$20.00.

FURTHER POSSIBILITIES

LIVESTOCK RESEARCH FOR RURAL DEVELOPMENT is not only a cheap medium for publication; it affords new potential for the transmission of scientific data.

Despite the simple form of the original disks, the journal may be printed on high quality laser printers for retention on bookshelves and in libraries.

Tabulated data in ASCII format can be further processed by the reader by statistical analysis or graphic presentation. The limitations of machine compatibility prevent the inclusion of graphs and diagrams in the journal but the subscriber is recommended to obtain a suitable graphics package such as LOTUS 1-2-3 or HARVARD GRAPHICS, to import the data, and to produce his or her own graphical material from the original data.

Future developments in technology, such as compact discs and other new storage media, will permit further development of the concept and increased capacity for publication.

EDITORIAL POLICY

Present day systems of livestock production in both industrialized and Third World countries are subjected to political, economic and environmental pressures, that infer the need to introduce new production technologies which are more sustainable.

Foreign exchange shortages present an opportunity for developing new production systems using local resources which are less dependent on fossil fuel derived inputs. Environmental pressures will force a decreasing role for fossil fuel and an increasing reliance on renewable biomass. Concem for animal welfare and natural food quality is leading to de-intensification of production systems and incentives for organic agriculture.

Tropical regions are in a strong position to take advantage of these changes, being richly endowed with natural resources in the form of solar energy, soil and water, and biological diversity. Correctly hamessed, these resources can form the basis of production systems which will confer a real competitive advantage to livestock production in these regions.

The last five years have witnessed a marked change in the economic and political pressures to which livestock production is subjected in both industrialized and Third World countries. The conduct of livestock production and the role of food products of animal origin have been influenced profoundly by these changes. As a consequence livestock production strategies are changing and will continue to change in response to these pressures.

Scientists in developing countries should be encouraged to embark on research topics which are responsive to the above issues, and which can be summarized in a single sentence.: *The project should contribute to the development of a sustainable livestock production system.*

In the present context, sustainable means that: natural ecosystems are enhanced rather than threatened; rural-based social structures are strengthened rather than fragmented; local resources are preferred and there is minimal dependence on inputs not produced directly on the farm; production techniques are increasingly directed to the reduction of stress at both animal and human level.

Research against this background may appear far removed from what is currently being published in the scientific journals in the industrialized countries, although already there are signs of impending change. What should be recognized is that research into sustainable systems is a unique opportunity for scientists in developing countries to establish their own priorities, to study new and different resources, and in so doing to set the groundwork for a future competitive advantage rather than the present dependency.

The editorial board seeks to promote the above changes and will encourage the publication of research that relates to the above issues.

THE IMPACT SO FAR

Three numbers have been published and the fourth is ready for distribution. Of the forty papers, the language breakdown is english 52.5%, spanish 37.5, french 7.5 and portuguese 2.5. The senior authors of the papers are from 14 countries, 11 of which are "developing".

The exact number of diskettes that are in circulation is not known. There are correspondents in 49 countries and four international agencies participating in the distribution network. With the financial support of CTA (Technical Centre for Agricultural and Rural Cooperation, Wageningen, The Netherlands) 1,500 diskettes of Volume 1 No 1 were distributed throughout ACP countries. With support from IFS (International Foundation for Science, Stockholm) a further 160 copies were sent to IFS grantees in Animal Production. From replies received so far, support for the concepts and philosophy of the journal is almost universal and has prompted both CTA and IFS to repeat the mailings for subsequent issues. Concern has been expressed about the potential risk from virus-infected diskettes. However, no specific cases have been reported. Some readers have expressed a wish for all papers to be translated into English.

It is too soon to draw firm conclusions but it is clear that some of the objectives have certainly been met. The journal is being received enthusiastically by the target audience -- professionals in developing countries. The authors and all the papers have their origins in developing countries. The logistics of preparing and distributing the journal have proved to be simple, effective and inexpensive. The time lag between receipt of a paper and its publication is less than two months. The project has a high degree of self-reliance. The journal was launched and is being sustained without external financial assistance.

THE ROLE OF SCIENTIFIC JOURNALS IN DEVELOPING COUNTRIES THE CASE OF PHYSICS IN LATIN AMERICA

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ABSTRACT

Firstly several reviews published in Latin America countries, especially Argentina, are studied measuring the flow of publications in Physics within the historical context The impact of publications in Physics in Latin America on the total world mainstream body of publications is discussed on the basis of recent research. Stress is laid on the strategical necessity of reviews to provide the means of publishing the outstanding contributions in the field without these suffering any form of discrimination. Various possibilities are discussed, some of which have already put into practice, especially the dilemma between short and full-length articles. The relevant indicators for the subsequent measuring and evaluation of scientific knowledge in the area are examined together with the possible political and social consequences that enhanced visibility of research in the region would bring about. In this connection the role of supernational organisations in the editing of these reviews is discussed.

RESUME

Plusieurs revues publiées dans des pays latino-américains sont étudiées en vue de mesurer rétrospectivement le flux des publications en physique. L'impact de ces revues latino-américaines dans le domaine de la physique sur la science mondiale est discuté à partir de travaux récents. On insiste sur la nécessité stratégique pour les revues de publier des travaux de bonne qualité .Plusieurs possibilités pour cela sont discutées, dont certaines ont déjà été mises en pratique, notamment en ce qui concerne le choix entre articles courts et longs. Les indicateurs de mesure et d'évaluation dans ce domaine sont évoqués ainsi que les conséquences que pourrait entraîner une plus grande visibilité. Dans ce contexte on évoque le rôle d'organisations supranationales dans la publication de ces revues.

INTRODUCTION

In this note we shall discuss the feasibility of editing a Latin American Physics journal, on a par with other international publications in the field, whose purpose would be to reflect scientific production in the region. To this effect we shall analyze data related to the history of publications in Physics in Latin America. In the first part of our study the scope of the editorial activities examined will be limited exclusively to Argentina, whilst in the second we propose to treat the data on scientific production in the whole of Latin America for the period 1981 - 1985.

HISTORICAL RETROSPECT

Under the name "Contribución al estudio de las ciencias físicas y matemáticas", a top quality scientific journal was published in Argentina between 1914 y 1931. The publication was divided into two series, "Mathematical & Physical" and "Technical", the first being devoted to works of pure science and the second to works which had an application in engineering. Only those scientists who were members of staff of the Faculty of Physico-Mathematical Sciences of the University of La Plata and those visitors who had carried out their research using the infrastructure of the said Faculty were able to publish in the journal.

During this period a total of five volumes, each some 500 pages in length were published in the "Mathematical & Physical" series. The journal was a faithful mirror of the research activities in the La Plata Institute of Physics. An examination of the general index shows that the articles are the work of very few authors, an outstanding contribution being that of Richard Gans who between the years 1914 and 1925 appears as the author of 32 articles dealing principally with subjects in the fields of Optics and Electromagnetic Theory. Only 28 authors published in the five volumes of the journal, among these figured the first graduates in physics of La Plata University: José Collo, Teofilo Isnardi and Ramó Loyarte. The majority of the articles, both Gans' and his disciples, were also published in German scientific journals as they dealt with highly advanced research topics. The journal made a comeback after 1935 and then reappeared under a new and less illustrious name, completely separated from the previous tradition -the publication of the Faculty came to be known simply as Revista.

During the period 1914-1925 the number of articles on Physics which appeared in "Análes de la Sociedad Científica Argentina" was very limited, whereas those which appeared in the Buenos Aires "Revista del Centro de Estudiantes" were decidedly didactic. It could be held that "Contribución" defined a fresh territory by its clearly scientific and research orientation. We should also mention the publications of the Instituto Nacional del Profesorado Secundario in Buenos Aires, as well as those carried out in the Institute of Physics of the National University of Tucuman from 1927 onwards.

A text by Teofilo Isnardi, in 1943, which was devoted to the relationship between scientific research, university and industry in Argentina clearly reveals the failure of physics, implemented some four decades before, and its difficulties due to the lack of funds (1). According Isnardi, the number of Argentine physicists was a mere fifteen, which for the population of the country at the time signified the ratio of one physicist per million inhabitants. At that same time, physicists in the United States represented an approximate proportion of one physicist per 10000 inhabitants. Furthermore, both in Buenos Aires and La Plata, the kind of professional life of the university staff made it impossible to envisage high level scientific production. Since there were no full time positions, the professors found themselves compelled to occupy various chairs, generally in different institutions, with the result that a large proportion of their time was absorbed by their teaching activities themselves and their journeys from one workplace to another.

The first publications of the "Nucleo de Física", the immediate predecesor of the Asociacion Física Argentina (AFA), began to appear around 1942 in the journal of the Unión Matemática Argentina, whose director was José Babini. Articles on physics' topics also appeared in the "Revista Tucumana" and in "Mathematicae Notae". Both these journals, which are still published today, appeared in the 1940s. Subsequent efforts in Argentina have been made, but no scientific journal devoted to Physics research topics has ever reached the standard of "Contribución".

Using the repository compiled by Small (2) on the discipline of Physics between 1920 and 1929, Pyenson and Singh have produced an interesting study of the state of physics in peripheral countries during this period (3). At this time there were only 9 Argentine physicists who had obtained PhDs. Between them they published 73 articles in foreign journals and an indication of the impact they achieved is given by their receiving 135 citations. Small's work however does not treat the articles published in "Contribución". A comparison with the scientific production of Argentina and that of India and Canada reveals that the two latter countries achieved a higher standard of excellence, occupying more higher roles than Argentina. As for the rest of Latin America its contribution to the world of physics research during this period was negligible.

Research work and studies in Physics in Latin America only developed in a continuous fashion after the end of World War II with the creation of Research Councils and full time university staff posts some thirty years ago which in several countries gave rise to the usual exponential growth (4).

RECENT SITUATION OF PHYSICS IN LATIN AMERICA

The first comprehensive study of research in mainstream science published in Latin America which we have knowledge of was carried out by Frame (5) who examined publications produced by Latin American countries appearing in the 1973, 1974 and 1975 editions of the Science Citation Index. During this period the contribution of Latin America was about 1.1% of the world papers' production.

Marcel Roche and Yajaira Freites have studied the specific case of Venezuela as regards the production and flow of information, although also including comments on other Latin American countries (6). Their work is based on the 1980 Science Citation Index. In this year Brazil was top of the league with 1551 articles, followed by Argentina with 1042, Mexico with 787 and Chile with 702. All these figures are significantly below the levels reached by developed countries, even when the population factor is taken into account. One should note that the Science Citation Index, which reproduces the abstracts of articles appearing in more than 3000 journals, evaluates only a score of Latin American journals.

In 1984, Garfield published two articles based on the 1978 Science Citation Index (7). According to this author in the year 1978 Latin America published 1% of the total world production with an impact of only 2.9 for the period 1978 - 1982 as compared for example with Australia which was producing 2% with an impact of 4.4 at the same time. In this study, as well as providing a variety of statistics on where scientists publish, in what languages they write and the impact of their publications, Garfield also gives interesting information on cluster research under which heading he identifies the current areas of Latin American research.

Flores Valdes and Pimienta de Rubio (8) have carried out a comprehensive study of research in Physics in Latin America basing their work on the periodical "Bibliografía Latinoamericana" which has been published by the Centro de Información Científica y Humanística of the National University of México (UNAM) since 1981. Their study takes into account articles published in journals outside the region whose first author works in a Latin American institution, without taking into account contributions to scientific meetings and books. The error margin due to omission is high and in some cases - for some Argentinian, Brazilian and Mexican institutions - the authors have estimated it when the total number of publications was ascertained on the basis of annual reports. The decision they took was to multiply the data obtained by a factor of two. While this is considerable in terms of the absolute value of the quantities measured, is not significant as regards the estimation of tendencies.

The number of articles published by each country between 1981 and 1985 is as shown in table 1. They also show that out of the nine institutions which during the period produced more than 100 articles, five are Brazilian (University of Sao Paulo, University of Campinas, Federal University of Pernambuco, Centro Brasileiro de Pesquisas Físicas), two are Mexican (UNAM and IPN) and two are Argentine (CONEA and University of La Plata). It is obvious that the Brazilian scientific institutions are also somewhat decentralized whilst their Argentine and Mexican counterparts are almost exclusively concentrated in the capital cities of these countries.

The most recent information that we have at hand is the comprehensive set of indicators published by Schubert, Glanzel and Braun in Scientometrics (9). We shall make use of this data which covers the period 1981-1985 to provide a brief survey of the current state of scientific research in Latin America.

Table 1. Number of articles published in Physics per country (1981-1985)

	1981	1982	1983	1984	1985	Total
Brazil	285	265	271	320	339	1480
Argentina	121	117	129	170	170	707
Mexico	95	126	107	156	134	618
Venezuela	35	47	64	43	34	223
Chile	17	13	27	1	1	20
Cuba	2	4	5	2	6	19
Uruguay	0	0	1	2	4	7
Peru	0	1	2	0	1	4
CostaRica	0	1	0	1	0	2
Ecuador	0	0	0	1	0	1
Total	561	578	611	740	725	3215

Source: Flores et al.

This volume of Scientometrics contains a compilation of data taken from the Science Citation Index database of the Institute for Scientific Information (ISI). The study includes 3711 journal titles which appear at least once in the database during the period under consideration. The scientific publications, which consist of articles, reviews, notes and letters have been divided into five major fields: Life Sciences, Physical Sciences, Chemistry, Engineering and Mathematics. The indicators used are the usual publication and citation counts, citation rates per paper, observed citation rates, expected citation rate and relative citation rate. A further interesting indicator is also used, the average citation rate to papers cited higher than average.

Table 2 gives us an idea of the scientific production of the region over the five year period under consideration by indicating those countries which produced more than 50 publications during this time.

As in the case of the previous studies, we observe that five countries dominate the field of scientific production and that for all of these, the observed citation rate is low when compared with the world value, which amounts to 3.11 for these five years. During the period under consideration, the publication count of the entire world, all science fields combined, reached the figure of 1,918,188 publications. It is interesting to remind the Latin American figures for academic productivity (1.12% of world share with 1.57 observed citation rate) with that of some other countries: Israel for instance repreesents 1.06% of world production by itself and shows a 2.69 observed citation rate; Australia reprsents 2.23% of world production and 2.82 citation rate; Switzerland has 1.22 of worlds share and 4.56 observed ciation rate.

Table 2. Academic productivity per million in habitants 1981-1985*

	Papers	Population	Papersp/m.	Obs. Cit. Rate
Brasil	6987	136	51.4	1.45
Argentina	5396	30	179.9	1.54
Mexico	3335	78	48.4	1.89
Chile	2813	12	234.4	1.56
Venezuela	1395	17	82.1	1.76
Colombia	303	29	10.4	1.61
Cuba	270	10	27.0	0.83
CostaRica	175	3	58.3	1.40
Uruguay	152	3	50.7	2.03
Peru	136	20	6.8	0.85
Guatemala	86	8	10.8	1.77
Panama	77	2	38.5	2.48

*Population figures for the year 1985.
Source: Schubert et alii.

Although the previous statistics have justifiably been criticized, for example by J. Gaillard (10), for taking into consideration only mainstream research and for leaving aside a very important part of the scientific production in developed countries, they do however give a clear indication of the low contribution of Latin American research on the international scale.

Let us now return to the principal field of our study. The world publication count for Physics is 370612 with an average citation rate of 3.44 and an outstanding citation rate of 11.43. The following table gives the relevant values for the six countries in the region which published more than fifty papers in Physics during the period 1981 - 1985.

Table 3. Volume of Physics Research in Latin America (1981-1985)

	Public. Count	World Share	Cit. Count	World Share	Cit. Rate (exp)	Cit. Rate (obs)	Cit. Rate (rel)	Act. ind.	Attr. Ind.
Brazil	1933	0.52	3491	0.27	3.46	1.81	0.52	1.43	1.61
Argentina	1063	0.29	1811	0.14	3.35	1.70	0.51	1.02	1.02
Mexico	822	0.22	2002	0.16	3.64	2.44	0.67	1.28	1.48
Chile	386	0.10	1585	0.12	3.97	4.11	1.03	0.71	1.68
Venezuela	316	0.0	9657	0.05	3.26	2.08	0.64	1.17	1.25
Cuba	53	0.01	37	0.00	1.80	0.70	0.39	1.02	0.77

Table 4. Volume of Physics Research in Latin America (1981-1985)

	Publ. Count	World Share	Cit. Count	World Share	Cit. Rate (Exp)	Cit. Rate (Obs)	Cit Rate (Rel)	Act. ind.	Attr. ind.
Astronomy and Astrophysics									
Chile	177	0.76	1324	1.28	5,37	7.48	1.39	5.29	17.36
Brazil	121	0.53	210	0.20	3.29	1.74	0.53	1.46	1.20
Argentina	102	0.45	208	0.20	3.38	2.04	0.60	1.59	1.45
Mexico	59	0.26	328	0.32	4.42	5.56	1.26	1.49	3.00
Atomic Molecular and Chemical Physics									
Argentina	159	0.49	451	0.31	4.21	2.84	0.67	1.74	2.20
Brazil	154	0.47	380	0.26	4.08	2.47	0.61	1.30	1.52
Mexico	94	0.29	318	0.22	5.06	3.38	0.67	1.66	2.36
Acoustics									
Argentina	75	0.88	52	0.39	1.17	0.69	0.59	3.13	2.80
Applied Physics									
Brazil	130	0.29	183	0.14	3.16	1.41	0.45	0.80	0.82
Mexico	68	0.15	84	0.06	3.17	1.24	0.39	0.87	0.61
Argentina	59	0.13	51	0.04	2.22	0.86	0.39	0.47	0.28
Cristallogr									
Brazil	51	0.39	77	0.29	2.51	1.51	0.60	1.06	1.70
Instruments and Instrumentation									
Brazil	73	0.41	61	0.24	1.42	0.84	0.59	1.11	1.40
Math.Phys									
Mexico	58	1.23	202	1.55	2.37	3,48	1.47	7.07	14.65
Brazil	53	1.12	89	0.68	2.67	1.68	0.63	3.08	4.03
Nuclear Physics									
Brazil	130	0.75	193	0.36	3.60	1.48	0.41	2.05	2.13
Argentina	107	0.61	182	0.34	3.93	1.70	0.43	2.18	2.45
Optics									
Argentina	51	0.48	50	0.22	2.25	0.98	0.44	1.72	1.56
Physics of Condensed Matter									
Brazil	488	1.22	920	0.71	3.76	1.89	0.50	3.36	4.18
Argentina	125	0.31	197	0.15	3.92	1.58	0.40	1.11	1.09
Mexico	106	0.27	213	0.16	4.55	2.01	0.44	1.53	1.55
Venezuela	86	0.22	238	0.18	3.87	2.77	0.71	2.96	4.45
Physics of Particles and Fields									
Brazil	101	0.92	179	0.32	5.07	1.77	0.35	2.4	1.89

The values obtained by Flores and Pimienta de Rubio are only 30% below the values shown in the Table 3. Their position of a factor 2 is understandable if we consider papers out of the mainstream because generally the institutions include titles of this kind in their reports.

Table 4 gives the presence of Latin American countries in the different areas of Physics. Only countries with 50 or more publications in each area figure in the table.

The analysis of these indicators shows that Argentina has a proportion of papers in Physics of 19.3% which is very close to the world proportion figure (19%), while Brazil shows a very high proportion (28.1). The latter figure is almost certainly related to the decision taken some twenty years ago whereby scientific research was given priority funding. Mexico with figures of 24.1% and Venezuela with 22.2% also show high proportional numbers.

These indicators show that in the case of Argentina, Brazil and Mexico the subfield of Applied Physics is one characterized by low activity and low attractivity. The implication for the desired technological derivations of physics research are evident and in consonance with the lack of technological development in each case.

Physical subjects of high activity and high attractivity in Argentina are Atomic and Molecular Physics, Optics and Nuclear Physics and Nuclear Science and Technology, the latter two being related to the activities of the CONEA (National Atomic Energy Commission), an institution whose budget has during the course of its existence at times permitted a high number of research projects to be carried out.

CONCLUSION: SOME EXPERIENCES IN SCIENTIFIC COMMUNICATION IN LATIN AMERICA

There is a general agreement in the Latin American Physics' community on the necessity of a high level Latin American journal of Physics (11). It would seem that a letters journal would be the most suitable form of journal to produce. The FELASOFI (Confederation of National Societies of Physics of Latin American Countries) is studying the possible issue of such a journal given that it is seen as necessary to support existing national journals whose interest is beyond doubt primordial. Some representatives however favour the idea of a review journal and their choice appears well justified; good review journals are read by a great number of people, indeed they appears in the statistics as the most cited of all the journals.

Local authorities in the region must be brought to realize not only the necessity for the technological revolution in their countries, but also that this will not be able to be carried out without basic research in a broad range of fields. It is essential to point out the vast sums of money earmarked for top level scientific institutes in the developed world.

At the present moment there are various examples of national journals which serve the dual useful purpose of connecting up researchers and of disseminating new ideas. The most important as regards circulation are the "Revista Mexicana de Física", "Revista Brasileira de Física" and "Acta Cientifica Venezolana". The former of these journals was founded in 1952, is a quarterly publication wich represents 700 pages per year. It is included in Physics Abstracts, Mathematical Reviews, Bulletin Signaletique, Physics Briefs, Chemical Abstracts, but not in ISI. During the period 1982 - 1986, 46% of the articles were devoted to research, 21% to teaching, 11% to book reviews, 10% to history and philosophy, 7% to instrumentation and 5% to academic policy. The journal subjects each article presented for publication to the opinion of a referee, the rate of articles rejected is about 40% of the articles submitted (12). The range and diversity of the topics published in this journal distinguish the journal from other international publications, but one wonders whether these very characteristics do not in fact serve to provide it with a comfortable niche in mexican society; undoubtedly the "Revista Mexicana de Física" carries out the highly useful role of disseminating ideas, both among scientists and students.

Economist in the region have begun to realize the need for technological change, but very often they only envisage the possibility of technological transfer without understanding how essential the deep need is becoming. We consider that in strictly economic terms there is a need for home-grown science and technology to be used as instruments for development, applying technical and scientific discoveries to the requirements of industry. In particular there should be specialization in certains problems which are included in technological-scientific projects involving various countries in the region with the object of achieving a first attempt of participation in the cycle of the production of new goods, thus circumventing the high price which normally must be paid for patents and the obstacles which are usually associated with the protection of know-how in monopolistic practices.

These projects should be accompanied by fundamental scientific research, not of course in isolated havens but in constant contact with teams of applied researchers. Within such a framework physics research is of fundamental importance. In order to train effectively an invisible college of Latin American physicists it is essential to have journals in which the results of their publications may appear and preventing scientific authors from suffering the evils of intellectual isolation and thus boosting their self-esteem.

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CITATION BEHAVIOR OF PHILIPPINE BIOLOGICAL SCIENTISTS

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ABSTRACT

The literature cited by Philippine biologists in two Philippine, refereed biological journals over a 10-year period compared favorably with some Asian newly industrialized countries in terms of age measured as proportion of citations five years old or less. The mean proportion of such references by Philippine authors in a national fisheries journal studied (33%) was close to that by Philippine authors in overseas journals (36%), but less than that of north American authors in one of the overseas journals (43%). However, pooling data over time was found to be inappropriate because the proportion of five-year-old or less citations in one Philippine journal decreased significantly over time while the other showed a marked significant increase over time. Also the proportion of recent foreign literature in the citations of one journal decreased markedly over time, while the reverse was true of the other. The journal exhibiting decline closed in 1983. It is suggested that these bibliometric parameters may thus be indicators of scientific endeavor in developing countries.

RESUME

L'age des références, mesuré en pourcentage de références ayant cinq ans ou moins de cinq ans, citées par les biologistes philippins dans deux journaux locaux avec comité de lecture sur une période de dix ans se compare favorablement avec les pays asiatiques nouvellement industrialisés. La proportion moyenne de ces références (de cinq ou moins de cinq ans) par auteur philippin dans un journal des pêcheries étudié (33%), est proche de celle par auteur philippin dans des journaux étrangers (36%), mais moins élevé que celle d'auteurs d'Amérique du Nord dans un des journaux étrangers (43%). Cependant, des irrégularités ont été relevées au cours de la période étudiée, la proportion de références de cinq et moins de cinq ans diminuant significativement au cours des années dans un des journaux philippins alors qu'elle faisait preuve d'une augmentation marquée dans le second au cours de la même période. De la même façon, la proportion de références étrangères récentes a diminué de façon significative dans un journal alors qu'elle augmentait dans l'autre au cours de la même période. Le journal témoignant de ces signes de déclin a interrompu sa parution en 1983. Les auteurs suggèrent que ces paramètres bibliométriques peuvent être utilisés comme indicateurs d'activités scientifiques dans les pays en développement.

INTRODUCTION

The debate about the usefulness or otherwise of the Science Citation Index (SCI) of the Institute of Scientific Information as a measure of the value of developing-country science has been largely based on SCI itself (e.g., Calleja 1980; Garfield 1983; Yutharong 1983; Arunachalam and Garg 1985, 1986; Singh and Arunachalam 1990.

Davis and Eisemon (1989) gave the most recent summary of what they call "mainstream and non mainstream science" and analyzed the latter in four Asian newly industrialized countries (NICs), Korea, Taiwan, Singapore and Malaysia.

The Philippines clearly also represents the non mainstream case. However, this country hosts several international and regional research centers such as the International Rice Research Institute (IRRI), the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC), the International Center for Living Aquatic Resources Management (ICLARM), and regional education centers (such as the Diliman and Los Banos campuses of the University of the Philippines).

We examined two locally published vehicles for research dissemination: (i) the Philippines Journal of Biology (Kalikasan), which was published three times a year between 1972 and 1983. It was included in the abstracting and indexing coverage of Chemical Abstracts, Biological Abstracts, Guide to Botanical Periodicals, Agrindex, Flora Malesiana Bulletin, Abstracts Journal, Entomology Abstracts, Asia Science Research References, Microbiology Abstracts, Cambridge Scientific Abstracts, Current Advances in Plant Sciences, Current Advances in Ecological Sciences, and Current Contents; (ii) The Fisheries Research Journal of the Philippines (FRJP), a semi-annual publication of the Fisheries Research Society of the Philippines produced with support from the Philippine Council for Aquatic and Marine Research Development (PCMARD) and the Bureau of Fisheries and Aquatic Resources. It commenced publication in January 1976 and continues to the present. It is monitored by the FAO Aquatic Sciences and Fisheries Information System (ASFIS) which produces a globally used abstracts journal. Except for two Tagalog (Philippine national language) articles in Kalikasan, both journals publish in English and accept articles by non-Filipino authors.

METHODOLOGY

Articles by Filipino authors in Kalikasan and FRJP were examined. The numbers and ages of citations were collated. Citations were grouped into those by overseas authors published abroad, non-Filipino authors published in the Philippines, Filipinos published abroad, and Filipinos published in the Philippines.

Table 1. Proportion of citations by authors in different journals according to age and source of citation

Journal	Years covered	Total citations	Proportion 5 years old (%)	Proportion by citation type(%)[3]				Mean Age (years)[3]
				00[4]	OP	PO	PP	
FRJP all	1976-1986	1827	26	54	3	4	18	10.8
FRJP[1] subset	1983-1986	550	33	54	7	3	22	9.2
Kalikasan	1972-1983	3135	28	70	1	2	10	10.1
Overseas[2]	1983-1986	478	36	75	6	11	2	9.0
Aquaculture	1985	290	43	100	-	-	-	8.1

[1]Fisheries Research Journal of the Philippines, subset for 1983-1986 to compare with the "Overseas" journal data
[2]Articles by Philippine scientist in Aquaculture, Aquaculture and Fisheries Management
[3]This part of the table excludes papers published before 1950 (16.6%)
4.00 = overseas authors in overseas journals; OP = overseas authors in Philippine journals; PO = Philippine authors in overseas journals; PP = Philippine authors in Philippine journals.

For comparison, articles by Filipinos published abroad and by foreign (North American) authors were examined using the same parameters. The north American author data were from the journal Aquaculture (covered by SCI) 1983-1986. Filipino articles were found in the journals Aquaculture, Journal of Fish Biology, Journal of Coastal Research, Fish Pathology, Marine Biology, Aquaculture and Fisheries Management, and Acta Biologica Hungarica, all of which are covered by Current Contents. The journals were searched successively over the years 1983-1986 until 30 articles were found. Cited articles published prior to 1950 were lumped and excluded in the computations of mean citation ages. The cutoff was fairly arbitrary but was made to keep taxonomy, etc., references, some of which date to previous centuries, from biasing the results.

RESULTS

The proportions of Philippine authors in the two Philippine journals were: Kalikasan 75% (n = 147) and the fisheries journal 90% (n = 63). In both, north American authors were the largest foreign group, with 21 and 2 authors, respectively.

Number of citations

On average, authors in Kalikasan used 7.5 citations, while those in FRJP cited 16.3. This compares with 15.9 for Filipino authors published abroad. The number of citations used by Kalikasan and FRJP authors diminished over time. The decline was more drastic for the FRJP authors (Fig. 1).

Age of citations

Table 1 shows that the mean age of citations differed little amongst the publication types, from 8 years for north American authors in Aquaculture to 11 years for Philippine authors in the Philippine fisheries journal.

Using 5 years or less as an age yardstick (as used by Davis and Eisemon 1989), there is a separation of Philippine and overseas journals, the latter with a clearly higher proportion of citations in this "young" category (36-43%) than Philippine journals (26-28%). However, the proportion of "young" citations used by Philippine authors in the 1983-1986 subset of the Philippine fisheries journal (33%) was nearly the same as that in the overseas journals in which they published (36%) in the same time period. The proportion of citations five years old or less decreased over time in Kalikasan articles and increased in FRJP articles (Fig.2). Clearly, the Philippine journal data are not homogeneous.

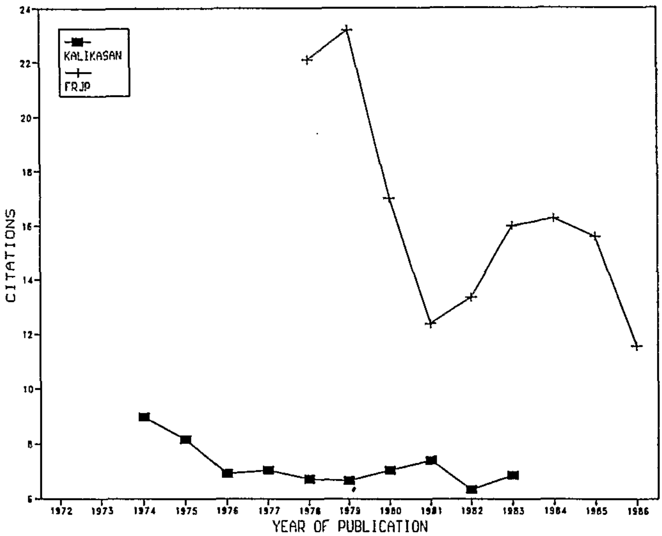

Fig. 1. Mean number over time of citations used per article for FRJP and Kalikasan. Points are 3-year running averages.

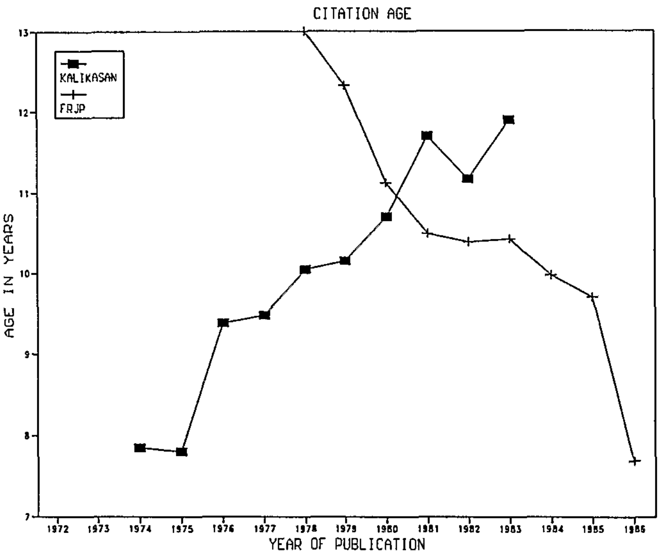

Fig. 2. Mean age over time of citations used for FRJP and Kalikasan. Points are 3-year running averages.

Citation types

The overall citation patterns of Philippine authors in the different publications exhibited some differences (Table 1). Nearly 70% of Kalikasan citations were to overseas authors in overseas articles while only around 50% of FRJP citations were in this category. FRJP authors cited more Philippine authors in Philippine journals. When publishing in overseas journals, Filipino authors used even higher proportions of overseas citations and almost no "home-grown" citations. However, some 11% of citations on average were to Philippine-authored articles in overseas journals.

The trend to younger citations in FRJP (Fig.2) was examined according to the categories of citation types in Table 1. The results (Fig. 3) show that citations to foreign authors in foreign journals is the dominant factor, in other words, FRJP authors are using more, more recent foreign materials. For Kalikasan the trend to increasing age of citations is similarly associated with a decline in the proportion of young foreign material (Fig. 4).

Interestingly for both journals, the proportions of other types of citations has varied little. It is only in the use of newer foreign articles in foreign journals where citation behavior has changed.

The overall temporal patterns of citation age by category are shown in Figs. 5 and 6. There is no discernible change in any category, not even in the use of foreign literature. Thus, Philippine fisheries scientists are not citing more foreign material by foreign authors, they are simply becoming more current.

DISCUSSION

The citation data on the two Philippine journals show that pooling results over time gave misleading impressions of the journals. Kalikasan showed a gradual decline in proportion of "young" overseas citations while the fisheries journal exhibited the opposite trend.

Some other interesting data, suggesting an overall decline in the usefulness of Kalikasan, were presented by Dizon (1990). Looking at a broad range of Philippine publications that cite Kalikasan, she found that the proportion of Kalikasan citations in Philippine primary literature declined from about 10% in 1972 to less than 3% in 1988 (Fig.7).

In another study of these two journals in our office, on the use of reprints, a questionnaire survey revealed that this aspect was apparently quite healthy. Most authors of both journals distributed all their free reprints (100 for Kalikasan; 25 for FRJP) (Carigma et al., unpublished data), and 94% of them used the "reprint system" (requested reprints) also. It might be noted that authors of Kalikasan, due to its international exposure via Current Contents, received twice as many reprint requests as FRJP. (Nearly 70% of Kalikasan reprint requests came from overseas, while only 40% of FRJP reprint requests were from overseas.)

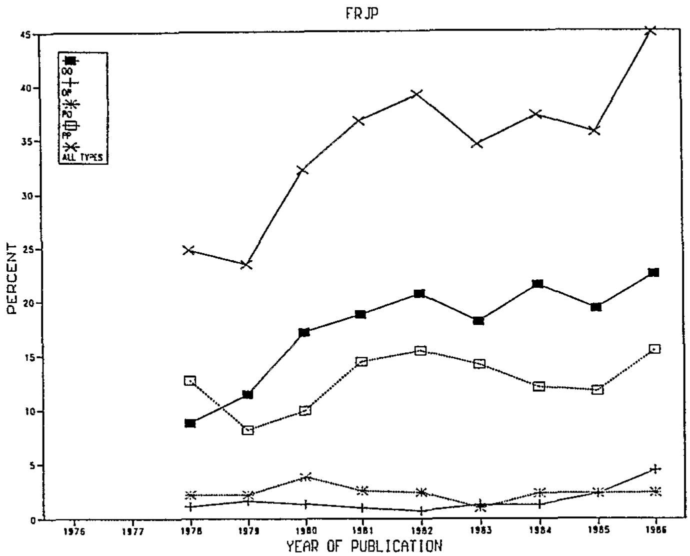

Fig. 3. Percentage over time of citations 5-years or less used in FRJP. Points are 3-year running averages.

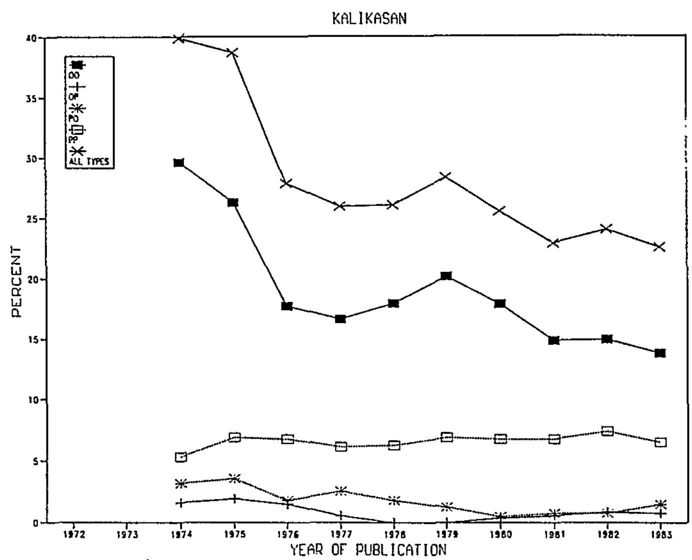

Fig. 4. Percentage over time of citations 5-years or less used in Kalikasan. Points are 3-year running averages.

Developing-country scientific literature is said to use older citations than its western counterpart. How old is old? Davis and Eisemon (1989) used the proportion of references five years old or less as a yardstick. They neglected to compare their data with mainstream articles in the same fields, so there was little to be gained in their analysis other than comparison across fields

The proportion of "young" citations in 1985 biology articles of the four Asian newly industrialized countries (NICs) studied by Davis and Eisemon (1989) was only 15%, well below the lower value (26%) for the Philippine journals. Figures for overall proportions of "young" citations in the NICs ranged from 20 to 33% in the national (non mainstream) literature. The Philippine biological journals fared better than three of the four Asian NICs.

Table 1 contains comparative data from the (mainstream) journal Aquaculture using the 5-year yardstick. It shows that north American authors in that journal have a higher percentage of references in the 5 years or less category but the differences are not great. The data suggest that Filipinos publishing in such journals would cite on average 2 less "young" articles in a paper with 20 references.

The proportion of national scientists publishing in a (national) journal in developing countries was equated to degree of "parochialism" by Davis and Eisemon (1989). Kalikasan, with 75% local authors, compared favorably with three of the four NICs they studied, while FRJP at 90% was still about the average NIC value. However, parochial is a rather nonsensical term applied to NIC or developing-country journals. There are national and there are regional journals. For example, the Journal that one of us (JLM) edits, Asian Fisheries Science, has authors from 18 countries in its three volumes to date (Appendix I). The journal is published in and distributed from the Philippines by the Asian Fisheries Society. There are other "cosmopolitan" journals in the aquatic field published in Asia, for example, the annual Asian Marine Biology from Hong Kong and the Journal of Aquaculture in the Tropics from India. Our results indicate that Philippine fisheries science authors (of FRJP) are not very far behind their western counterparts in age of citations, and that they are "catching up" in the use of new overseas materials. That the proportions of overseas materials has remained steady probably reflects the continued use of local literature to provide the necessary perspective, appropriate methodologies and data sets suitable for local conditions.

Philippine fisheries scientists may also be making use of recently available technologies in literature searching and retrieval, such as computerized literature searches and document delivery systems of the regional and international fisheries informations systems established in the Philippines. These services generally provide access to a larger and more current pool of literature that what is available in many national research centers or personal reference collections. This is, of course, a more economically reasonable method to stay abreast of recent developments as few, if any, local fisheries scientists can afford to subscribe to abstracting and indexing services.

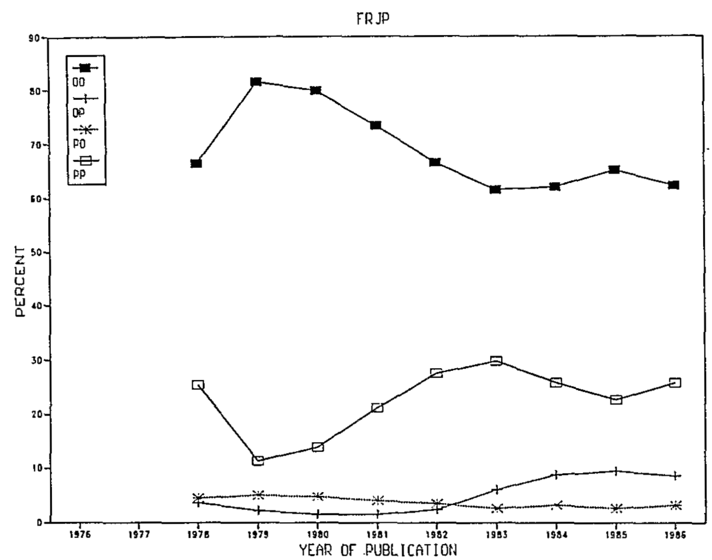

Fig. 5. Proportions over time of the different citation types used in FRJP. Note this includes citations prior to 1950. Points are 3-year running averages.

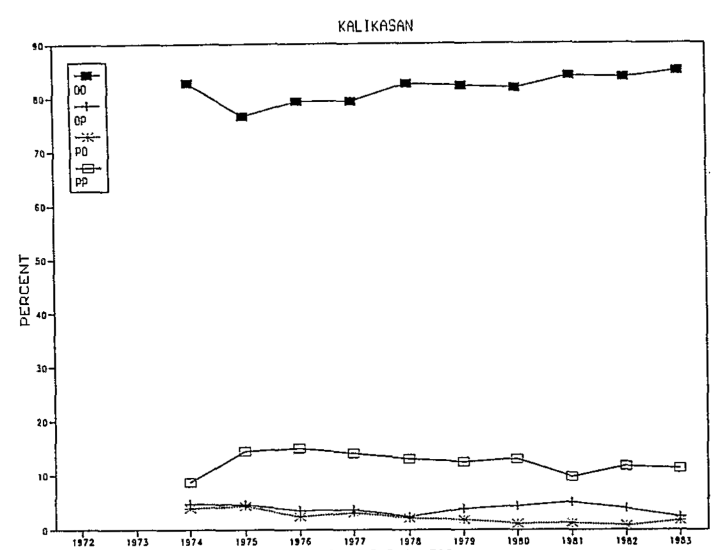

Fig. 6. Proportions over time of the different citation types used in Kalikasan. Note this includes citations prior to 1950. Points are 3-year running averages.

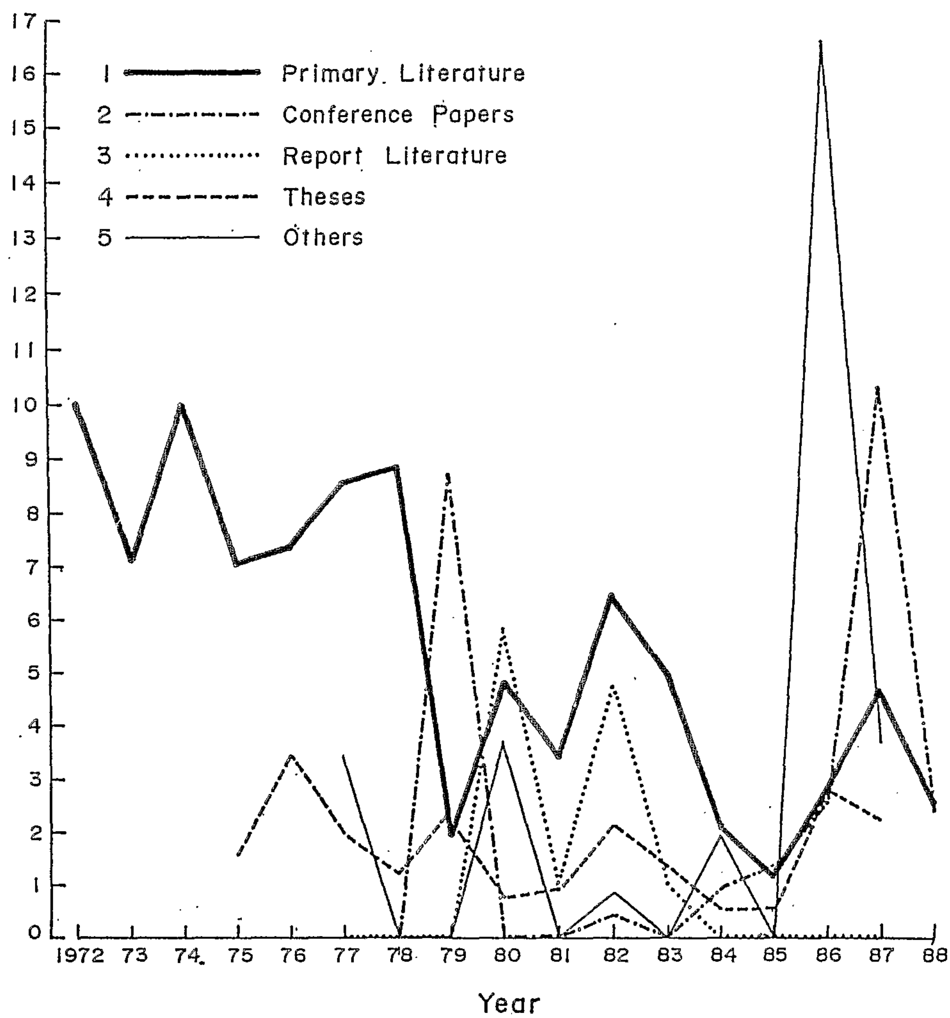

Fig. 7. Proportion over time of Kalikasan citations in reference lists of articles that cite at least one Kalikasan item.

ICLARM has been running an international information service, sponsored by the International Development Research Centre (IDRC) of Canada, for the past 7 years. From 1988, IDRC changed its policy to requiring or at least promoting a user-pays approach to make such services self-finàncing. Our subsequent experience was that developing-country researchers cannot afford to pay for information, while the number of donor-financed researchers is also inadequate to sustain an information service.

Finally, the demise of Kalikasan in 1983 officially due to lack of funding support, was in spite of its more international character - less parochialism; high proportion of overseas reprint requests; and covered by Current Contents. However, the journal's death may also have been associated with authors' declining use of recent overseas literature; increasing age of citations; and declining numbers of citations in the Philippine primary literature. Perhaps these are some of the parameters that, taken together with others, provide indicators of scientific endeavor in developing countries.

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Appendix I. Countries of authors publishing in Volumes 1-3 (1987-1990) of Asian Fisheries Science, showing number of authors from each country with number of papers of which they are authors, in parenthesis.

Australia	17	(11)
Bangladesh	13	(7)
China	3	(1)
France	2	(2)
Germany (West)	1	(1)
India	25	(9)
Iraq	1	(1)
Japan	3	(1)
Kuwait	4	(2)
Malaysia	8	(4)
Nepal	1	(1)
Philippines	22	(12)
Singapore	2	(2)
Sri Lanka	14	(9)
Taiwan	10	(5)
Thailand	2	(1)
UK	5	(4)
USA	6	(4)

SIXIEME PARTIE

LES SYSTEMES NATIONAUX DE RECHERCHE

MEASURING THE DEVELOPMENT OF NATIONAL AGRICULTURAL RESEARCH SYSTEMS

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ABSTRACT

Agricultural research is facing new and renewed demands to generate the knowledge and technologies required to sustain productivity growth in agriculture in order to feed and clothe a burgeoning world population. In addition, the increased political awareness of the environmental impacts of agricultural production practices is placing still further demands on national agricultural research systems (NARS) to address such issues. Access to reliable statistics on the state of NARS on a global scale is a prerequisite for sound analysis and informed policy debate. Careful measurement begets reliable statistics. It is our purpose in this paper to describe the on-going efforts at the International Service for National Agricultural Research (ISNAR) to compile and maintain a set of global indicators of NARS in both the more- and less-developed countries.

RESUME

La recherche agricole doit faire face à de nouvelles et pressantes demandes. pour générer des connaissances et des technologies susceptibles de maintenir la croissance de la productivité en agriculture afin de nourrir une population mondiale croissante. De plus, une attention politique croissante quant aux impacts des pratiques agricoles sur l'environnement implique une attente renouvellée sur les systèmes nationaux de recherche agricole (SNRA) pour répondre à ces préoccupations. L'accès à des statistiques fiables sur l'état des SNRA est un préalable aux analyses et aux débats sur les politiques à mener. L'objectif de cet article est de montrer l'effort actuel du Service International pour la Recherche Agricole (ISNAR) qui vise à compiler et entretenir un ensemble global d'indicateurs à la fois sur les pays les plus développés et les moins développés.

Background

ISNAR's mandate is to assist less-developed countries with policy, management, and organizational issues related to agricultural research, thereby placing it in a unique position to monitor the development of NARS throughout the world. The organization's frequent contacts with a wide range of less-developed country NARS is helpful but far from sufficient to ensure that the global policy analysis and policy making community have access to reliable measures of current agricultural research capacity on an international, regional or national scale, let alone meaningful indications of such developments over time. The disparate and often conflicting information that is generally available must first be synthesized into a meaningful set of statistics before a global overview of NARS is possible.

Some five years ago ISNAR began the process of developing and maintaining a set of basic statistics on NARS with an emphasis on compiling annual, national-level, research expenditure and personnel data. The resulting ISNAR Indicator Series, as reported in Pardey and Roseboom (1989), represents a fully documented and sourced compilation of data on NARS in 154 more- and less-developed countries, where possible, for the 27 years 1960 through 1986. Our initial efforts entailed a complete recompilation of existing data sets such as those by Boyce and Evenson (1975), Judd, Boyce, and Evenson (1983 and 1986), and Oram and Bindlish (1981). These series were then integrated with new data obtained from three primary surveys carried out by ISNAR -- one at a global level and the other two targeted to the Pacific and West Asia & North Africa regions respectively - plus data drawn from a review of over 1000 documents which included published papers, monographs, country reports, and a substantial amount of unpublished grey literature. A concerted effort was made to ensure that a consistent and comparable institutional coverage was maintained both within a country, over time, and among countries.

We placed a premium on compiling an historical rather than simply a contemporaneous set of agricultural research indicators. Agricultural research is appropriately seen as an investment activity. Research eventually leads to an increase in the stock of knowledge or an improvement in technology, which in turn generates a stream of future benefits that continues until the new technology or knowledge is superseded or becomes obsolete. But, for agricultural research to realize its growth promoting impacts takes some time. There are lags in the research process itself (Pardey 1989) and further lags in the uptake of new technologies and new ideas (Lindner 1981; Tsur, Sternberg, and Hochman 1990). As a result, the productivity effects of research can persist for up to 30 years (Pardey and Craig 1989). Thus, relatively long time series of research expenditure and personnel data are required if they are to be of help in informing policy makers on the efficacy of alternative research investment portfolios and institutional arrangements.

Defining a NARS

Before quantifying the capacity of a NARS in terms of expenditures and number of researchers employed, it was necessary that we developed a precise idea of what, in fact, was being measured. The NARS concept in general use by ISNAR and others, while useful for some conceptual and policy purposes, is of limited value for statistical purposes. In system theory language it is a *soft system* concept, that is to say it is an abstract idea which can help bring order to a complex and obscure reality. A source of considerable confusion, however, is that this abstract notion of a system is "... used in everyday language in an unreflecting way as if it were a label word for an assumed ontological entity, like 'cat' or 'table'. We casually speak of 'the education system', 'the legal system', 'the health care system', ... ['the national agricultural research system'], as if all these were, unproblematically, systems" (Checkland 1988). In order to move beyond the inherently soft system characteristic of a NARS, we chose to give some statistically meaningful precision to the concept by dissecting a NARS into its three dimensions namely (a) national, (b) agricultural and (c) research, and to consider each of these dimensions separately.

National

The notion of what constitutes a "national" set of statistics on agricultural research is open to many interpretations. One option is to adopt a geographic interpretation and include all agricultural research --be it in the public or private sector-- performed within the boundaries of a country. Another possibility is to pursue a sectoral approach and include domestically targeted research activities funded and/or executed by the public sector of a particular country. This latter approach was adopted for the Indicator Series, which attempts to include all agricultural research activities that are financed and/or executed by the public sector, inclusive of private, nonprofit agricultural research. It explicitly excludes private, for-profit agricultural research. This sectoral coverage corresponds to that adopted by the OECD (1981, 83-91) and includes the government, private nonprofit, and higher-education sectors, but excludes the business-enterprise sector.

The government sector was taken to include those federal or central government agencies, as well as provincial or state and local government agencies, that undertake agricultural R&D. One must be careful to avoid double-counting federal resources that fund agricultural research at the state or provincial level, and ensure that nonresearch activities are excluded such as rural extension.

The private, nonprofit sector generally includes only a small number of institutions, which are nevertheless, very important for some countries. Some commodity research in less-developed countries, particularly that concerned with export-oriented estate crops such as tea, coffee, and rubber, is often financed wholly or in part by (industry-enforced) export or production levies and performed by private or semiprivate nonprofit research institutions. These institutions often operate as pseudo-public-sector research agencies or, at the very least substitute directly for such agencies, and therefore are included as public agricultural research.

The higher-education sector is fairly readily identified but does present special problems when agricultural research statistics are compiled. Care was taken to isolate research from nonresearch activities (e.g., teaching and extension) and to prorate personnel and expenditure data accordingly.

The national agricultural research statistics reported in the Indicator Series excluded the activities of research institutions with an international or regional mandate, such as CIMMYT, IRRI, and WARDA, along with ORSTOM and CIRAD. While their research output may often have substantial impact on the agricultural sectors of their host countries, their mandates direct their research activities towards international and regional, rather than national applications. However, all foreign research activities that are either funded or executed in collaboration with the national research agencies (or administered by them) were included in the series.

Agricultural

When measuring science indicators by socioeconomic objective, the OECD (1981, 113) recognizes that two approaches are possible. They can be classified

a.according to the *purpose* of an R&D program or project;

b.according to the general *content* of the R&D program or project.

For example, a research project to improve the fuel efficiency of farm machinery could be placed under "agriculture" if classified by purpose, but "energy" if classified by R&D content. The Indicator Series adopted the procedure used by the OECD and classified research by purpose rather than content, as it is generally the purpose for which research is undertaken that has the greatest relevance for policy.

The definition of agricultural research used for the Indicator Series includes research in primary agriculture (crops, livestock, plus factor-oriented topics) as well as forestry and fisheries. In general terms, this corresponds with the coverage used by both OECD (1981) and UNESCO (1984). For policy and analytical purposes, it would be desirable to differentiate agricultural research among commodities, but the way most agricultural research expenditure and personnel data are reported makes it an unsurmountable task at a global level.

A further difficulty is that a significant amount of agricultural research has an effect at the postharvest stage, while the technology is embodied in inputs that are applied at the farm level. Take, for example, the efforts of plant breeders to improve the storage life of horticultural crops or to alter the baking quality of cereals. These characteristics are embodied in new crop varieties that are adopted by farmers. Furthermore, there is a lack of uniformity in the way research that is applied directly at the postharvest stage is currently reported. The OECD (1981, 115) classification omits "R&D in favor of the food processing and packaging industries" from their socioeconomic objective of *agriculture, forestry and fisheries*, while UNESCO (1984, 64) includes "R&D on the processing of food and beverages, their storage and distribution." The Indicator Series sought to implement a variant of these approaches, excluding, where possible, research applied directly at the postharvest stage. Omitting research on food processing and packaging improves the compatibility of these statistics with value-added measures such as agricultural GDP and the like. Nevertheless, public sector research targeted directly to food and beverage storage (and in some cases, processing) may in practice be included in this series, although this is more likely to be true of advanced systems in the more-developed countries.

A final difficulty was to obtain statistics for the higher-education sector, classified by purpose or "socioeconomic objective." The more general case is to find personnel and, possibly, expenditure data, classified by field of science, where the basis of classification is the nature rather than the purpose or objective of the research activity itself. In those cases where it was necessary to rely on field-of-science data, the series attempted to follow the UNESCO (1984, 77) procedure and consider agronomy, animal husbandry, fisheries, forestry, horticulture, veterinary medicine, and other allied sciences, such as agricultural sciences, thereby excluding fields such as bacteriology, biochemistry, biology, botany, chemistry, entomology, geology, meteorology, zoology, and other allied sciences. These latter fields are more appropriately classified as natural sciences, although in some cases the classification is a little hazy. It was therefore necessary to apply a "purpose or objective test" to some of these so-called natural science disciplines and to include in the series research undertaken in these areas when the ultimate purpose or objective of that research could have a direct impact on the agricultural sector.

Research

It is possible to identify a continuum of research from basic, or upstream, research to applied, or downstream, research. Much agricultural research has been characterized as mission-oriented in the sense that it is problem-solving, whether or not the solution to the problem requires basic or applied research. OECD (1981, 28) states that "the basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty." For instance, monitoring the incidence of plant and animal diseases is not considered research if it is only undertaken to enforce quarantine regulations or the like. But, using this information to study the causes or control mechanisms associated with a particular disease is considered research. Of course, some screening of the literature, newly available plant and animal material, and alternative production practices should be included as research, where this is used to adapt existing agricultural technology to local conditions.

Agricultural research includes a significant amount of maintenance research that attempts to renovate or replace any deterioration in gains from previous research. Gains in output are often subject to biological degradation as pests and pathogens adapt to research-conferred resistance and control mechanisms. The role of maintenance research is substantial not only in many more-developed countries where current production practices employ technologies that are biologically intensive, but also in many less-developed countries, particularly those situated in the tropics where relatively rapid rates of pest and pathogen adaptation tend to shorten the life of research-induced gains.[1]

The difficulties of differentiating research from nonresearch activities is especially pertinent in the case of agricultural research, given the dual role of many public-sector agencies charged with agricultural research responsibilities. It is common to find such agencies involved in additional nonresearch activities such as teaching; extension services; certification, multiplication, and distribution of seeds; monitoring and eradicating plant and animal diseases; health maintenance (involving veterinary medicine activities distinct from research); and analysis and certification of fertilizers. In general, it is separating the research component from the joint teaching-research activities (in the case of universities) and the joint extension-research activities (of ministerial or department-based agencies) that is most difficult. If direct measures of expenditure and personnel data were not available at the functional level, then secondary data were often used to estimate the appropriate breakdown of aggregate figures into their research versus nonresearch components.

Even in the case of those institutions whose mandate is ostensibly limited to research, there were problems in obtaining consistent coverage of research-related activities. For example, general overhead services, including administrative personnel or expenditures required to support research, can be excluded from reported figures for a variety of reasons. In some instances, the institutional relationship between a national research agency and the ministry within which it is located means that overhead services and the like are charged against the ministry and not the research agency. Alternatively, some research agencies report total personnel and expenditure statistics based on an aggregation of project-level rather than institution-level data. In such cases, administrative overheads may not be allocated across projects and thus omitted entirely or in part from the agency-level statistics.

A further issue involved identifying the research component of the farm operations that are usually undertaken in support of agricultural research. To the extent that such farm operations are necessary to execute a program of research, it seems appropriate that they be included in a measure of the commitment of national resources to agricultural research. However, some systems undertake farm operations at levels well above those required to support research, with the surplus earnings from farm sales being siphoned off to support research and even various nonresearch activities. In some instances, including all the resources devoted to the farm operations of a NARS substantially overstates the level of support to agricultural research within the system.

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[1] Recent evidence (Adusei and Norton 1990) suggests that the US devotes around a third of its total agricultural production research to maintenance work.

There was also the need to make a clear distinction between economic development and experimental development. According to OECD (1981, 25), "experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products, or devices, to installing new processes, systems, and services, or to improving substantially those already produced or installed." Experimental development is therefore concerned with applying new findings from formal and informal research activities. This contrasts with the notion of economic development, which in general terms, is concerned with improving the well-being or standard of living of members of a society in a particular country or region.

Clearly, while improvements in agricultural productivity that follow from experimental development contribute to the process of economic development, they represent only part of the story. Improvements in rural infrastructure, via investments in irrigation, transportation and communication facilities plus improved rural health and education services, also contribute to the economic development of the agricultural sector and, ultimately, to society as a whole (Antle 1983).

A problem arises when one attempts to compile statistics on agricultural research and experimental development activities in less-developed countries. A substantial portion of R&D activity is financed and/or executed as part of an economic-development aid package. It is often difficult to identify the experimental versus economic-development component of an aid package, particularly given the project orientation of much development aid. For instance, development assistance to establish, upgrade, or rehabilitate irrigation facilities can often incorporate research to evaluate water quality and identify preferred crop varieties as well as agronomic and irrigation practices. However, including all of the project's resources in a measure of NARS capacity could seriously overestimate the level of resource commitment to agricultural research.

Another less obvious difficulty concerns the somewhat transient nature of some of the agricultural research funded through development projects, which tends to be of relatively short duration (one to five years). In some cases it is undertaken largely by expatriates and is never a part of the existing national research infrastructure. This type of research presumably contributes to the overall level of national research activity and should be captured in a NARS indicator, particularly if one is concerned with measuring sources of growth or technical change within a country. However, to the extent that such research is not integrated into the existing national research infrastructure, it is not a good measure of the "institutionalized research capacity" of a national system. The strategy pursued in this case was to include such development-financed research only when the research component could be isolated from the nonresearch component with an acceptable level of precision, and when it appeared to be integrated into the existing agricultural research infrastructure within a country.

Translation Procedures

Compounding the difficulties of simply measuring agricultural research expenditures is the need to translate these value aggregates reported in current local currency units into some comparable real value or implicit volume measures. There are two practical methods for deriving research volume measures, namely:
(a) first convert the local currency values into US dollars and then apply an appropriate US price index to account for price level variability;
(b) first deflate the local currency values using appropriate price indices which account for temporal variability in local price levels and then convert into a constant US dollars using some base year measure of relative currency values.

The choice of an appropriate local price index entails some conceptual difficulties. Readily available price indices are typically general indices that may not reflect price developments in specific sectors or components (such as agricultural research) of an economy. Another problem is that price indices are commonly constructed using fixed quantity weights, as in a Laspeyres price index. The advantage of these measures is their ease of interpretation; they tell us how much the cost of purchasing exactly the same basket of research inputs has changed over time. Their disadvantage lies in the fact that they tend to overstate changes in the general price level by failing to allow for changes in the composition of the basket of research inputs which are likely to occur if there are changes in *relative* prices over the period being considered. The longer the time horizon of the study, the more likely it is to understate the volume of research inputs by deflating with a fixed weight index that fails to account for substitution. As argued in the index number literature, the use of chained (Divisia) price indices which incorporate rolling price weights would alleviate this last problem. However, in an international context, these indices are so rarely constructed, if ever, that they are currently not an option for international comparative analysis.

There are numerous deflators and currency converters that can be incorporated into either of the translation procedures described above. Unfortunately, the choices matter. Since we have no independent measure of the truth, we are forced to proceed using some rules of thumb.

In choosing a price deflator, one should use the price index that most nearly reflects the composition of the research aggregate to be deflated. In multicountry studies, this rule of thumb will argue for an algorithm in which value aggregates are deflated first with a local price index whenever adequate price indices are available for each country in the sample. The basket of research inputs covered in a local price index may be quite different from that of a numeraire country's index when living standards and local relative prices vary substantially across the countries in a sample. This cross-sectional variability would lead to biases in measurement whose direction and magnitude would be difficult to predict.

A more subtle problem is the combined choice of deflator and converter. If the values to be compared are the total values of a single uniform good, the two algorithms (deflation then conversion or conversion then deflation) yield the same result if and only if the deflator and converter are defined over the specific good. If the values to be compared are aggregates -- as they are in our case -- the deflator and the converter must be defined over the specific basket of inputs represented by the aggregate. General price indices, market and/or official exchange rates, and nonspecific purchasing power parities[2], PPPs, all introduce biases to the extent that they reflect aggregates whose composition may differ from the research input aggregate of interest.

Even with properly defined deflators and converters, the problems of aggregation cannot be escaped. As demonstrated in Pardey, Roseboom, and Craig (forthcoming) the two algorithms will yield different volume series unless it is the scale and not the composition of the research aggregates that varies over time and across countries. Both algorithms diverge from the desired volume measure as the composition of the research aggregate changes across the sample. When using the convert-first procedure, the volume measure will be biased unless the composition of the numeraire country's aggregate is representative of all other countries in all years of the sample. The deflate-first procedure will generate biases in the volume measure whenever the base-year basket of research inputs within each country is not representative of that country for the period being considered.

So, in a particular application, the choice of algorithm must be made on the basis of whether it is the temporal or cross-sectional composition of the research aggregate that is likely to vary most. Researchers have shown a preference for converting local currencies to dollars first and then deflating using a US price index. However, in a data set that includes countries at diverse stages of development, it is quite likely that cross-country differences in the composition of the research aggregates will dominate the temporal variability unless the data span several decades; hence, a deflate-first procedure would demand far less of the data.

Table 1 reports research volumes resulting from the application of a deflate-first procedure using two alternative currency convertors. For this application, no price index covering the specific mix of labor, materials, and equipment peculiar to agricultural research was available in each country, so the implicit GDP deflator was a practical compromise. The annual average exchange rate (AAER) used was the yearly official market rate, which generally corresponds to the IMF's *rf* or inverted *rh* rate. The PPP series, which was defined over GDP, represented another compromise. Published PPPs either cover too few countries or a basket of goods that is not particularly representative of agricultural research. The commodity coverage of PPPs obtained from the Summers and Heston (1988) used here did, at least, correspond closely to that of the implicit GDP deflators being used.

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[2]Purchasing power parities, by definition, measure the local cost of buying a bundle of goods and services in a particular country at its own prices relative to the corresponding cost in, say, dollars for the same bundle in the US.

Table 1: *Regional Volumes of Agricultural Research Resources; Alternative Measures*

Region	Deflate first and convert with 1980 annual average exchange rates		Deflate first and convert with 1980 purchasing power parity indices	
	million 1980 dollars	%	millions 1980 PPP dollars	%
Sub-Saharan Africa (43)[a]	373	5.3	372	5.0
Asia & Pacific (28)	522	7.5	1160	15.5
Latin America & Caribbean (38)	480	6.9	709	9.5
West Asia & North Africa (20)	342	4.9	455	6.1
Less-Developed Countries (129)	1718	24.6	2696	36.0
More-Developed Countries (22)	5273	75.4	4785	64.0
Total (151)	6991	100.0	7481	100.0

Source: Annual average exchange rates and implicit GDP deflators are primarily taken from World Bank (1989), PPPs from Summers and Heston (1988), and agricultural research expenditures from Pardey and Roseboom (1989). [a]Figures in brackets represent number of countries.

Across the two procedures the global volume of resources committed to agricultural research on an annual basis averaged over the 1981-85 period varies by approximately $500 million. Differences across translation methods at the regional level are even more dramatic -- especially for the less-developed countries. In particular the Asia & Pacific region almost doubles its share of the global volume of research resources if PPPs rather than AAERs are used as currency convertors. This can be traced to the fact that relative price levels in less-developed countries, and in particular those in the Asia & Pacific region, as reflected in Summers and Heston's (1988) PPPs, are lower on average than those implied by market exchange rates.

Figure 1a: *Percent deviation of convert-first from deflate-first formula using AAER converters and implicit GDP deflators (Base-year = 1980)*

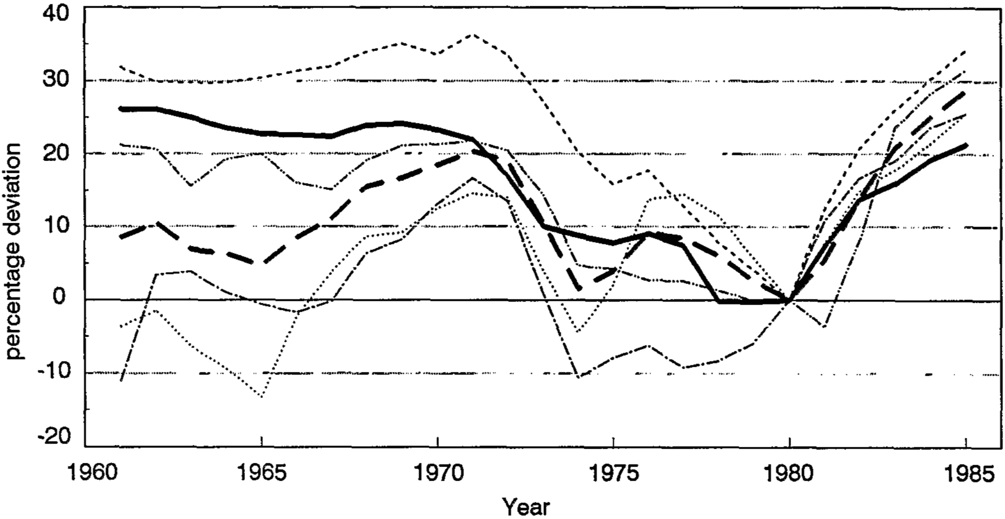
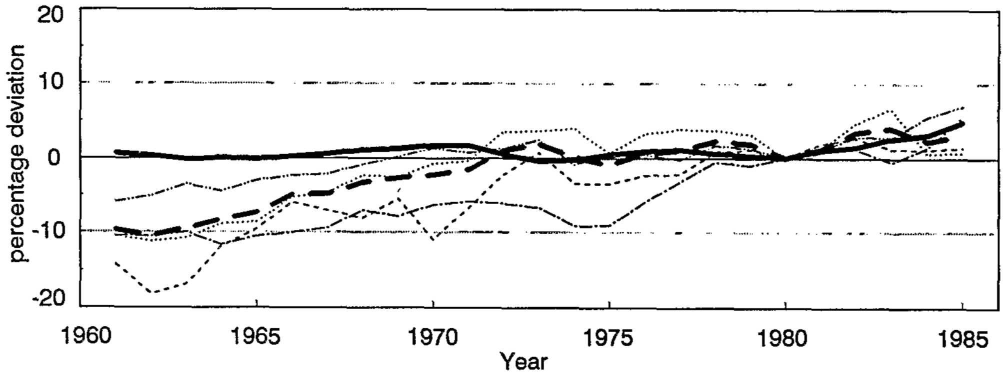


Figure 1b: *Percent deviation of convert-first from deflate-first formula using PPP convertors and implicit GDP deflators (Base-year = 1980)*



Legend:

- ------ Sub-Saharan Africa (32)
- .... Asia & Pacific (11)
- -.-.-.-. Latin America & Caribbean (17)
- —-—- West Asia & North Africa (8)
- — — Developing countries (68)
- —— Developed countries (22)

As previously mentioned the choice of algorithm is also important; particularly over longer periods of time and when AAERs are used. Figure 1a presents the percent deviation of the deflate first versus the convert first volume measures when annual average exchange rates and implicit GDP deflators are used to derive the respective volume measures. In figure 1b the same graph is presented for the volume series which used PPP exchange rates and GDP deflators.

When AAERs are used, the deflate-first algorithm led to a consistently larger volume measure than that obtained when expenditures were converted first. This suggests that, ceteris paribus, either the US dollar was undervalued with respect to virtually every country's currency in 1980, or that movements in local price levels were imperfectly translated by changes in the official AAERs. The difference between these two volume measures is most pronounced in the Bretton Woods years when all exchange rates were essentially fixed. This gives further credence to the idea that official exchange rates may carry little or no information about changes in the relative purchasing power of different currencies and so will be inappropriate converters for the purposes of international comparisons of long time series.

The temporal pattern of deviations of the PPP converted measures in figure 1b is far less dramatic than those in figure 1a. By construction, changes in PPPs over time should do a better job of capturing changes in relative price levels between countries. In contrast to the measures with exchange rate conversions, there appears to be no systematic differences between the convert- and deflate-first methods for the more-developed countries in any particular subperiod and for most less-developed country regions in the post Bretton Woods years. With these data, the convert-first procedure generates a larger volume measure than the deflate-first method for many less-developed country groupings during the Bretton Woods years. It is difficult to make too much of this trend as pre-1975 PPPs for many of the less-developed countries were derived using so-called short-cut extrapolation methods based, among other things, on market exchange rates without the benefit of local price measures based on benchmark survey data (Summers and Heston 1988).

Having briefly canvassed some of the definitional, measurement, and translation problems associated with compiling agricultural research indicators on a global scale the following section will sketch some of the trends that are revealed by a preliminary assessment of our new data.

Global Trends in Agricultural Research -- A Preliminary Review[3]

The pattern of global investments in agricultural research has undergone dramatic changes over the past two decades. The system as a whole has grown substantially, while at the same time the less-developed countries have

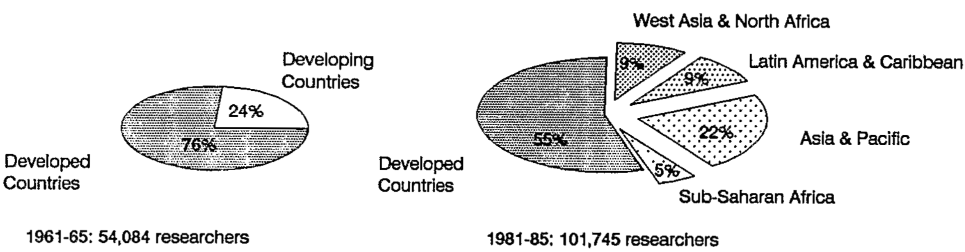
[3]The data presented in this section is preliminary in nature and currently undergoing final revision for inclusion in Pardey, Roseboom, and Anderson (forthcoming).

significantly increased their share of the installed agricultural research capacity within the public sector. However, recent trends indicate a marked departure from this historical pattern of growth -- there are signs that it is slowing, particularly with regard to financial support for agricultural research in sub-Saharan Africa and Latin America & Caribbean.

Research Personnel

Averaging over the 1981-85 period, the global total[4] of agricultural researchers working in the public sector stood at just over 100,000 full time equivalent researchers (table 2). This represents a 1.9 fold increase in the number of public sector agricultural researchers since the 1961-65 period which translates into an annual growth rate of 3.2%. Over this same period the number of researchers grew in a fairly uniform manner across all the less-developed regions at almost four times the rate (6.3%) than it did for the more-developed countries (1.6%). As a result the global share of researchers in less-developed countries increased from 24% in 1961-65 to 45% in 1981-85 (figure 2a). In 1981-85 the Asia & Pacific region accounted for 49% of the less-developed country total in table 2, with around 20% of the less-developed country researchers residing in both the Latin America & Caribbean and West Asia & North Africa regions, and the remaining 11% in sub-Saharan Africa. By including South Africa in these regional figures the number of researchers in the sub-Saharan 1981-85 total reported in table 2 increases by around 39% and more than doubles the number of scientists in the region who hold a post-graduate degree.

Figure 2a: *Agricultural researchers, regional shares*



[4]Countries excluded from the totals reported in this paper are detailed in the notes to table 2.

Table 2: *Agricultural Research Personnel and Real Expenditures (regional totals)*

Region	1961-65	1966-70	1971-75	1976-80	1981-85
Agricultural Researchers (full time equivalents)					
Sub-Saharan Africa (43)[a]	1,323	1,841	2,416	3,526	4,941
Asia & Pacific (28)	6,641	9,480	12,439	18,559	22,576
Latin America & Caribbean (38)	2,666	4,122	5,840	6,991	9,000
West Asia & North Africa (20)	2,157	3,485	4,746	6,019	8,995
Less-Developed Countries (129)	12,787	18,929	25,440	35,095	45,513
More-Developed Countries (22)	41,297	44,424	47,726	51,253	56,233
Total[b] (151)	54,084	63,353	73,167	86,348	101,745
Agricultural Research Expenditures (1980 PPP dollars, millions)					
Sub-Saharan Africa (43)[a]	149	227	277	359	372
Asia & Pacific (28)	317	475	651	928	1,160
Latin America & Caribbean (38)	229	355	487	679	709
West Asia & North Africa (20)	127	250	301	341	455
Less-Developed Countries (129)	822	1,307	1,716	2,308	2,696
More-Developed Countries (22)	2,191	3,057	3,726	4,172	4,785
Total[b] (151)	3,013	4,365	5,442	6,480	7,481
Real Expenditure per Researcher (1980 PPP dollars)[c]					
Sub-Saharan Africa (43)[a]	113,000	123,400	114,600	101,800	75,300
Asia & Pacific (28)	47,700	50,100	52,400	50,000	51,400
Latin America & Caribbean (38)	85,900	86,200	83,300	97,200	
West Asia & North Africa (20)	58,800	71,700	63,400	56,700	50,600
Less-Developed Countries (129)	64,300	69,100	67,400	65,800	59,200
More-Developed Countries (22)	53,000	68,800	78,100	81,400	85,100
Total[b] (151)	55,700	68,900	74,400	75,000	73,500

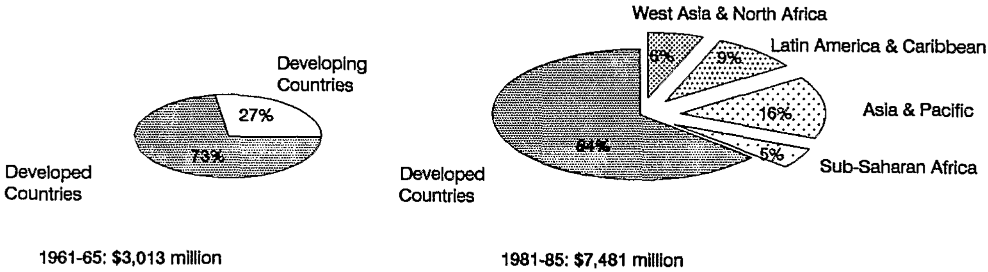
Source: Pardey and Roseboom (1989), and preliminary data from Pardey, Roseboom, and Anderson (forthcoming).

[a]Bracketed figures represent number of countries in the regional totals. [b]World totals which, due to data limitations, excludes USSR, Eastern Europe, China, Mongolia, North Korea, Vietnam, Cambodia, Djibouti, Bhutan, South Africa and Cuba. [c]Figures represent weighted averages rounded to the nearest hundred dollars.

Research Expenditures

Global spending on public agricultural research averaged $7.5 billion in 1981-85, up by a factor of 2.5 (compared with 1.9 for research personnel) on the global level of real expenditures just two decades earlier. The less-developed countries expenditure share grew from 24% in 1961-65 to only 35% in 1981-85, considerably less than the corresponding fraction of the world's agricultural researchers (45%) employed by the public sectors of the less-developed countries (figure 2b).

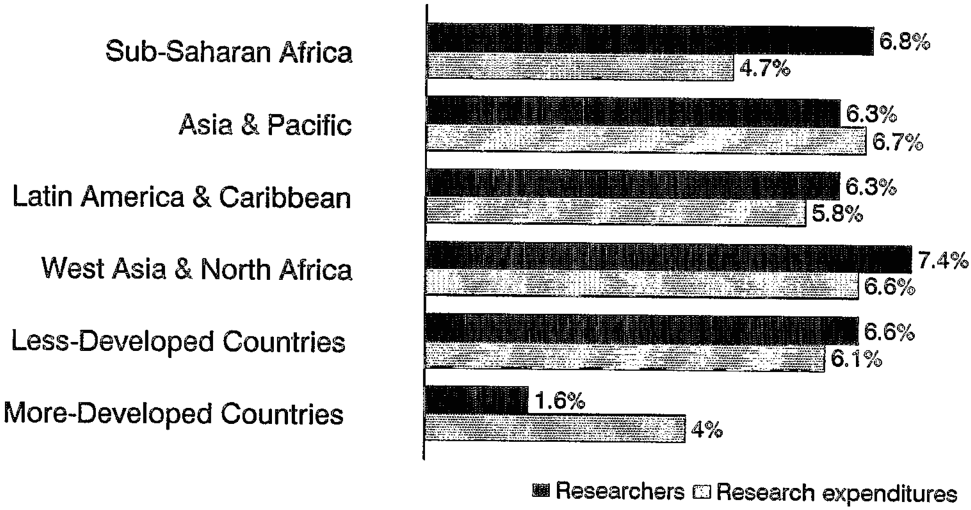
Figure 2b: *Agricultural research expenditures (1980 PPP dollars), regional shares*



Comparative patterns of growth in research personnel and expenditures are presented in figure 3. While the 6.1% rate of increase in real spending for less-developed countries as a group was approximately 50% larger than real spending increases for the more-developed countries over the 1961 to 1985 period, it fell marginally short of the 6.6% increase in research personnel experienced by the less-developed countries over the corresponding period. By contrast, the more-developed countries, as a group, increased their real expenditures at approximately double the rate of their research personnel.

A closer study of the period-to-period averages in table 2 reveals a general contraction in financial support for agricultural research in the less-developed countries during the latter period of the sample. The precipitous decline in the rate of growth in real spending for sub-Saharan Africa over the last period in our sample reflects a widespread slow down throughout the region compounded by a 23% decline in total spending by the Nigerian system, which alone accounts for approximately one quarter of public spending on agricultural research in all of sub-Saharan Africa. Anecdotal evidence suggests this contractionary pattern of support for public sector agricultural research has continued or even accelerated over the more recent past for many less-developed countries and may even have spread to some of the more-developed countries as well.

Figure 3: *Annual average growth of research personnel and expenditures, 1961-65 to 1981-85*



Spending per Scientist

Regionally comparative indicators of real expenditures per researcher are also presented in table 2. With real expenditures measured in 1980 PPP terms, the overall spending per scientist ratio for more-developed countries increased steadily from $53,000 in 1961-65 to $85,100 in 1981-85. Thus, the more-developed countries as a group moved steadily towards more capital intensive -- both human and physical -- research systems over the past two decades. Evidence based on detailed data from the US state agricultural experiment stations on the changing factor mix of their research systems points to a significant increase in human rather than physical capital over the longer run. By contrast, the less-developed countries spent $64,300 per researcher in 1961-65 -- some 21% more per researcher than the more-developed countries for the same period -- which peaked during the early to mid-1970s, followed by a steady decline to $59,200 by the 1981-85 period. Moreover the pattern of growth in spending per scientist ratios among less-developed countries is rather uneven.

The overall decline in labor productivity and at best stagnation in land productivity that characterizes sub-Saharan agriculture since the early 1970s somewhat belies the growth in research personnel and real expenditures which were reported in table 2. Certainly distortionary government policies that accelerate the transfer of resources out of agriculture and bias public sector infrastructural investments in favor of urban as opposed to rural areas have played a role here as elsewhere. However the sustained and substantial decline in spending per scientist ratios observed since the early 1970s -- and which during the last period in our sample spread to 65% of the region's NARS -- may provide clues to some additional causes of this productivity paradox. For one, the rapid growth in the region's researcher cadre has been realized through large increases in the number of relatively inexperienced, and hence less expensive, nationals. Expatriate ratios have dropped from approximately 90% in the early 1960s to around 29% in the 1981-85 period, with the limited evidence available suggesting that during this latter period 60% of the region's researchers had less than 6 years research experience. Moreover, the region's NARS are especially reliant on donor sourced funds -- our estimates placing the donor share during 1981-85 at around 36% -- and as a consequence staffing decisions have a tendency to be decoupled from expenditure decisions. Personnel decisions are made largely within the context of a domestic policy environment often constrained by civil service regulations while expenditure levels, and equally importantly research priorities, must also respond to the various agenda's of multiple donor agencies. In such an environment it is difficult to harmonize personnel and expenditure allocations that maintain an appropriate factor mix (i.e., labor, capital, support services etc.) as well as desirable remuneration and incentive structures that stabilize attrition rates, particularly for the more skilled researchers, within a national research system.

The Asia & Pacific region displays an erratic and barely perceptible drift upwards in real spending per researcher levels that historically have been low when compared with other regions of the world. These low spending levels persisted even after factoring in the region's relatively low average price levels. Indeed our translation procedures substantially increased, in fact doubled, the region's share of the global volume of resources committed to agricultural research relative to the alternative translation procedures used by others in the past. Economies of scale and economics of scope accruing to the large research systems that dominate the Asia & Pacific figures would tend to lower average costs per unit of research output and in turn account, to some extent, for the region's lower spending per researcher ratio. In addition, relatively lower labor service costs, resulting from a comparative abundance of labor, would induce a substitution of labor for capital and other inputs in the knowledge production process, to also drive down the region's spending per scientist ratio.

Average spending per scientist ratios for the Latin America & Caribbean region as a whole were relatively stable over the 1961-75 period, increased during the late 1970s (mainly due to the larger South American NARS) and declined throughout the region in the early to mid 1980s. This decline was driven as much by stagnating expenditure levels as it was by a relatively rapid growth in research personnel which, given the current austerity measures facing many countries in the region, will pose continuing problems for these NARS.

Support for NARS

Securing and maintaining domestic political support for the public sector component of NARS and translating that into financial support for agricultural research is a fundamental issue confronting all national research policy makers. Agricultural research intensity (ARI) ratios that express expenditures on public sector agricultural research as a proportion of agricultural product (AgGDP) are commonly cited measures of the support afforded NARS. The data in table 3 shows an approximate doubling of ARI ratios for both less- and more-developed countries alike over the 1961 to 1985 period. This data also confirms the positive correlation between income levels and ARI ratios noted by earlier observers, with ARI ratios for high income countries more than double those of low- and middle-income countries.

Table 3: *Agricultural Research Intensity and Relative Research Expenditure Ratios*

	Agricultural Research Intensities[b]			Relative Research Expenditures[c]
Income Class[a]	1961-65	1971-75	1981-85	1981-85
Low (29)[d]	0.30[e]	0.40	0.66	8.5
Lower-middle (28)	0.49	0.69	1.00	9.5
Middle (18)	0.47	0.58	0.84	8.7
Upper-middle (18)	0.59	0.82	1.26	8.3
Low and middle (93)	*0.45*	*0.60*	*0.91*	*8.8*
High (16)	1.03	1.82	2.37	11.3
Total (109)	*0.49*	*0.69*	*0.85*	*9.2*

Source: Pardey and Roseboom (1989); and preliminary data from Pardey, Roseboom, and Anderson (forthcoming).

[a]Countries assigned to income classes based on mid-period, 1971-75, per capita GDP averages where: Low, < $600; Lower-middle, $600-1500; Middle, $1500-3000; Upper-middle, $3000-6000; High, > $6000.

[b]Agricultural Research Intensities (ARI) ratios measure agricultural research expenditures as a proportion of AgGDP.

[c]Relative Research Expenditure (RRE) ratios measure agricultural research expenditures as a proportion of government expenditures on agriculture. These ratios include 19 low, 20 lower-middle, 13 middle, 16 upper-middle and 12 high income countries. This particular series is definitely provisional and will be subject to further revisions.

[d]Bracketed figures represent number of countries in each income class.

[e]All figures represent simple averages across all countries in each income class.

However, as Pardey, Kang, and Elliott (1989) observed, a potentially more instructive approach to understanding the structure of support for agricultural research is gained by placing publicly funded research in the context of the overall level of public support for agriculture. The relative research expenditure (RRE) ratio in table 3 represents the proportion of total public expenditure on agriculture spent on agricultural research. It thus provides an indication of the *relative* importance given to research on agriculture within the constraints imposed by overall public spending on agriculture. Clearly the income linked pattern of support for agricultural research that many have implied from an inspection of ARI ratios is far less evident in the RRE data. While cognizant of the general assertion that governments in low-income countries tend to discriminate against agriculture (while high-income countries discriminate in favor of agriculture) our data, at least for the present, leaves open the question of whether or not policy makers in poor as opposed to rich countries give a *differential* (i.e., lower) level of priority to agricultural research within the overall constraints of spending on agriculture. More fundamental limitations to increased public support for research in low income countries may well lie in the financial and political constraints imposed by overall and agricultural-specific levels of public sector spending. Certainly much more analysis is needed if we are to understand the (political economy) forces that shape the support for NARS and give policy guidance that duly recognizes such constraints.

SUMMARY REMARKS

Over the last five years a small team at the International Service for National Agricultural Research, ISNAR, The Hague, has been working to establish a global database on national agricultural research systems. The database contains a fully sourced and extensively documented set of research personnel and expenditure indicators for NARS in 154 more- and less-developed countries for the 27 years 1960 through to 1986, where possible. The series was reported in a volume by Pardey and Roseboom published in October 1989.

In addition to the conceptual and practical difficulties of measuring the capacity of a NARS and of maintaining consistency of coverage over time and across countries, a major measurement issue involves the translation of research expenditures expressed in current local currency units into a constant (i.e., base year) numeraire. The findings on alternative translation procedures presented here have relevance not only for our own work but for all international comparison work. We experimented with alternative translation procedures and demonstrated that the choice of procedure matters, particularly for the less-developed countries. Our preferred approach suggests that the *real volume* of resources committed to research in less-developed countries is substantially greater than that obtained using conventional translation procedures.

The preliminary assessment of our data shows a rapid expansion of the capacity of NARS over the period 1961-65 to 1981-85. Less-developed country NARS grew on average more rapidly than more-developed country NARS. In many less-developed country NARS, however, the number of researchers has increased at a greater rate than real expenditures. As a consequence spending per researcher across less-developed countries has declined steadily since the early 1970s -- in contrast to a sustained increase in spending per scientist in the more-developed countries since the beginning of our sample (1961) -- particularly in sub-Saharan Africa, West Asia & North Africa and, of late, in Latin America.

Aknowledgment

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REGIONAL DATABASES AND S&T DEVELOPMENT INDICATORS: PROBLEMS, ACHIEVEMENTS AND UTILIZATION OF GRADE's LATIN AMERICAN DATABASE

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ABSTRACT

GRADE (Group of Analysis for Development) has from 1970 onwards accumulated a large volume of S&T and socio-economic indicators gathered in a database. The purpose of this database is to maintain updated statistical data which can be used to monitor the evolution of scientific production in the region, as well as to assess its contribution to social and economic development. After two years of project implementation this article is discussing the achievements and the reasons for its relative underutilization.

RESUME

GRADE (Groupe d'Analyse pour le Développement) a accumulé depuis 1970 une quantité importante d'informations S&T et socio-économiques qu'il a rassemblé dans une base de données. L'objectif de cette base est de tenir à jour les données statistiques nécessaires à l'observation de l'évolution de la production scientifique dans la région, ainsi qu'à l'évaluation de sa contribution au développement économique et social. A près deux années de fonctionnement cet article discute les résultats obtenus et les raisons de sa relative sous-utilisation.

INTRODUCTION

For several years since its creation in 1980, researchers at GRADE have been conducting theoretical and empirical studies on Science and Technology (S&T) policy. They have at the same time been monitoring the evolution of policies applied in Latin America and in the Caribbean countries, as well as their differential results. While several books and many scholarly and policy papers in those two fields of work have been published[1], particularly by Francisco Sagasti, two review reports on the situation of S&T in these regions, published as working papers in 1983 and 1985[2], have been most frequently quoted as valuable sources of information[3].

I - ORIGINS, PURPOSES, OUTCOMES AND PROSPECTS OF GRADES' S&T DATABASE

In the course of those activities, the institution had by 1987 accumulated a large volume of statistical information. Therefore, it was decided, with support from the Organization of American States and of Canada's International Development Research Centre, that the best way to put it to advantageous use was to create a computerized database, containing statistical series dating from 1970 onwards on the most commonly used indicators of S&T development.

The data which were originally incorporated include annual standard input and output measures for each of 33 Latin American and Caribbean countries, as well as general social and economic development indicators which are useful to assess the relative standing of each of the region's countries. These statistical series are as complete as allowed by the periodicity with which relevant primary information is collected in each country.

Examples of those indicators are the following: number of Research and Development (R&D) units and projects; scientists, engineers and technicians in R&D; enrollment and staff in different levels of higher education; university degrees; R&D expenditures; export and import composition; direct foreign investment; foreign royalty payments.

Other data refer to production and productivity indicators such as patents, mainstream S&T journal publications, citations and authors, domestic S&T publications and international prizes obtained by local scientific researchers or innovators. Also included are general socioeconomic indicators such as population, birth and mortality rates, life expectancy at birth, population per physician and hospital bed, daily per capita calory supply, gross domestic product, per capita energy consumption, value added in manufacture, exchange and inflation rates and foreign debt.

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1 A representative set of such papers can be found in Sagasti et al. (1988). Other more recent publications include Cueto (1989), Garland (1988 and 1989), Garrido Lecca (1985), Sagasti and Garland (1985).

2 Sagasti et al.(1983); Sagasti and Cook (1985).

3 A representative set of such papers can be found in Sagasti et al. (1988). Other more recent publications include Cueto (1989), Garland (1988 and 1989), Garrido Lecca (1985), Sagasti and Garland (1985).

Many of the input variables are in turn disaggregated according to the different criteria proposed by UNESCO: type of research (basic, applied, experimental development), scientific field (exact and natural, agricultural sciences, engineering and technology, health, social, others), sector of performance (public and private; productive, higher education, general services), economic sector, etc.. Another important classification criterion is main economic aim (evaluation and exploration of the earth, sea, and atmosphere; civil space; agricultural, forestal, and silvicultural development; industrial development; production, conservation and distribution of energy; development of transport and communications; development of educational services; development of health services; social development and socioeconomic services; environmental protection; advancement of knowledge; defence; other aims).

The purpose of this project has been to assemble and maintain updated statistical data which can be used to monitor the evolution of scientific production in the region, as well as to assess the efficacy and efficiency of its contribution to social and economic development. The S&T DB is intended to provide this information in a timely, homogeneous and comparable manner to a variety of users, including academics, planners, politicians and public officials working in this area.

At first glance it may seem strange that this task be assumed by a private research center. One would believe that its "natural" location would be a national S&T promotion or regulatory agency or a regional development agency interested in these issues. However, the instability of policies and politicians in Latin America, as well as of their administrative styles, and the precarious financial and institutional conditions in which they must operate, including high rotation rates of technical personnel, in addition to GRADE's own initiative, determined that this institution would carry out the project in its first phase.

The initial --and continuing-- processes of identifying sources of primary and secondary information, of obtaining their collaboration, of reviewing and contrasting data obtained from different sources, of assessing the methodologies applied for collecting and processing data in each country, and of evaluating the completeness of the obtained information were rather difficult. While the volume of information quickly became substantial, notorious gaps were left open. It was not possible to determine whether those gaps could be attributed to a real lack of primary data sources or rather to the simple fact that communication efforts had been insufficient or less productive than desired. Establishing contact with information providers was rather more difficult than anticipated, even in spite of the good offices of the agencies who had previously promoted and financed national surveys on S&T capacity in this region and who were supporting the current effort.

A simple optimistic explanation might have been that the existence of the database remained yet largely unknown, and that well planned dissemination efforts would take care of the problem in the near future. However, serious consideration had to be given to the possibility that the general thrust of the project, or the way in which it was being carried out (that is, incorporating at first the conventional S&T input and output indicators), did not respond to the real needs of planners and decision makers.

Moreover, uncertainties about the quality of the available information (which database managers are constantly trying to assess, requesting generating agencies' cooperation) and about the appropriateness of some of the standard development indicators were not assuaged throughout that first stage of the project. Repeated requests for comments, suggestions and criticisms submitted to potential policy-making users remained largely unmet.

It became evident to database managers that, in order to promote cooperation with and utilization of the system, they would have to be the first users of their own services. Thus, two simple studies on scientific production and productivity were carried out in 1988 and 1989. It was expected that their publication would show the type of use that could be given to the available data. It would generate more interest in the information source and would stimulate demand for its services, assessments of data validity and reliability and discussion of necessary additions or changes in the database.

The better known of those papers[4], which was published as part of the International Development Bank's 1988 annual development report and later on as a GRADE working paper, reviewed available statistics on papers authored by Latin American and Caribbean researchers in mainstream scientific journals, citations of those publications, patents requested and awarded in this region of the world and international prizes granted to Latin American scientists. In this same line of work, an essay was written[5] which compares research productivity --measured in terms of the relationship between the number of registered mainstream publications and citations, the number of scientists and engineers involved in research and development, and the volume of R&D expenditures-- as well as its thematic distribution among the largest countries of the region.

Thereafter, information obtained from the papers themselves, and through direct requests to GRADE, has been used quite frequently by researchers both within the region and elsewhere. The papers have been extensively cited and have allowed the incorporation of their authors into international academic networks. They have also elicited varied and contradictory reactions regarding both their practical utility and their academic soundness, on grounds of many of the issues which are being considered in the various sessions of this meeting.

However, the project's objectives were mainly and explicitly aimed at satisfying information needs of those involved in the design, application and/or evaluation of S&T development policies for individual countries or for the region as a whole, who could use the S&TDB indicators to compare their domestic situation with that of other Latin American countries in terms of the sufficiency,

4 Arregui (1988).

5 Torero and Arregui (1989).

efficacy and efficiency of resource allocation. By comparing the results obtained in other places with different policies, they could, for example, explore the convenience of introducing changes in the strategies pursued in their own countries. In that process, it was expected that they would alert database managers on data errors and limitations, articulating demands for additional and different variables to be included in it and promoting that responsible agencies in each country would devise means for assembling new necessary statistics. The final outcome of this continuous process would be the availability of a sound information system for decision making in this important development field.

Among those who were initially identified by database managers as those "involved in the design, application and/or evaluation of S&T development policies" and who were therefore targeted as primary potential users, can be found a wide range of social institutions and actors. While there was a definite implicit interest in satisfying information needs of scientists, professional organizations and trades unions, scientific associations, universities and other educational institutions, international technical cooperation agencies and academics (particularly those studying science itself), prime intended subjects whose information needs were to be met --and prompted-- were politicians, congress members, productive sector representatives, national S&T promotion and regulation agencies, national or regional planning bodies and governmental executive offices.

After two years of project implementation, it must be admitted that those planners and policy makers, however, are not yet among those utilizing the information provided by the S&T DB. For some reason, the "numbers" are not being "sold".

Thus, there is now a need to evaluate the present usefulness of the database and to plan its future evolution. Furthermore, it is necessary to evaluate the adequacy of the conventional indicators it contains, particularly in terms of their relevance for planners active in the field of S&T policy. Therefore, the project's current objective is to assess these issues and to propose and promote the adoption of additional and/or alternative indicators, as well as to improve those currently available.

A series of activities are being carried out this year, which will certainly benefit from the discussions being held during this international meeting. Those activities include the updating and verification of available data, the preparation of users' guides, the provision of information to interested parties, the application of a user survey and the design and publication of a statistical handbook based on the information in the database.

Furthermore, a Latin American seminar has been scheduled for the end of November, during which participants will review "state of the art" issues related to the design, collection and utilization of S&T indicators, will analyze theoretical, methodological and technical aspects of those issues and will jointly evaluate user reaction to the database. Efficient means of data collection and processing, as well as the appropriate balance between national and regional information systems will also be given consideration. By the end of the year, decisions about the continuity of the project, about the data it should contain and about the most convenient institutional framework for its future development will be taken.

II - POTENTIAL NEEDS AND RELATIVE UNDERUTILIZATION OF GRADE'S DATABASE

Having briefly described the origins, purposes and current outcomes and prospects of this project, in what is left of this presentation, I would like explore some of the reasons why demand for the data base's services has not been forthcoming from its targeted audience. Obviously, there is a whole set of issues dealing with theoretical, conceptual and methodological aspects and limitations of conventional indicators which may have made it difficult for local officials to utilize them as planning instruments. Many of the presentations in this meeting have dealt with those issues, however, and I will therefore concentrate on a somewhat different matter: institutional aspects of the project's development which may better explain its relative underutilization by those parties whose needs it most particularly sought to satisfy.

In the first place, it is convenient to recall what it is that S&T indicators seek to measure and with what aims. Their objective is to evaluate the situation, the pace of progress being attained and the impact of S&T activities, as well as to foresee their likely contribution to social and economic development. They can be used to make decision makers aware of the interrelationships among the many variables which intervene in a scientific system's efforts and help them to establish priorities for the allocation of scarce resources to various disciplines and institutions. They can also be used to improve research institutions' management of their programs, given that they allow detecting implicit changes in the objectives of scientific efforts, and to evaluate their linkages to other social activities.

Supposedly, a country's S&T regulatory and promotion agencies would require information in order to facilitate decision making and day-to-day management, as well as to design and propose mid- and long term policies in this field. In practice, however, this may be far away from the real interests of these organizations, which can easily become so bureaucratized that their sole concern is their own survival, or which can be used by their leaders as a power base for the recruitment of future political support. Where this is true, it is clear that policies effectively applied will not easily be congruent with the "planning" focus of efforts such as the previously described database.

With respect to other potential users of the database, that is, academics, politicians, providers of S&T services, entrepreneurs, etc., almost as little is known about their perceived needs, except that when they are in urgent need to make some public declaration or to present some diagnostic statement or proposal, they request particular bits of information.

It is difficult to believe there are no real needs, for which reason it will be momentarily assumed that the problem lies in a lack of channels through which demands can be formulated. When thinking about how S&T indicators are used elsewhere, the first image which comes up is that of scientific establishments as lobbies or particular interest groups and their negotiations with governments in order to obtain a larger piece of the pie in public resource allocation. Data provided by the National Science Foundation are waved by the educational system to demand more resources with arguments such as "The Japanese are taking up all openings in science graduate programs in the U.S.. Meanwhile, less and less resources are being allocated to basic research. It is essential to increase the quantity and quality of those programs if we are not out to destroy our industrial competitiveness and to relinquish our position in international trade". Another typical use of indicators occurs when mainstream publication and citation counts of a university's faculty are compared to average output or to other institutions in order to argue in favor of continued financial support from the federal government or of increased contributions from alumnae to institutional investment funds. Why is it that this does not occur in our countries?

A tentative response is that, very much like our industry, science has developed under the --not very-- protective mantle of the State. One could argue over the effectiveness of that protection, over its consistency through time or over its coherence with other public policies in the State's spheres of social and economic intervention. However, few practitioners of S&T activities would advocate that the obtention and distribution of resources for science should be determined solely by the free play of market forces.

However, once interest groups are successful in establishing public agencies responsible for the promotion or regulation of S&T activity, they back up and cease to provide them with information and other inputs --including the pressure of their demands for processed information-- which those agencies would require in order to fulfill their role. The typical document containing S&T plans which --with luck-- these agencies may regularly produce remains largely unread.

Other problems which occur in Perú may be also true of many of our countries. The general public does not perceive any tangible benefits arising from science or technological innovation which might make it worthwhile for them to become more interested in their development[6]. The productive system

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[6] Arregui and Acosta (1988), in a study of desirable scenarios for the future of Perú, found that S&T factors have no space in young Peruvian leaders' expectations for "a better future". With the almost single exception of references to the positive impact of the introduction of computers into may spheres of social and personal life, the few other spontaneous references to S&T incorporated into their descriptions of their dreams and expectations were remarks on the need to control them so that "progress" would not increase unemployment.

nourishes its weak growth with imported technologies and does not demand much from the local S&T system. Scientists do not organize themselves as pressure groups (except the few which teach in universities) in order to demand support. Therefore, none of these potential sources of demand for information to support policy proposals becomes effective.

Another reason which might explain why there has not been more interaction between information supply (i.e., the database) and potential demand is the difficulties which assail dialogue between research institutions and public sector agencies. Researchers and bureaucrats have different cultures, logics, discourses and languages, which make two-way exchanges rather difficult. It would be necessary that *active* scientists become more involved in public planning work, even at the price of their already fragmented time availability[7]. They should participate not only as technical advisors in their fields of specialization, but in all phases of what should be a constant process of identifying consensual mid and long term objectives, fixing targets, formulating strategies and evaluating results. Planners, in turn, need to invest time in convincing scientists that resources are really scarce, that priorities therefore need to be established and that they need to use available funding effectively and efficiently.

Finally, another reason why there is no demand for information from planners is that no real planning is going on. Increasingly over the last decades, social planning, which is eminently a mid- and long term oriented function, despite being considered necessary, appears more and more distant from the main and urgent concerns of politicians and decision makers (Sagasti 1988). Moreover, even where, in spite of the awareness of its problems and limitations, people and governments accept the possibility and convenience of rational interventions to guide national development, planning agencies tend to easily become some sort of technical secretariat of the Presidency, attending short term issues and becoming involved in political controversies (Sagasti 1988) in ways which contradict its essentially "harmonizing" (*concertadora*) mission (Santa Cruz 1990).

It is crucial to redefine the role and structure of planning institutions, clearly establishing that the main responsibility of its central body, specially in this age of information overload, should be the reception, filtering, organization and distribution of information for high-level decision making.

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7 "...a full time researcher in an American university probably spends more time really doing research than his officially equivalent Latin American colleague, who in fact spends half his time teaching and advising, another half doing research, another half doing administrative and planning activities, half time doing private consulting, half time looking for funding, half time carrying out public relations for his or her institution, saving only two of his remaining half times in order to write mass-audience articles based on his studies, take care of his personal hygiene and try to balance his checkbook (always in the red, to be sure)..." (Arregui 1990, pp.16-17).

FINAL REMARKS

Meanwhile, and while the future course of the database project is determined, I can't help but make use of this opportunity to request support from all of you, by providing new data and corrections to the samples of output which we have distributed during this meeting, by making suggestions as to the strategy which ought to be followed in order to obtain more cooperation from relevant statistical offices and, specially, by giving us your opinions about the value, real or potential, of this effort. Thank you.

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A PROFILE OF SCIENTIFIC RESEARCH ON HEALTH IN VENEZUELA

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ABSTRACT

This paper analyzes the case of Venezuelan health research and constitutes part of a broader project which includes Argentina, Cuba, México and Brazil. Research projects, Researchers, Graduate Courses and available information systems are considered. Research activities in health are considered further than just biomedical research, including research projects in all those activities that affects the quality of human life. Venezuelan Data Bases are very incomplete, discontinuous and far to be updated, so the information in this project comes mostly from primary sources. The purpose is to try to establish a different kind of data base and help in the design of health science and technology policies. Preliminary results show some characteristics such as regional and institutional concentrations of projects and graduate courses, a majority of women in the field but a higher proportion of males in research projects. Venezuelan research activities in health seem to be an individual task; more than 55 of the total are developed by one person. Production in health (publications) appears mainly in international journals. Graduate courses were used as a scientific potential indicator which, in the case of health, seems to come more from the non-medical field.

RESUME

Cet article étudie le cas de la recherche en santé au Venezuela. et fait partie d'un plus large projet qui inclut l'Argentine, Cuba, le Mexique et le Brésil. Les projets de recherche, les chercheurs et les cours de troisième cycle sont étudiés. Les activités de recherche en santé sont considérées dans un sens plus large que la seule recherhe

[1] This paper is a product of the project "Current Trends and Profile of Venezuelan Health Scientific Production" (ISVEN) which is being carried out in the Science and Technology Department at the Centro de Estudios del Desarrollo (CENDES) of the Universidad Central de Venezuela, sponsored by Pan American Health Organization (PAHO/WHO). There are also two more researchers participating: Nelson Prato, from the Sociohistoric Department and Carlos Walter from the Theory and Methods of Planning Department. The research group also includes research aids Vilma Hernández and Yolanda Spinetti and the computer programming and processing by PROSERVFACICA (Luis Marzulli) of the Faculty of Science of the Universidad Central de Venezuela.

biomédicale, et incluent des projets qui affectent la qualité de la vie. Les bases de données vénézuéliennes sont incomplètes de sorte qu'il a fallut créer un base à partir de données primaires. L'objectif est de construire une base de données utile pour la prise de décision dans ce domaine. Les résultats préliminaires montrent certaines caractéristiques comme la concentration régionale et institutionnelle des projets et des cours de troisième cycle, la forte participation des femmes dans le domaine mais une plus large portion d'hommes au sein des projets de recherche. Les activités de recherche sont essentiellement issus d'initiatives individuelles; plus de 55% des projets sont menés par une seule personne. La production en santé (publications) paraît essentiellement dans des revues internationales. Les cours de troisième cycle sont utilisés comme un indicateur valable du champ et montrent que la majorité des activités a lieu en dehors du strict domaine médical.

I- INTRODUCTION

The main purpose of this project is the characterization of research activities in the field of health in Venezuela, considered in the socioeconomic situation of the country. The case study of Venezuela is a part of a larger project that includes similar studies in Argentina, Brazil, Cuba and México. These studies have been sponsored by the Pan American Health Organization during 1988-1990.

The field of health is considered in its extended meaning, not reduced to biomedical studies. The characterization of scientific research activities had centered on the gathering and analysis of primary and secondary information (with the aid of computer processing). The units of analysis are research, centers, projects, researchers, graduate courses, professors, production and information services. This information in presented by means of a set of indicators and Tables similar for all the countries participating in the project.

An important goal of the project has been to provide a more integrated view of scientific activity by means of the simultaneous consideration of projects, graduate courses and publications. The interaction between these activities are considered an important source for understanding the dynamics of the field and key elements for exploring its prospective behavior.

The links between the profile of scientific research and the analysis of socioeconomic conditions is meant to provide support for policy design for scientific research on health.

II- INFORMATION AND INDICATORS

It is not possible in Venezuela, as in many other Latin American countries, to know with precision the state of research in the field of health. This is mainly due to the fact that there are no adequate data bases. Those that do exist are discontinuous, incomplete incompatible in their classifications and in most cases not focused on academic and disciplinary characteristics of research or researchers but on administrative and economic aspects at a very aggregate level. Management of resources for research on health has been done following traditional criteria, predominantly oriented towards medical problems, and the role of the planning agencies has often been superseded by researchers' personal and individual interests. These are possibly some of the reasons why the use of resources may not always correspond to the country's priorities on health

The project had to dedicate an important part of its efforts to create a more complete data base from information acquired directly from the institutions and the researchers. After decades of important discussions, programs for creating the technical capacity and availability of computer power (hardware and software) oriented to the creation of information systems and data bases on scientific capacity in Venezuela, there still does not exist adequate information on research activities. The government's Secretariat for Science and Technology (Consejo Nacional de Investigaciones Cientificas y Tecnologicas, CONICIT) has done important efforts in this direction, but they have had to struggle against the absence of systematized information at the research center level, which should provide it for aggregation, being forced to gather it directly from the researchers (an estimated 4300 for 1984).

In the health field the MESH and BIREME classifications have contributed very much to achieve common terms for classification of materials. Nevertheless, the fact that there is still not a universal use of this classification and the need in this project to use other not strictly medical or health sources, demanded reclassification of some materials, with new possible sources of error and still another mediation for assignation to fields.

Advances to more pertinent and sophisticated indicators in relation to scientific and technological activities, require that the more basic type of information, even simple inventories, exist in a continuous and compatible data base. Lack of reliable and up to date inventory type of information is still the more important bottleneck for advance in work on indicators. A very important part or resources (financial, technical) and time available for indicator work, has to go to the gathering of the basic unavailable data, and compatibilization of multiple partial sources.

Indicators refer to: thematic and disciplinary areas, of the projects, the researchers, graduate courses according to level. They are considered in relation to age, sex, geographical situation, concentration, institutional links, scientific publications, etc. The time period considered is 1988-89 for the research projects, 1984-89 for the graduate courses and 1979-89 for the publications. The number of research centers included is 218 (at the most desegregated level), the number of projects 1776 and the number of graduate courses 279. In the analysis, more aggregate levels are considered such as faculties, universities and regions.

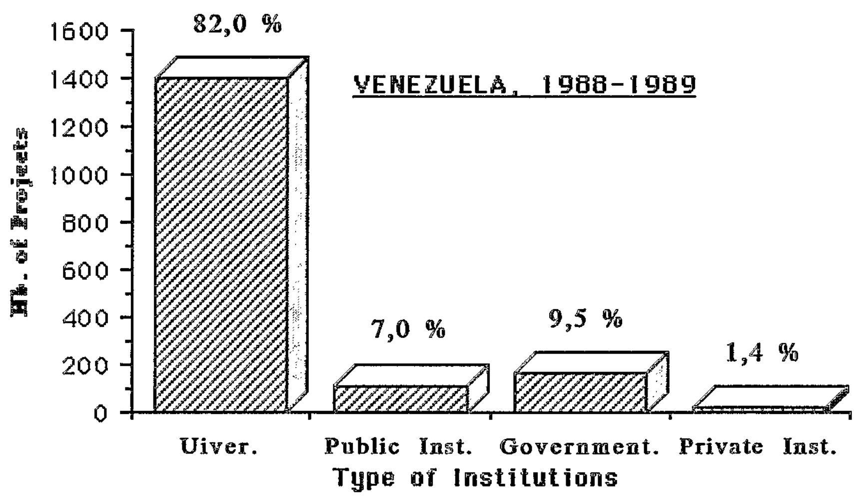
The projects and graduate courses were classified by subject fields according to the BIREME classification for health and disciplines according to the UNESCO classification. Researchers were classified according to their project affiliation (if a researcher appears in more than one project he will be counted as many times as he appears in the corresponding subjects or disciplines). This common classification permits cross tabulations of the characteristics of projects, researchers and graduate courses, and to a lesser extent, publications.

Data bases on production (publications) for the period were not available. The information on this variable was obtained from several data bases of international character with coverage of health such as LILACS, MEDLINE and EXCERPTA MEDICA. This search was done for the project as a whole by CICH Universidad Nacional Autónoma de México and UNICAMP (University of Campinas, Brazil). The subject classification was fully compatible only for data from LILACS which covered the same BIREME fields as those considered for projects, graduate courses and researchers.

III. INSTITUTIONAL LOCUS OF RESEARCH ON HEALTH

The "institution" is the research center where the projects are located. Only those institutions where two or more projects were identified, have been included.

Figure 1. Research projects in health by type of institutions



Source: Proyecto ISVEN. CENDES. Caracas, 1990

This figure shows a high concentration of projects in public universities (82%) and only 1,4 % in private institutions. It was also found (Table A, annexes), that in the institutions with the largest number of projects, there existed the largest dispersion of subjects and the least dispersion (greatest concentration on subjects) in those with the smallest number of projects.

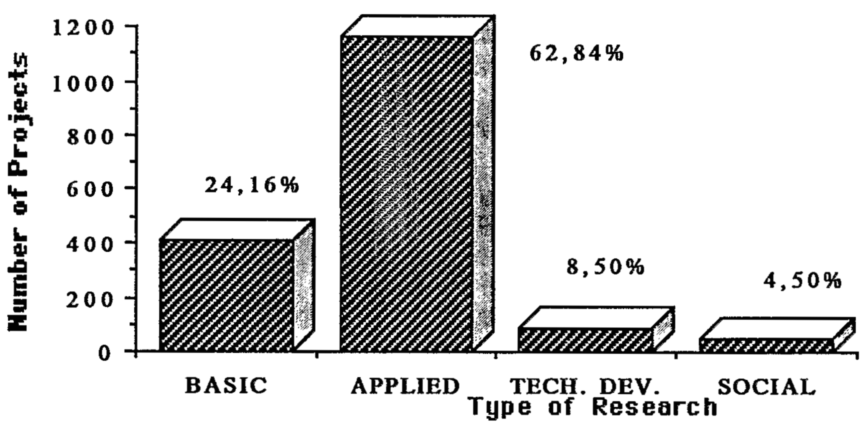
More than two thirds of the institutions are located in the Capital region where Caracas, the capital city, is situated. From the institutional point of view there is a great concentration not only regional, but also in terms of the type of institutions. Of the 1776 projects registered, 72 % are located in the Capital Region, 57.7 % of these at the Universidad Central de Venezuela and 80 % of them at the School of Medicine. Therefore, concentration is not only a matter of geographical location by region but also a question of institutional location. Notwithstanding, it must be said that we also found some regions in which some disciplines were particularly relevant, as is the case of Anthropology in the Andean region, having 66,3 % of the total research being done during the period under study.

IV.SUBJECTS AND DISCIPLINES OF RESEARCH PROJECTS

At the most aggregated level of analysis, we found that more than nine hundred projects out of 1776, are concentrated in three subjects: Diseases, Biological Sciences and Medical Instruments. Only forty projects have to do with health care.

Projects were grouped according to type in Basic, Applied, Technological Development and Social Sciences. Most of Venezuelan research on health is applied, one fourth is basic research and only 4.5 % has to do with Social Sciences. Figure 2 shows the distribution of projects according to the type of research.

Figure 2. Research projects in health by type of research



Source: Proyecto ISVEN. CENDES. Caracas, 1990

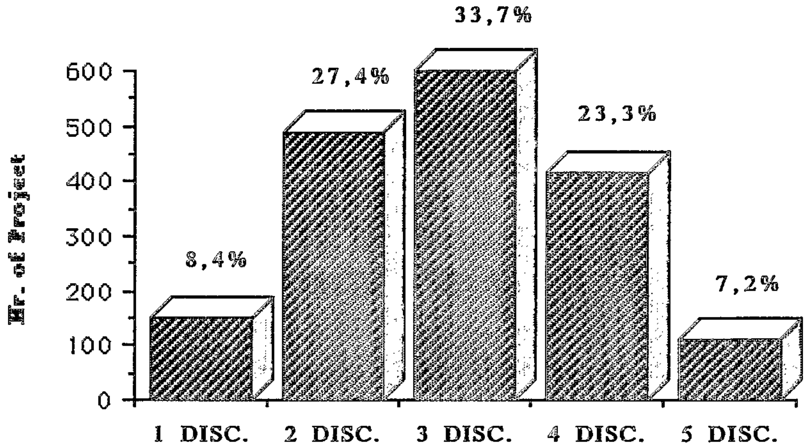
Although we do not have a precise information about the type of matters included in the projects, we do have the number of disciplines each of them incorporates. Figure 3, shows the number of disciplines per project.

V- SOME ATTRIBUTES OF THE RESEARCHERS.

One of the most salient features of the researchers studied was the number of researchers per project. Almost 90 % of the projects are carried out on the basis of research teams made up of 1 to 4 persons. Individual projects represent the largest group, 55.2 % (699) are carried out by a single person.

Information in relation to the age of the researchers has not been completed yet, but some indicators have been estimated on the information available on 811 (out of 1413) researchers. This group graduated between 1935 and 1988; 340 of them obtained their degrees between 1969 and 1977, which seems to indicate that the group of researchers is aging. This coincides with the present worry of the Venezuelan Scientific Community that not enough young researchers are being

Figure 3. Health research projects by number of disciplines incorporated

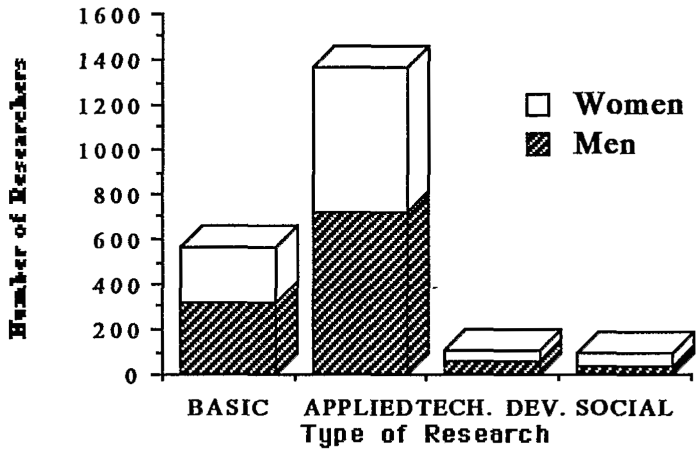


Source: Proyecto ISVEN. CENDES. Caracas, 1990

incorporated and trained for the future. There are more women (723, that is 51.1%) than men (690) working in research on health.

Figure 4 shows the composition of researchers according to the different types of projects; (as we mentioned before the total number may be larger than 1776 due to their being counted ore than once if they participate in more than one project). It is also interesting to take a look to what happens with women and men in the different disciplines of the projects in Table 1.

Figure 4. Researchers by type of projects and sex (1988-1989)



Source: Proyecto ISVEN, CENDES, Caracas, 1990

Table 1. Researchers by main discipline and sex (1988-1989)

	MEN		WOMEN				
DISCIPLINE	N	%	N	%	Total	N	W
Mathematics(12)	3	75,0	1	25,0	4	0,2	0,1
Physics(22)	9	81,8	2	18,2	11	0,7	0,2
Chemistry(23)	83	42,8	111	57,2	194	6,8	9,8
Sciences of Life(24)	469	52,7	421	47,3	890	38,3	37,1
Agricultural Sciences(31)	23	62,2	14	37,8	37	1,9	1,2
Medical Sciences(32)	562	55,6	449	44,4	1011	45,8	39,5
Technological Sciences(33)	35	36,8	60	63,2	95	2,9	5,3
Planning(39)	2	66,7	1	33,3	3	0,2	0,1
Anthopology(51)	1	25,0	3	75,0	4	0,1	0,3
Demographics(52)	13	41,9	18	58,1	31	1,1	1,6
Economical Sciences(53)	2	100,	0	0,0	2	0,2	0,0
Political Science(59)	1	14,3	6	85,7	7	0,1	0,5
Psychology(61)	9	37,5	15	62,5	24	0,7	1,3
Sociology(63)	13	27,1	35	72,9	48	1,1	3,1
Ethics(71)	1	100,0	0	0,0	1	0,1	0,0
TOTAL	1226	100,0	1136	100,0	2362	100,	100,

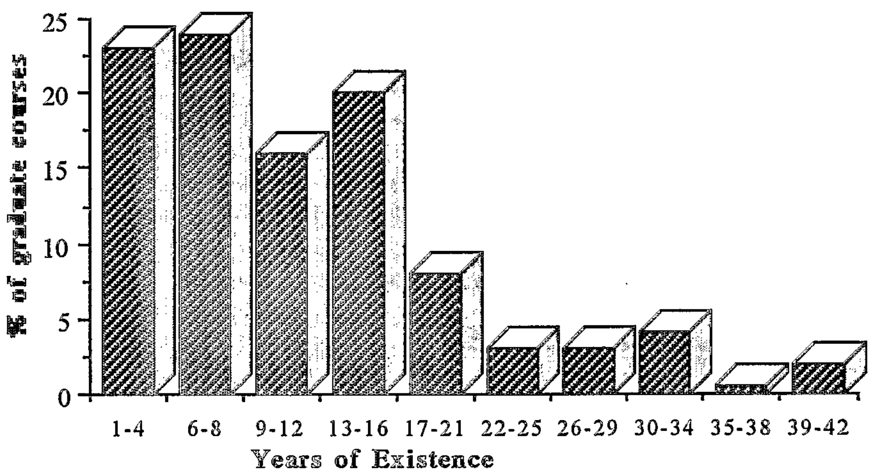
Source: Proyecto ISVEN. CENDES, Caracas, *1990*

Women are present in more than 63 % of the Technological Sciences research projects and in 57 % of research on Chemicals and Drugs. Differences in other disciplines are not notorious. In Medical Sciences and Agricultural Sciences, men are still majority. This, and the fact that there are more women than men in the enrollment at university level in Venezuela, may indicate that the next generation of researchers will probably be mostly female.

VI. EVOLUTION OF GRADUATE HEALTH COURSES IN VENEZUELA

Figure 5 presents the proportion of graduate courses in relation to their span of existence. Courses in Medical Sciences are the oldest ones. The first ones were created in 1937, but the majority of them started in the 70's. If we look at the regional distribution we perceive the same proportions we saw in relation to projects. However the growth of courses after 1980 occurs in other regions outside the Capital. This trend could be related to changes in educational and economic policies, that seek to decentralize the country's administration.

Figure 5. Venezuelan graduate courses in health by years of existence



Source: Proyecto ISVEN. CENDES. Caracas, 1990

Fundación Gran Mariscal de Ayacucho (FUNDAYACUCHO) is the name of one of the main financing agencies for graduate studies. Especially during the period of rising oil prices, it provided funds for studies not only in Venezuela, but in foreign countries also. Table 2 shows the number and proportion of scholarships awarded by FUNDAYACUCHO in all fields, and in health in particular, between 1979 and 1984.

Table 2. Scholarships awarded by FUNDAYACUCHO in health (1979-1984)

YEARS	TOTAL	N	%
1979	1174	92	7,8
1980	1436	142	9,9
1981	986	132	13,4
1982	559	67	12,0
1983	592	89	15,0
1984	476	109	22,9
TOTAL	5223	631	12,1

Source: Ciencia y Tecnología en Cifras. CONICIT. Caracas, 1986.

Medical graduate courses represent the largest group. However, when one thinks of graduate courses as indicators of scientific potential, there appears a problem that requires some prior clarification. There are three types of courses under consideration: "Especialización" a professional type of training course that confers the degree of "Especialista", Master's Degree, and the Doctorate level (Ph.D.). There are 202 courses out of 279 located in Medical Schools; 189 of those are specialization courses which are mainly used for the training of personnel in fields where health services are needed. Master and Ph.D. courses are specifically designed for training in research (cf.Table 3).

Table 3. Graduate courses by institution and conferred degree

	Especializ.		Magister		Doctorate		
INSTITUTIONS	N	%	N	%	N	%	Total
U. Central de Venezuela	119	55,3	18	37,5	8	50,0	145
Universidad Simón Bolivar	5	2,3	2	4,2	2	12,5	9
Universidad del Zulia	36	16,7	6	12,5	0	0,0	42
U.C-O.Lisandro Alvarado	8	3,7	0	0,0	0	0,0	8
U.N.Exp.Francisco de Miranda	3	1,4	1	2,1	0	0,0	4
Universidad de Los Andes	16	7,4	6	12,5	0	0,0	22
Universidad de Carabobo	18	8,4	1	2,1	0	0,0	19
Universidad de Oriente	7	3,3	4	8,3	0	0,0	11
Universidad Rafael Urdaneta	2	0,9	0	0,0	0	0,0	2
CIPPSV	1	0,5	3	6,3	0	0,0	4
Inst.Ven.de Inv. Científicas	0	0,0	7	14,6	6	37,5	13
TOTALS:	215		48		16		279
PERCENTAGES		77.1		17.2		5.7	

Source: Fichas de Postgrado. Proyecto ISVEN. CENDES. Caracas, 1990

Graduate courses constituted by one discipline are 67 % of the total, and this could be associated with the majority of "especialización" courses which are more specifically and narrowly oriented than Masters' and PhD.'s ; therefore the less specialization, the more disciplines they incorporate.

VII- SCIENTIFIC PRODUCTION IN HEALTH.

The search carried out in the different data bases provided results (table 4) that may give a preliminary idea of the distribution of publications by subject. More detailed work is still being done. Still, these numbers provided only an approximated image, since they express particular search strategies that cover only a selection of what may have been included. The different percentages for the same subjects permit us to see that the presence of the different subjects differs according to the data bases and remind us, once more, that those results must be very carefully used. The tendency to prefer international journals for publications by most researchers in almost every underdeveloped country, the very small number of Venezuelan journals included in these data bases must also be taken into consideration for the interpretation of these numbers.

Table 5. Biomedical production by Venezuelan Scientists in National and International Journals

	79	80	81	82	83	84	85	86	87	88	89	Total
National	297	273	264	345	298	289	192	227	186	53	3	2427
International	322	337	387	393	428	409	353	300	313	328	244	3814
Total	619	610	651	738	726	698	545	527	499	381	247	6241
National	225	213	207	261	233	222	159	197	164	46	2	1929
International	194	200	231	239	265	249	220	184	209	220	153	2364
TOTAL	419	413	438	500	498	471	379	381	373	266	155	4293

Source: same as table 4.

In this series one can see how the number of publications increased until 1983, and then consistently decrease. Though it may be a premature conclusion, this decrease seems to coincide with the financial crisis, devaluation of the bolívar (Venezuelan currency) in relation to its dollar equivalence, or it could also be seen as an inverse of the increase in the rate of inflation during that period.

Table 4. Publications of Venezuelans in several data bases classified by MESH Categories, 1979-1989.

	MED LINE Inter.		MED LINE Nat.		EXCE RPTA MED Inter		EXCE RPTA MED Nat.		BIOSIS		BIBL AT		PERIO DICA	
CARDIOVASCULAR	85	6,60	28	2,40	134	7,32	5	1,22	107	7,06	64	7,41	86	5,16
SURGERY	39	3,03	41	3,51	24	1,31	19	4,63	38	2,51	33	3,82	215	12,91
DERMATOLOGY	85	6,60	17	1,45	102	5,57	15	3,66	66	4,36	45	5,21	34	2,04
ENDOCRINOLOGY	21	1,63	9	0,77	86	4,70	15	3,66	84	5,54	40	4,63	63	3,78
FARMACOLOGY	88	6,84	29	2,48	192	10,49	19	4,63	126	8,32	116	13,43	80	4,80
GASTROENTEROLOGY	38	2,95	154	13,17	75	4,10	67	16,34	68	4,49	44	5,09	100	6,00
HUMAN GENETICS	67	5,21	28	2,40	71	3,88	8	1,95	56	3,70	27	3,13	34	2,04
OBSTERTICS AND GYN.	10	0,78	16	1,37	25	1,37	20	4,88	47	3,10	19	2,20	239	14,35
HEMATOLOGY	40	3,11	21	1,80	106	5,79	14	3,41	226	14,92	51	5,90	44	2,64
NMUNOLOGY	71	5,52	19	1,63	169	9,23	11	2,68	166	10,96	107	12,38	69	4,14
MICROBIOLOGY	204	15,85	74	6,33	285	15,57	29	7,07	79	5,21	96	11,11	163	9,78
NEFROLOGY	30	2,33	5	0,43	74	4,04	9	2,20	41	2,71	29	3,36	34	2,04
NEUMOLOGY	15	1,17	5	0,43	27	1,48	6	1,46	29	1,91	11	1,27	30	1,80
NEUROLOGY	44	3,42	9	0,77	141	7,70	13	3,17	101	6,67	58	6,71	81	4,86
OFTALMOLOGY	9	0,70	0	0,00	22	1,20	49	11,95	0	0,00	6	0,69	42	2,52
ONCOLOGY	60	4,66	58	4,96	75	4,10	9	2,20	45	2,97	42	4,86	72	4,32
OTORRINOLARINGOLOGY	5	0,39	1	0,09	17	0,93	2	0,49	9	0,59	4	0,46	8	0,48
PEDIATRICS	122	9,48	198	16,94	72	3,93	31	7,56	59	3,89	28	3,24	144	8,64
PSICHIATRY	59	4,58	97	8,30	28	1,53	9	2,20	66	4,36	18	2,08	28	1,68
PUBLIC HEALTH	195	15,15	360	30,80	105	5,74	60	14,63	102	6,73	26	3,01	100	6,00
SUBTOTAL	1287	100	1169	100	1830	100	410	100	1515	100	864	100	1666	100
OTHERS	322		392		283		195				68		64	
TOTAL	1609		1561		2113		605		1515		932		1730	

SOURCE: La Producción Científica Latinoamericana en Biomedicina, Centro de Información Científica y Humanística, UNAM, Mexico, Dec. 1989. (*) Data Bases icluded in previous Table.

VIII- PROJECTS; RESEARCHERS; GRADUATE COURSES; SCIENTIFIC PRODUCTION.

The classification by subjects and disciplines provides the basis for the tables relating the proportions for projects, researchers, graduate courses and scientific production. The next Tables (6 and 7) present these by subject (BIREME) and by discipline (UNESCO). In the case of subjects, production is included according to the BIREME classification of "presence of terms" (which means one article can be present many times if classified according to several terms) and terms refer to contents of Venezuelan journals (which may include contributions by non-Venezuelans) as well as publications by Venezuelans in journals of other countries.

As may be seen, there seem to be important differences in the presence of subjects in each of the different types of activities. There are situations where the number of graduate courses seems to be to too small in relation to the number of projects, and others where the number of courses does not seem to be backed by proportionate presence of projects or researchers. Production (with the restrictions mentioned above), presents a similar situation.

This last group of indicators summarizes the different dimensions of research on health and may serve as a more complex, interrelated profile of what "is going on" in the field, what potential may be not used enough, and what groups may be overburdened and should receive more support.

FINAL COMMENTS

Complex and single indicators used as a set provide a relatively simple approach to a more adequate identification of profiles of research in scientific and technological fields.

Indicators used in this project demonstrate that the use of any single ones cannot provide an adequate "profile" of health research. The use of "complex indicators" (a set of single ones), seems a better solution than an "index" representing the aggregation of different elements or single indicators.

The quality, or even possibility of existence of adequate indicators for Science and Technology in Venezuela, requires new efforts in the construction of data bases that may provide the elementary components of existing activities that may serve as the basis for more efficient and pertinent complex indicators.

On the other hand, if the trends described are going to be used in the design of scientific policies, it is important to consider the near future trying to imagine what the situation could be. Research activities supposedly made up mainly by women, a lack of significant organization for scientific production, and a restricted potential, should drive the public and private agencies to develop a different policy than just one that considers mainly the financial and

Table 6. Graduate courses, projects and researchers classified by bireme categories and some of the relationships between them, Venezuela, 1990.

	GRAD. COURSES		PROJECTS		RESEARCHERS	
BIREME CATEGORIES	N	%	N	%	N	%
ANATOMICAL TERMS	18	6,47	153	8,61	215	9,10
ORGANISMS	0	0,00	136	7,66	190	8,04
DISEASES	116	41,73	389	21,90	506	21,42
CHEMICALS AND DRUGS	3	1,08	192	10,81	220	9,31
MEDICAL INSTRUMENTS	75	26,98	319	17,96	404	17,10
PSYCHIATR. AND PSICHOL.	12	4,32	33	1,86	51	2,16
BIOLOGICAL SCIENCES	38	13,67	379	21,34	536	22,69
PHYSICS	0	0,00	9	0,51	17	0,72
ANTHROP.EDUC.SOCIAL Sc.	0	0,00	33	1,86	44	1,86
TECNOL.IND.AGR.FOOD	7	2,52	65	3,66	76	3,22
HUMANITIES	0	0,00	2	0,11	2	0,08
INF.AND COMMUNIC. Sc.	0	0,00	9	0,51	14	0,59
NAMED GROUPS OF PEOPLE	0	0,00	11	0,62	16	0,68
HEALTH CARE	9	3,24	46	2,59	71	3,01
TOTAL	278	100	1776	100	2362	100

BIREME CATEGORIES	GRAD. COURSES PER PROJECTS	GRAD COURSES PER RESEARCHERS	PROJECTS PER RESEARCHER
ANATOMICAL TERMS	0,75	0,71	0,95
ORGANISMS	0,00	0,00	0,95
DISEASES	1,91	1,95	1,02
CHEMICALS AND DRUGS	0,10	0,12	1,16
MEDICAL INSTRUMENTS	1,50	1,58	1,05
PSYCHIATRY AND PSICHOL.	2,32	2,00	0,86
BIOLOGICAL SCIENCES	0,64	0,60	0,94
PHYSICS	0,00	0,00	0,70
ANTHROP.EDUC.SOCIAL Sc.	0,00	0,00	1,00
TECNOL.IND.AGR.FOOD	0,69	0,78	1,14
HUMANITIES	0,00	0,00	1,33
INF.AND COMMUNIC. Sc.	0,00	0,00	0,85
NAMED GROUPS OF PEOPLE	0,00	0,00	0,91
HEALTH CARE	1,25	1,08	0,86

SOURCE: Proyecto ISVEN. CENDES. Caracas, 1990. Preliminary Results.

Table 7. Graduate courses, projects and researchers by disciplines (UNESCO) and some relationships between them, Venezuela, 1990.

	GRAD. COURSES		PROJECTS		RESEARCHERS	
DISCIPLINES	N	%	N	%	N	%
MATHEMATICS	0	0,00	3	0,17	4	0,17
PHYSICS	0	0,00	6	0,34	11	0,47
CHEMISTRY	2	0,72	106	5,97	194	8,21
SCIENCES OF LIFE	35	12,54	590	33,22	890	0,88
AGRICULTURAL Sc.	8	2,87	50	2,82	37	1,57
MEDICAL SCIENCES	212	75,99	835	47,02	1011	42,80
TECHNOLOGICAL Sc.	15	5,38	104	5,86	95	4,02
PLANNING	3	1,08	2	0,11	3	0,13
ANTHROPOLOGY	0	0,00	3	0,17	4	0,17
DEMOGRAPHICS	0	0,00	23	1,30	31	1,31
ECONOMICAL Sc.	1	0,36	5	0,28	2	0,08
POLITICAL SCIENCE	0	0,00	6	0,34	7	0,30
PSYCHOLOGY	3	1,08	20	1,13	24	1,02
SOCIOLOGY	0	0,00	22	1,24	48	2,03
ETHICS	0	0,00	1	0,06	1	0,04
TOTAL	279	100	1776	100	2362	100

BIREME CATEGORIES	GRAD. COURSES / PROJECTS	GRAD. COURSES / RESEARCHERS	PROJECTS / RESEARCHER
MATHEMATICS	0,00	0,00	1,00
PHYSICS	0,00	0,00	0,73
CHEMISTRY	0,12	0,09	0,73
SCIENCES OF LIFE	0,38	0,33	0,88
AGRICULTURAL Sc.	1,02	1,83	1,80
MEDICAL SCIENCES	1,62	1,78	1,10
TECHNOLOGICAL Sc.	0,92	1,34	1,46
PLANNING	9,55	8,47	0,89
ANTHROPOLOGY	0,00	0,00	1,00
DEMOGRAPHICS	0,00	0,00	0,99
ECONOMICAL Sc.	1,27	4,23	3,32
POLITICAL SCIENCE	0,00	0,00	1,14
PSYCHOLOGY	0,95	1,06	1,11
SOCIOLOGY	0,00	0,00	0,61
ETHICS	0,00	0,00	1,33

SOURCE: Proyecto ISVEN. CENDES. Caracas, 1990. Preliminary Results.

administrative aspects. Is it possible to bring together researchers of varied fields, to define priorities, and work as teams? Would the researchers oppose this initiative because of the necessary freedom of the scientist?. Scientific policies are not easy to implement because they are related, not only with the groups' interests, but also with the social needs and demands and the whole country's political future as well as with the broader political forces that play prominent roles in Venezuelan society.

THE MEASUREMENT OF NATIONAL SCIENTIFIC AND TECHNOLOGICAL POTENTIAL FOR POLICY-MAKING PURPOSES

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ABSTRACT

The concept of "national scientific and technological potential" originated within the Science and technology policy division of UNESCO in the early sixties. Il was gradually developed and made operational by actual surveys there of in a number of volunteer countries. The data collected through precoded questionnaires administered to the heads of Research and Scientific service units gave rise to computerized data bases whose processing and analysis made it possible to produce the most essential "indicators" needed by policy-makers in the field of science and technology. The paper discusses the main steps of this process, the listings that can be obtained from the survey data, the principal indicators to be derived there from as well as the major statistical analyses which may be carried out.

RESUME

Le concept de "potentiel scientifique et technique national" a été conçu au début des années soixante par la division des politiques scientifiques et technologiques de l'UNESCO. Il est devenu opérationnel à la suite d'enquêtes effectuées dans plusieurs pays volontaires. Les données collectées à partir de questionnaires précodés ont été stockées dans des bases de données informatisées à partir desquelles ont été produits les principaux indicateurs nécessaires aux décideurs politiques du domaine de la science et de la technologie. Cet article présente les principales étapes de ce processus, les listes de données que l'on peut obtenir de l'enquête, les principaux indicateurs et analyses statistiques qui en découlent.

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I. ROLE OF THE NATIONAL SCIENTIFIC AND TECHNOLOGICAL POTENTIAL (STP) SURVEY (*)

The National Scientific and Technological Potential (STP) survey is primarily a policy-making and management tool in the area of Research (R&D) and Scientific and Technological Services (STS) at the national level. The data base generated and periodically updated by the survey includes : (i) numerical data (commonly known as science statistics and obtained by direct quantification) and (ii) descriptive or nominal (ie. administrative, functional, structural or qualificatory) data obtained by descriptive analysis.

These exclusively factual-numerical and descriptive-data cover all of the country's R&D and STS units and are deliberately restricted to the basic data characterizing the resources of national R&D and STS systems, namely their human, financial, physical (material base) and informational resources.

The Survey also includes data on the organization of the country's national R&D ans STS systems, and on scientific activities (R&D and STS) in progress in its component units.

II. UNESCO NATIONAL STP SURVEY METHODOLOGY AND DESCRIPTION OF THE SURVEY QUESTIONNAIRES

The STP Survey collects information from respondents at four levels of responsibility :

1. First level : the identification questionnaire (N°0)
is addressed to the controlling authorities of the Ministries and organizations (*) to which the S&T units to be surveyed belong.

2. Second level : the questionnaire on the S&T Units (N°1) Part I
is addressed to the Head of each Unit. The general section contains questions regarding the identity of and the place occupied by the S&T Unit in the body or institution of which it is a part, the year of foundation of the Unit, its legal status and the type of S&T activities it carries out.

Part II contains questions on the number and rotation of the personnel of the Unit : scientists and engineers, technicians and auxiliary personnel.

Part III concerns financial resources : it contains questions on the sources from which S&T activities are financed and the nature of the Unit's expenditure, intramural (current expenditure, including staff costs and capital expenditure), also extramural expenditure.

(*) This paper is based on the Unesco methodology for surveying the national scientific and technological potential (STP) which was developed, field-tested ans published by the Organization.

(*) Including public and private production enterprises.

Part IV concerns the physical resources (material base) of the Unit : buildings, land, equipment and computers.
Part V concerns informational resources and activities ; this includes books, periodicals ans microfiches and the Scientific and Technological Information and Documentation (STID) Services used by the personnel of the Unit.
3. Third level : Questionnaire N°2 is addressed to the principal person in charge of each R&D project or STS activity which is carried out in the S&T Unit.
The general section contains questions on the following aspects of each R&D project or STS activity : title, objectives, discipline concerned, target group, state of progress, geographical bearing, staff, budget, duration and evaluation dates.
The section reserved for projects concerns the type of research carried out and the likelihood of achieving the assigned objectives.
4. Fourth level : Questionnaire N°3 is completed by the scientific staff (scientists and engineers) of the S&T unit.
Part 1 contains questions on the individual scientists and engineers of the Unit : their training, age, field of competence, legal status of employment, level of responsability and an estimation of their time allotment.
Part II is devoted to scientific researchers and seeks more information on their qualifications, professional experience, function in the Unit and seniority in R&D activities. Information is also sollicited concerning R&D products, such as books, articles and other publications as well as Ph.D. thesis.

III. INDICATORS DERIVED FROM THE NATIONAL STP SURVEY

One of the constant of Unesco is to bring the National Surveys of Scientific and Technological Potential of its Member States into line with the need of each Member State to make international statistical comparisons of scientific and technological development possible. There are two basic approaches to the derivation of indicators :
a) The static approach which involves the analysis of a situation at a specific point in time, and, a variant of this approach, the chronological or historical approach in which the analysis leads up to, and ends at a given out-off point ; this is the approach adopted in the present paper.
b) The dynamic approach which involves research and extrapolation on the basis of current trends and the projection of plans for the future. This approach is of special interest to planners.

The data obtained in the National STP Survey can be used to construct indicators to assess the status and the evolution of national scientific and technological development policy in a given country. These indicators measure both STP development level and STP structure.

A. Indicators of STP development level

These indicators measure the level of development of research (R&D) and scientific and technological services (STS) of a country in terms of the human, financial and informational resources and buildings assigned to them.

1. Indicators of human resources

a) The number of scientists and engineers and the number of technicians and auxiliary personnel engaged in S&T (R&D + STS) activities in a country. This indicator measures the actual capability of a country in terms of the scientific and technological staff who are engaged in these activites.

b) Number of scientific researchers (scientists and engineers and research technicians. This indicator measures the R&D potential of a country. It is usually expressed in Full-Time Equivalent (FTE) units, at least in the case of research scientist.

c) Number of research technicians per scientific researcher. This indicator measures how much assistance is provided to scientific researchers.

d) Number of scientific researchers (R&D) as a percentage of all scientists and engineers engaged in S&T (R&D + STS) activities. This indicator measures the relative weight of R&D and STS activities in a given country.

e) Number of teaching researchers as a percentage of the total number of scientific researchers in higher education and the overall number of scientific researchers in the country. These indicators measure the relative importance of R&D in higer education and the extent of the symbiosis between R&D activities and higher education in a country.

f) Number of scientific researchers per 10,000 inhabitants. Data on the ratio of scientific researchers to the population of a country are useful for making international comparisons. This indicator measures the R&D effort of a country in relation to its population. Ratios indicating the "density" of scientific and technological personnel in a country are widely considered to be among the most important indicators of the level of its development.

g) All scientific researchers : (i) by age group; (ii) by nationality; (iii) by sex.

- Age-group distribution is and indicator which may be used in trend forecast of the total number of scientific researchers of a country.
- Nationality distributions provide information on the foreign contribution to R&D in a country (proportion of foreign scientific researchers to all scientific researchers of a country).
- Sex distributions provide useful information on the access of women to scientific research careers.

2. Indicators of financial resources

These indicators are expressed in monetary units (national currencies and/or US dollars). The original figures are most often given in national currencies. For the purpose of international comparisons, the data have to be converted into a standard unit, which is most often the United States dollar, using official rates of exchange.

a) Intramural R&D expenditure (national R&D expenditure). This indicator measures the financial support which a country gives to R&D activities. For the purposes of international comparison, intramural R&D expenditures are expressed : (i) as percentages of GNP; (ii) as percentages of GDP; (iii) as percentages of national income.

b) Intramural R&D expenditure per scientific researcher. This indicator measures the material conditions (expenditure on personne, supplies and equipment) in which research scientists carry out their R&D work. This indicator is more significant when expressed by groups of major disciplines. (*)

c) Intramural R&D expenditure per inhabitant. This indicator measures the effort devoted to R&D activities in relation to the population of a country.

d) Ration of capital to current expenditure on R&D. This indicator roughly measures the pace of modernization of the scientific and technological research plant of a country.

e) Ratio of expenditure of staff to total current expenditure on R&D. As this indicator approaches 100 per cent it signifies that scientific researchers do not have the means to carry out their work and that, accordingly, their work is likely to be quite ineffective.

f) Intramural R&D expenditure as a percentage of the total intramural expenditure on all S&T (R&D + STS) acitivities. This indicator measures the extent of the national financial outlay of a country on R&D in relation to its STS activities.

3. Indicators on buildings and informational resources

a) Usable laboratory floor space (in m2) per scientific worker (scientists and engineers). This indicator measures the work space assigned to scientific workers for the execution of their S&T (R&D + STS) activities.

b) Usable laboratory floor space (in m2) as a percentage of total usable floor space (laboratories and other premises). This indicator measures the importance which laboratories occupy in relation to the total building resources assigned to the S&T activities of a country.

c) Average number of books possessed and individual periodical subscriptions taken out per S&T unit. This indicator measures the volume of scientific and technological documentation placed at the disposal of the scientific workers of a country, and is major factor in the effectiveness of their work.

4. Other indicators

a) Average size of S&T Units. This indicator measures the average manpower strength of S&t units. It is usefully broken down into scientists and engineers, technicians and auxiliary personne.

(*) The two-digit level of Unesco's proposed international standard nomenclature for fields of science and technology (Document UNESCO/NS/ROU/257 rev. 1).

b) Average number of R&D projets per unit. This indicator measures the distribution of efforts and the extent of teamwork in research units.
c) Average annual number of meetings in the country and abroad attended by scientific researchers. This indicator measures the effort which a country devotes to the national and international exchange of experience between scientific researchers ; it measures the extent of the oral and firsthand scientific and technological information to which a country's scientific researchers have access.
d) Average seniority of scientific researchers in R&D. This indicator measures the average length of R&D experience of the scientific researchers of a country.
e) Average age of scientific researchers. This indicator can be used to monitor the ageing (or the rejuvenation) of the scientific researcher population of a country, and, through the construction of chronological series, to make trend forecasts in this connection.
f) Average number of patents registered per scientific researcher.

B. Indicators of STP structure

Because these indicators are both quantitative and qualitative in nature, they provide a better understanding of the orientation of the S&T policy of a country.

1. Human resources
a) Number of scientific researchers per discipline (fields of current employment). This indicator identifies the most highly developed disciplines that are in a given country, and can be used to compare the deployment distribution of research personnel with the priority distribution of the various disciplines with regard to the socio-economic development objectives of a country. (*)
b) Percentage of scientific researchers whose degree (highest and/or last degree) corresponds with their field of current employment. This indicator measures the extent to which training matches the deployment of scientific researchers in the major S&T fields or disciplines.
c) Distribution of scientific researchers by sector of performance. This indicator can be used to measure the distribution of the R&D work force according to the three sectors of performance (Higher education, General service and Production enterprises).
d) Distribution of scientific researchers by the type of activity in which they are engaged (in percentage of time). This indicator identifies the type of activity in which scientific researchers are engaged : R&D, STS, STET. (**)

(*) See on this subject n°40 in the Unesco series Sciences Policy Studies and Documents (SPDS) entitled "Method of priority determination in Science and Technology".
(**) STET = Sciences and Technology Education and Training.

2. Financial resources

a) Intramural R&D expenditure by sector of performance. This indicator measures the respective weight of the three performance sectors (Higher education, General service and Production enterprises) in the research effort of a given country.

b) Intramural R&D expenditure by type of research. This indicator measures the distribution of national effort by type of research (basic, applied, experimental development).

c) Intramural expenditure on R&D projects by source of funds. This indicator measures the extent to which the financing on R&D activities is dependent on each source of funds, the three principal sources of funds being the State, Production enterprises and Foreign Sources. This indicator is particulary important in the case of developing countries because it shows the extent to which these countries are dependent upon foreign aid.

d) Funds allocated to R&D activities by S&T discipline. This indicator can be used to identify the way the financial effort of a given country is allocated to various disciplines and to compare this distribution pattern with the performance of the same disciplines in support of national socio-economic development goals. (This is similar to the indicator of the number of research scientists per discipline - cf B/1/a above).

e) Funds allocated to R&D activities by socio-economic objectives. This indicator is used to determine the weight given to the promotion of each of the thirteen major R&D goals identified by Unesco (see Annex 1) and to determine to what extent the objectives receiving the most funds coincide with the priority socio-economic goals of national development plans.

In conclusion, the indicators thus defined serve to identify the structural imbalances and lack of coordination that can characterize the deployment of the research effort of a given country. For example, a given country may have a low indicator of R&D expenditure along with a high indicator of R&D manpower ; this is the case in countries where R&D is ineffective for lack of funds. In another example, certain indicators may identify the bottlenecks and the inadequacy of the national R&D effort in certain R&D disciplines or sectors of performance in relation to national socio-economic development needs.

IV. STATISTICAL ANALYSES BASED ON THE STP SURVEY DATA 2 (COMPOSITE INDICATORS)

Statistical analyses of the STP data involve the transformation of the primary data contained in the STP date base grouped together according to the type of resources which characterize a national R&D and STS system : human, financial, physical and informational resources

The primary data used for these statistical analyses are identified by references to the running numbers of the questions in the survey questionnaires (Q1, Q2, Q3). Each section contains the following headings : the aim of the analysis, the table(s) corresponding to the analysis and how to draw up this/these table(s).

A. Utilization of data relating to human resources

These data are collected at the level of the S&T Unit, at the level of the R&D project or the STS activity and at the level of the scientific worker.

1. Number of personnel in the R&D and STS System (Scientits and Engineers) (SE), technicians and auxiliary personnel by type of institution to which the units belong, by sector of performance and by economic sector.

By means of this analysis it is possible (i) to determine the distribution of scientific workers and technicians (total number and full-time equivalent) engaged on R&D and STS by type of institution and by sector of performance in the national R&D and STS system ; and to determine the total number of auxiliary personnel in the system; and (ii) to determine the trends in the development of these various groups, the scale of which may be assessed on the basis of the statistical series covering several years.

The data required for the completion of these tables are obtained by aggregating the data collected from Questionnaire n°1 only.

2. Number of S&T units and average number of scientific workers and technicians by unit, by type of institution and by sector of performance. The aim of the analysis is to obtain the average size of the S&T unit by type of institution and by sector of performance.

The date required for the completion of this table are obtained from Questionnaire n°1.

3. The number of R&D projects and the average number of scientific researchers and technicians by R&D project on a full-time basis in full-time equivalent by type of institution and by sector of performance. This analysis provides the distribution of personnel assigned solely to R&D projects in absolute numbers and in full-time equivalents, as well as their average number by research project. It also reveals the technical support supplied to researchers participating in R&D Projects and the auxiliary personnel allocated to them.

4. Distribution of scientists and engineers by type of activities on which they are engaged. R&D : for scientific researchers; STS : for STS personnel; STET : for teacher researchers, by type of institution and by sector of performance on the one hand, and economic sector on the other. The analysis provides the exact number (total in FTE) of scientist and engineers engaged on the three types of activities; R&D, STS and STET. It can also be used to establish significant ratios. These various ratios provide the basis for a sensible policy of symbiosis

and cross-fertilization between R&D on the one hand and STS and STET on the other.

The data required for the completion of these tables are obtained from Questionnaire n°3.

5. Total number of scientific workers (R&D and STS) by major discipline (2-digits level) of their initial training and current employment. The analysis establishes the correspondence between the training and employment of R&D and STS personnel by major S&T field or discipline. It is required by science and technology policy-makers to ensure the sound planning of training for the personnel required for R&D and STS.

The data required for the completion of these tables are obtained from Questionnaire n°3.

6. Distribution of scientific researchers by percentage of time spent on R&D, STS, STET activities, purely administrative tasks and other activities. This analysis identifies the type of activity which takes up most of the time of scientific researchers. It shows up those cases in which scientific researchers spend more time on purely administratve tasks than on R&D, STS or STET activities. An analysis by type of institution provides a factual basis for forecasting the efficiency of R&D in the various sectors of performance.

The data required for the completion of these tables are obtained from Questionnaire 3 and 1.

7. Distribution of scientific researchers by age-group, nationality and sex. The analysis is used to construct an age-pyramid for scientific researchers and provides a significant indicator for estimating future personnel in the field of science and technology (R&D and STS). The distribution by sex provides information about women's access to scientific and technological careers. The distribution by nationality (foreigners and nationals) provides information about international mobility and indicates the proportion of foreigners in the total number of scientific researchers.

The data required for completion of these tables are obtained from Questionnaire n°3.

8. Utilization of data relating to financial resources. These date are collected at the level of the S&T Unit and at the level of the R&D project or STS activity.

B. Utilization of data relating to financial resources

1. Intramural expenditure on scientific and technological activities (R&D and STS) by source of funds, by type of institution, by sector of performance and percentage of total spent on R&D. This analysis provides as assessment of the relative importance of the main sources of funds scientific and technological

activities and it measures : (i) the proportion represented by productive enterprises in total national scientific and technological activities; (ii) the foreign contribution to this effort.

This analysis also provides an estimate of the national R&D obtained from Questionnaire n°1.

2. Intramural expenditure for S&T activities by source of funds and by nature of expenditure for the various types of institutions. This analysis highlights indicators of considerable importance at the national level - by types of institution and sectors of performance - in respect of intramural expenditure on scientific and technological activities : (i) the relative percentage of capital expenditure and current expenditure; (ii) the percentage of expenditure on personnel in current expenditure.

The data required for the completion of these tables are obtained from Questionnaire n°1.

3. Total intramural expenditure on R&D activities by type of institution and by sector of performance as a percentage of GNP, GDP and national income. This analysis identifies the types of institution and sectors of performance which are the largest spenders of the financial resources allocated to R&D. It enables the authorities responsible for national scientific technological policy to orient support for R&D programmes in the light of these data with due regard to national development policy.

The data required for the completion of these tables are obtained from Questionnaire n°1. The figures for GNP, GDP and national income are taken from the annual reports of the World Bank.

4. Total expenditure on R&D projects by type of institution, by sector of performance and by type of research. This analysis provides the basis for an assessment of the distribution of national R&D effort by type of research (basic, applied and experimental development).

The data required for the completion of these tables are obtained from questionnaire Nos Q2 and Q1.

5. Total funds allocated to R&D projects (or STS activities) by main field (discipline) of S&T reduced to two-digit codes. By means of this analysis it is possible to compare the funds allocated (or STS activities) by main fields of S&T and to calculate the ratios for the average cost of a scientific researcher by type of discipline. It can also be used to assess the probability of the achievement of the aims defined in 6 below.

The data required for the completion of this table are obtained from Questionnaires n°2.

6. Total funds allocated to R&D projects and STS activities by socio-economic aims grouped in accordance with Unesco's thirteen aims. By means of this analysis it is possible to determine the importance attached to the advancement of a clearly defined aim. The intented purpose of the national R&D effort may be assessed from the apportionment of public funds.

The data required for the completion of these tables are obtained from Questionnaire n°2.

C. Utilization of date relating to buildings and land

1. The surface areas in sq. metres of the premises and the area in ha. of the experimental stations by type of institution and by sector of performance. This analysis provides indicators for the usable laboratory space per scientific worker (scientists and engineers) according to the types of institutions. A second series of useful indicators is obtained by calculating for the type of institution the relationship between usable laboratory space (laboratories and other premises) for each type of institution and by sector of performance.

The data required for the completion of these tables are obtained from questionnaire n°1.

D. Utilization of data relating to informational resources

1. Distribution of Scientific and Technological Information and Documentation (STID) Centre and average number of their informational resources by type of institution and by sector of performance. The aim of this analysis is to locate the sectors of performance and types of institutions where STID Centers are situated and to determine their size.

The data required for the completion of these tables are obtained from questionnaire n°1.

2. Distribution of libraries and their average number of informational resources by type of institution and by sector of performance. The aim of this analysis is to locate the sectors of performance and types of institutions where libraries are situated and to determine their size.

The data required for the completion of these tables are obtained from questionnaire n°1.

References

1. National Scientific and Technological Potential (STP) Survey, n°67 in the UNESCO Series. "Science Policy Studies and Documents" Paris. 1990 (Exists also in French). Second enlarged and fully computerized edition of the methodology first published in 1965 under n°15 in the same UNESCO series.

2. A field-test application of the statistical analyses described in this paper relates to the countries of the member States of the Community of West African States (C.E.A.O.) which was published jointly by UNESCO and UNDP (1986) in "Le potentiel scientifique et technologique de la Communauté des Etats de l'Afrique de l'Ouest".

Annex

Objectives of aims ot the S&T activities (*)

National activities in R&D and STS should be classified by major socio-economic aims objectives as listed below, on the basis of funding (ex-ante) or expenditure (ex-post) financed from public funds and, if possible, from all other sources of funds.

i) Exploration and assessment of the earth, sea and atmosphere
ii) Outer-space (civil)
iii) Development of agriculture, forestry and fishing
(iv) Promotion of industrial development
(v) Production, conservation and distribution of energy
vi) Development of transport and communication
vii) Development of education services
viii) Development of health services
ix) Social development and other socio-economic services
x) Protection of the environment
xi) General advancement of knowledge
xii) Other aims
xiii) Defence.

(*) Source : Recommendation concerning the International Standardization of Statistics on Science and Technology. Twentieth session of the General Conference of Unesco, Paris, 27 November 1978.

LES ENJEUX EN MATIERE D'INFORMATION SCIENTIFIQUE ET TECHNIQUE DANS UN PAYS EN DEVELOPPEMENT LE CAS DE MADAGASCAR

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RESUME

Trois années après la création du CIDST (Centre d'Information et de Documentation Scientifique et Technique), cet article dresse le bilan des réalisations et en tire les leçons pour l'avenir.

ABSTRACT

Three years after the creation of CIDST (Technical and Scientific Information and Documentation Center, this article presents the achievements and draws the lessons for the future.

INTRODUCTION

Depuis 1984, Madagascar a de nouveau marqué sa volonté d'aller de l'avant pour mettre la science au service du développement par la mise en place du Ministère de la Recherche Scientifique et Technologique pour le Développement (MRSTD), dont les premières activités ont abouti à la restructuration et au renforcement des anciens organismes de recherche et à la création de nouvelles institutions de recherche visant à cerner de plus en plus les besoins vitaux de la population.

Au nombre de priorités fixées alors, des enquêtes, études, inventaires ont été menés sur la situation de l'IST à Madagascar, des objectifs nouveaux ont été définis et les efforts ont conduit à la création du Centre d'Information et de Documentation Scientifique et Technique (CIDST) en Mai 1987[1].

Le programme de mise en place de ce Centre est à la fois inscrit dans la politique générale de l'Etat et entre dans le cadre des Programmes d'investissements publics et des Programmes intégrés de recherche pour le développement. Dans ce cadre, l'IST permet de rentabiliser l'utilisation du potentiel existant en matière scientifique et technique et de diffuser les résultats de la recherche.

Des moyens importants sont mis a la disposition du CIDST tant du point de vue du financement que des moyens humains. Le budget de fonctionnement du CIDST en 1990 représente environ 8% du budget total du MRSTD. Sur 80 agents, on note une vingtaine de cadres de niveau supérieur dans diverses disciplines.

Le CIDST s'est doté d'une structure destinée à répondre aux objectifs qui lui ont été assignés. Il ne travaille pas seul, mais collabore avec d'autres institutions notamment dans le cadre de réseaux documentaires fonctionnels depuis 1989. Enfin, il forme également ses utilisateurs.

EXPERIENCES

Après trois années de fonctionnement, le CIDST peut-il aujourd'hui parler de ses expériences? Jusqu'en Juillet 1990, 6487 ouvrages ont été enregistrés, 724 rapports, 1433 thèses et 710 titres de périodiques. Près de 2000 microfiches de travaux réalisées par les organismes (ORSTOM-CIRAD-BDPA)[sont en attente. De nombreux produits documentaires ont été réalisés (Répertoire des chercheurs, bulletins bibliographiques, divers catalogues). En plus de ces produits documentaires, le Centre édite et publie les périodiques suivants:

- Recherches pour le développement (série sciences de l'homme et de la société, série sciences biologiques, série sciences technologiques);
- Le journal du chercheur;
- Archives de Centres nationaux de recherche.

De nouvelles collections sont en préparation pour paraître cette année: Collection scientifique de Madagasikara et Collection Médecine.

Environ 17000 références sont disponibles dans la Banque de données, portant sur le fonds CIDST et ceux des Unités documentaires inventoriées. Le CIDST fournit également des prestations de service: Informatisation d'unités documentaires de ministères et d'institutions de recherche, reclassement de fonds, formation en informatique documentaire

Au niveau des utilisateurs, la demande ne cesse de s'accroître. L'éventail des sujets concerne principalement les sciences agricoles (27% de la demande, techniques de cultures comme le riz, blé, maïs..., apiculture, oviculture, alimentation animale, technologies alimentaires, technologies appropriées), les sciences sociales (24%, gestion de l'entreprise, marketing, création ou rentabilisation des PME-PMI), les sciences technologiques (20%, technologie chimique, huiles essentielles, energies renouvelables, informatique, technologie des matériaux), les sciences biomédicales (15%, maladies infectieuses -paludisme, SIDA-, plantes médicinales, pharmacologie) et les statistiques (13,5% de la demande exprimée).

Le souci constant des utilisateurs est d'avoir des informations, des données immédiatement exploitables. Dans cette perspective les cadres du CIDST ont fourni un travail supplémentaire en collectant les informations auprès des Centres de documentation, services ministériels, entreprises, sociétés, artisans ou auprès de personnes privées. Ces enquêtes ont permis l'élaboration de fiches techniques ou des statistiques.

La constitution de références bibliographiques a connu un regain d'activité. A cela s'ajoute la diffusion sélective de l'information et l'interrogation de banques de données à l'extérieur à partir du Minitel dont dispose le Centre. L'expérience acquise pendant la constitution du Fichier central confirme la nécessité d'une collaboration avec les autres centres d'information spécialisés de Madagascar. La réalisation de cette coopération permettrait de concevoir un véritable réseau d'IST dans lequel le CIDST jouerait le rôle de coordonnateur. Une charte du réseau, définissant les procédures communes et les responsabilités respectives, a été établie et a permis le démarrage des activités en coopération : le réseau multidiciplinaire MIREMBY, des réseaux spécialisés (MAMPITA sur les sciences agricoles, BETAFITA sur les sciences technologiques). D'autres réseaux sont en cours de constitution, comme le réseau en sciences sociales et le réseau en sciences biomédicales.

Les réseaux sont constitués dans le but de faciliter l'accès des chercheurs à l'IST. Les informations suivantes, à titre d'exemple ont déjà été fournies par le CIDST: références et synthèses bibliographiques sur le paludisme, sur les techniques appropriées appliquées à Madagascar par secteur thématique, sur les problèmes liés aux sources et à l'exploitation de l'énergie (énergie solaire, foyers améliorés, biogaz), sur les actions sur le développement menées à Madagascar pendant une période déterminée. Les activités des différents réseaux malgaches sont menées à bien en suivant les résultats et l'expérience obtenus dans le cadre d'autres proiets internationaux de systèmes et réseau: d'IST comme PADIS, AGRIS, INFOTERRA et INTIB.

Le dernier volet est consacré à la formation des utilisateurs du système. Face à une situation nouvelle et surtout à des ressources encore mal connues et sous exploitées, le Centre estime urgent et prioritaire de former et familiariser ces utilisateurs avec son système d'IST, dont l'exploitation doit être développée pour justifier les importants moyens humains et financiers investis. C'est ainsi qu'un programme continu de formation et de sensibilisation des utilisateurs est poursuivi depuis 1988. Une autre démarche a été adoptée pour sensibiliser et familiariser les chercheurs en sciences sociales avec les structures du CIDST: quatre ateliers ont été créés pour permettre des échanges entre chercheurs sur les domaines suivants: urbanisme et santé; expression, pouvoirs et développement; écosystèmes et sociétés humaines ; environnement urbain ; problème fonciers.

LES BESOINS DU PAYS

Le bilan des activités du CIDST fait apparaître des réalités nouvelles, des besoins nouveau. En effet, le pays est aujourd'hui en phase de mutation économique, politique, sociale, scientifique et technologique. Cette mutation a engendré une volonté certaine de mesurer les acquis en particulier ceux de la recherche. Des synthèses, des guides, des inventaires touchant divers secteurs ont été élaborés, émanant d'organismes très divers et transparaissant à travers les quelques titres parus ces deux dernières années (voir encadré ci-dessous). Les demandes exprimées au sein du CIDST confirme cette phase de mutation: 13,5% de celles-ci sont axées sur des données brutes immédiatement exploitables.

Recensement national de l'agriculture et système permanent des statistiques agricoles.
Recensement national des établissements et enquêtes préliminaires sur l'emploi.
Répertoire du personnel des organisations participant aux programmes des Nations Unies-RDM
Etude sectorielle : population.
Etude de la flore forestière
Enquêtes entomologiques préliminaires aux environs d'Antananarivo, Mahatsinjo, Marovoay.
Annuaire et Guide des affaires
Annuaire des compétences nationales au niveau des bureaux d'études des cabinets d'expertise comptable d'audit et de conseil en gestion a Madagasikara.
Annuaire national de la République Démocratique de Madagasikara.
Guide d'application du manuel de procédures et de suivi de la comptabilité des crédits de fonctionnement et du Fonds National de développement et d'équipement du budget géné ral de l'Etat.
Les artisans recensés à Madagasikara
Inventaire des ONG à Madagasikara
Inventaire des ressources naturelles
Inventaire de la documentation disponible a Madagasikara
Projets de coopération bilatéraux et multilatéraux (1980-89)
Evaluation des besoins en cadres halieutiques
Plan directeur de la recherche agricole
Bilan de la recherche agricole
Introduction d'espèces exotiques a Madagascar (inventaire des ressources ligneuses).

Il s'avère donc nécessaire de satisfaire cette nouvelle demande en réalisant des études pour vaincre les velléités de rétention de l'information freinant tout le processus mis en marche. Les statistiques occupent une place prépondérante. Par ailleurs, des utilisateurs se heurtent à la carence de certaines données vitales pour l'application de la science. Un exemple nous est fourni par l'évaluation des technologies du biogaz effectuée par Alain Ranaivosoloarimaralala[2] qui fait

ressortir les difficultés à surmonter pour que la science parvienne aux opérateurs du développement :
-d'une part, la réalisation d'une technologie exige la connaissance des conditions spécifiques dans lesquelles s'appliquera celle-ci. Les critères économiques, sociologiques, géographiques et les matériaux disponibles sur place doivent être pris en considération pour déterminer le choix d'un digesteur pour ce cas précis. Les facteurs technologiques ne suffisent pas toujours.
-d'autre part les expériences faites dans divers pays sont à prendre en considération à titre d'information mais ne doivent pas être copiées aveuglement.

Si la phase de mutation actuelle engendre ce qui a été dit précédemment, elle nous oblige à de nouvelles perspectives.

PEPSPECTIVES

L'IST est une ressource nationale et internationale; le progrès scientifique et technique dépend en grande partie de la maîtrise et de l'accès à cette ressource et de son utilisation efficace, avec l'information économique, sociale et culturelle; elle constitue un facteur primordial d'accélération du développement. Ceci est d'autant plus vrai pour les pays en développement où la recherche doit être axée sur les problèmes auxquels la population est confrontée. Le CIDST doit insister sur sa position et rajouter à sa politique globale les points suivants :

1. Les liens avec les institutions de développement et les opérations de développement doivent être renforcés pour améliorer les échanges d'information, l'identification des problèmes de développement, et la détermination des priorités de la recherche. Cet objectif ne peut être atteint que si les documents produits par ces organismes sont diffusés à grande échelle, et que si les études faites par ces derniers contiennent les données de base déterminantes qui permettent l'action effective.
2. Tout utilisateur d'information doit disposer de statistiques satisfaisantes c'est-à-dire fiables, exhaustives, actualisées: les entreprises, les groupements de paysans, les artisans doivent connaître avec exactitude les paramètres de leur environnement pour pouvoir agir avec efficacité en matière de production, d'investissement, d'emploi. Pour y parvenir, il serait souhaitable qu'une collaboration étroite s'instaure entre les organisations économiques, les entreprises, et les centres d'information. Il s'agit de bannir les réticences qui ont prévalu jusqu'à aujourd'hui.

Pour pallier l'absence de références, de données sur les pays en développement dans les banques de données internationales, il serait souhaitable de reconsidérer les critères de selection, la vision occidentale ne favorisant pas toujours les pays périphériques. En tout état de cause, une nouvelle stratégie devrait permettre d'assister l'utilisateur non seulement en amont de son travail mais également en aval, domaine souvent négligé jusqu'alors: les résultats atteints dans les unités pilotes, à une échelle adaptée au contexte des pays en voie de développement doivent être transformés en projets susceptibles d'être divulgués auprès des petites et moyennes entreprises et industries, et occuper une large place dans les banques de données.

Reférences

[1] Cf. Juliette RATSIMANDRAVA, Valorisation de l'IST à Madagascar, Afrique Contemporaine, La Documentation Française, Paris, no. 151 (1989), p. 76-82.

[2] Alain Ranaivosoloarimaralala, *Etude et évaluation des technologies du biogaz*, Mémoire de DEA Energétique, Antananarivo, 1990.

BIBLIOMETRIC ANALYSIS APPLIED TO A SCIENCE POLICY DATABASE

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ABSTRACT

The bibliographic database on science policy developed at JNICT is briefly described as well as the changes made in its structure in order to be able to use it for bibliometric purposes. The first objective was the management of the collection of periodicals received in the library, However as the work was carried on we realised that it could be interesting to consider the following variables : title of publication, edition language, edition country, corporate source, descriptors and subject code. Though the sample is very limited because we only considered 1,532 articles relating to the perlodicals received in 1987 and 1988, we are confident that future developments can be interesting.

RESUME

Cet article présente la base de données bibliographiques mise au point par le JNITC ainsi que les changements introduits dans sa structure afin de pouvoir l'utiliser dans le cadre d'études bibliométriques. Le premier objectif était la gestion de l'ensemble des périodiques reçus par la bibliothèque. Les variables suivantes ont été définies : titre de la publication, langue, pays de publication, le pays et l'institution de l'auteur ainsi que des descripteurs et des codes par domaine scientifique. Bien que la taille de l'échantillon soit très limitée (1532 références inclues dans les périodiques reçus en 1987 et 1988) nous pensons que des développements futurs peuvent se révèler intéressant. Nous présentons ici les résultats de ce premier essai.

INTRODUCTION

The use of scientific and technical databases for other purposes than the conventional bibliographic search has been very much developed during the last decade. Though the subject oriented searching continues to be considered as the main use of databases it is also true that the manipulation of big quantities of data rendered possible by automated systems enable to perform studies that are practicaly impossible to perform by manual methods. The quantitative analysis of the bibliographic caracteristics of documents - bibliometrics - is one of these studies and for its development the automated databases are a powerful tool (1). Barbara Stefaniak (2) points out the various searchable elements that describe the bibliographic characteristics of the documents referred in a database. "Some of them are subject oriented such as classification codes, descriptors, key words, words in the title, while other features point out the type of publication (e.g. Journal papers, conference papers, books, patents, reports), source (e.g. journal title, country of its editor, ISSN number, patent number, and year of publication, volume number of issue, pages), language of publication, name and corporate affiliation of the authors (name of organization, city, country), as well as data on secondary source (year, volume and number of the abstract)."

Besides these characteristics it is also possible to find lists of references that were cited by the authors of particular papers and this is what makes the difference of the databases developed at the Institute of Scientific Information in Philadelphia. The citation indexes prepared from those lists opened new areas of research in scientometrics - areas dealing with all the quantitative aspects of science of science - which has been very much developed since the publication of Science Citation Index (SCI) in I961 (3). Through the citation analysis and in spite of all criticism involving citations above all when small countries or non English speaking countries are in question (4), many interesting aspects of the science of science have been studied such as science mapping, interdisciplinary relations, detection of new areas of research, the obsolescence of scientitic literature, etc. But it is as a source for the evaluation of scientific production thatthe SCI has been usually used.

The study of science through the analysis of a set of scientific documents contained in a bibliographic database can be made in different directions. HAWKINS (5) described some of them: identification of competing research organizations or authors; comparisons of journal coverage; identification of leading Journals in a given field; finding neglected areas of research.

The identification of the leading Journals in a given field is very interesting in librarianship as it makes easier the management of the library collections. This is the aspect that motivated the study presented in this paper concerning the structure of the database on science policy "C&T" developed at the Scientific and Technical Information Division of the National Board for Scientific and Technological Research. The database contains interdisciplinary information distributed by four main fields :

-scientific and methodological foundations of science and technology policies;
-scientific and technological potential;
-formulation,implementation and monitoring of science and technology policies;
-sectoral science and technology policies.

The database began in 1976 and contains articles of the main journals specialised in the area of science policy, monographs,reports and papers to congresses and expert meetings. The total number of references is around 15.000 from Portuguese, foreign and international origin. The process of automation started in 1987 and the database contains all the documents received since then and also those referring to 1986. For the purpose of the present study were only considered the article of the journals entered in the base during 1987 and 1988, in the total number of 1,532 references distributed by 119 journals.

OBJECTIVE OF THE STUDY

As previously mentioned the first objective was to contribute to a better management of the collection of journals received in the library by knowing the core of journals which contributed the most to the database. But as the work unfolded it was decided to take into consideration other variables taking advantage of the changes that meanwhile have been made in the structure of the base.

METHODOLOGY

The "C&T" database has been developed with the Unesco Mini-micro CDS-ISIS software adapted by Portuguese National Library PORBASE. As that version didn't include some of the variables we were interested to search some changes in the structure of the base have been made and consequently in the input of data But it was also necessary to harmonize some criteria and standardize some data. As a matter of fact the use of the base for bibliometric purposes had not been foreseen before and therefore the detection of some lack of standardization was only possible when the search was needed in certain fields.

The wide variation and great inconsistency that exists in bibliographic databases in representing the same journal titles, author names, corporate organizations etc. is usually taken as a constraint for their easy utilization for bibliometric purposes. Various authors have dedicated their attention to the aspects of harmonization and standardization mainly as far as authors and corporate sources are considered. (6 and 7)

In the definition of the base the most important chance was the introduction of the field corporate source. Considering the experimental phase of our study this field was only fulfilled when it referred to Portuguese authors. The following variables were introduced:

- Title of the publication (TI)
- Edition language (LG)
- Edition Country (OR)
- Descriptor (AS)
- Subject Code (CD)
- Corporate Source: Country of the author (PA)
  Institution (IA)
  Department (DA)
  City (CA)

For descriptors and subject categories we are using the UNESCO Spines Thesaurus (Science Policy Information System).

RESULTS

Dispersion of articles

Journals were ranked according to their decreasing productivity so that the journal relating to science policy and contributing the most articles to the base was ranked in the first place, the journal with the next greatest number of articles was ranked number two, and so on. In the present sample we find that the largest number of articles contributed by a single title was sixty three. On the other hand there were twenty six journals contributing only one article each. We can still observe that 18 journals (15,1%) contributed with half of the articles

Language distribution

Table 1. Language Distribution

Language	Number of articles	%
English	1,036	63,0
French	285	17,3
Portuguese	285	17,3
Spanish	38	2,3

We can observe that more than fifty per cent of the documents are of English origin and that Portuguese has a small share, which as a matter of fact is still smaller because all the documents written in Portuguese are included here. This means that they can stem from any Portuguese speaking country.

Distribution by edition country

When we compare the distribution of country of edition with the distribution by languages we see , as far as Portuguese is concerned, that there is a decrease in the number of documents edited in Portugal since sixty eight of them are edited in Brazil. This confirms the observations made above (Table 2).

Table 2. Distribution by editing country

USA	258
FRANCE	256
HOLLAND	254
PORTUGAL	215
SWITZERLAND	79
BRAZIL	68
OTHERS	505
TOTAL	1635

Corporate source

As previously mentioned this field was created in the scope of the present study. Therefore the input of data concerning the institution,the department and the city of the author was made always when those data were mentioned in the article but only if they concerned Portuguese authors.

Distribution by Spines subject categories

The category BO3 *Scientific and technical information* is the one which is gathering the greatest number of articles We have to admit that this is due to a certain ambiguity that exists in this category because it includes all the theoretical aspects of information science, scientific and technological information, information processing documentation software, factual data and statistics ... etc. (cf. Table 3).

Table 3. Distribution by SPINES Subject categories

SPINES subject categories	No. of articles
A00 - Foundations of S&T policy-making of which Sociology of Science = 96	306
B00 - Science and Technology Ressources of which .Human Ressources = 91 .S&T information = 324	513
C00 - Practice of S&T policy-making of which .Elaboration, implementation and monitoring of S&T policy = 136 .S&T forecasting and assesment = 250 . Organization and management = 227	735
D00 - General content and results of S&T plans, programmes and projects	269
TOTAL	1581

Language distribution by subject category

As an example we show below the language distribution concerning the category A04 *Sociology of Science and Technology* and once again we can see the great representativity of the English language: 73,9%

The total number of articles is 96 distributed as follows

English	71
French	10
Portuguese	13
Spanish	2

Other indicators can be used as for exemple the number of authors by country in each SPINES subject category on the frequency of some descriptors in relation to the journal titles.

Final remarks

According to Moravcsik (8) bibliometric indicators as an evaluation method are less problematic and less questionable when they are applied to big quantities of documents. In the present case we consider that the sample is too small to achieve conclusive results and therefore they must be considered as provisional.

Future developments of the 'C&T' database aiming at bibliometric studies can supply important indicators for decision making concerning the management of library collection of journals. But they can also contribute to a better knowledge of the scientific production in the area of science policy, identify gaps, research groups or research centres

It could also be possible to analyse research trends by following the scientific production in a certain area for a given period of time.

More detailed studies, namely those concerned with co-word analysis would only be possible with the aid of powerful cumputerised means and the support of specialized human ressources. It is a very active research line for example in France and in United Kingdom. It will be very helpful for future oriented and evaluation studies but it is far from our present capacities.

For a small country like Portugal where the representation of scientific production in International databases is not very accurate it seems that the development of local databases enabling the measurement of S&T outputs can be an useful tool for the evaluation of research and for the decision making. It is not the only method but when used with peer review or other evaluation methods, it makes the judgement process much more independent.

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RESEARCH ON CHINA'S SCIENCE AND TECHNOLOGY INDICATORS

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ABSTRACT

This is a brief presentation of China's effort in creating statistics and indicators on science and technology.

RESUME

Cette communication présente de façon synthétique les récents efforts réalisés en Chine pour créer des statistiques et des indicateurs sur la science et la technologie.

1.BACKGROUND

China's economy has been developing steadily and continuously since the Chinese government started to reform and concentrate its main efforts on economic construction since 1979. Soon it has been felt than in order to understand the current situation in China. it would be necessary to create standard statistics. But, at that time, it was difficult to get timely and comprehensive understanding of the current and rapidly changing situation on social, economic, science and technology areas: there existed not enough statistics and no effective methods. Also, it appeared impossible to make any international comparison. We started to solve this problem in 1980. Several basic statistics have been collected throughout the whole country in the last decade, which include:
- the third population census in 1982;
- China's Science and Technology Survey in 1985;
- China's industrial survey in 1986 which also contains an "input-output" table.

On the basis of these surveys and statistics, a periodic survey system or yearly sampling survey system was set up for each of the above statistical series. These laid the foundations for research on China's S&T indicators and the establishment of our information management system.

2. ESTABLISHMENT OF THE INFORMATION SYSTEM ON SCIENCE & TECHNOLOGY (S&T) IN CHINA

Being short of unified national leadership, China's scientific statistics were incomplete before the S&T Survey was performed (1985). Because various departments (Academia Sinica, Educational institutions and various industrial departments) have their own S&T information system set up for their own need, there were no unified statistics and indicators which could be used by all the departments. Most systems were only confined to S&T input. Also there was no standard sets of definitions to be used for the construction of indicators. It proved difficult, if not impossible to make a national comparison, obviously it was impossible to perform international comparisons. Therefore, the single most important step was to set up a unified and complete indicators system for the S&T Survey in 1985, with standard definitions. At the beginning, in order to speed up the process of establishing our own indicator system, the general framework we used was a Input-Activities-Output model, as recommended by UNESCO indicators, and a similar S&T activities classification scheme was applied. But considering China's specific situation, we made some changes and supplements, for example:

A. Planned projects were added into the set of Activities and a project survey table was designed;

B. Based on general industry classifications, specific indicators were designed for new technological industries with strategic importance;

C. Some changes of the R&D classifications were made. The following pattern was used: a. Basic Research, b. Applied Research; c. Experimental Development; d. Engineering Design and Test Production; e. Technological Diffusion and Services; f. Productive Activities.

This survey was finished in 1986 and the results have been published in Chinese, Russian and English. Various analytical reports have been published by many departments and regions. Since this survey, a conventional S&T statistics report system has been set up. Each province had to have its own statistics group which had to supply statistics on its Province. Also a national computer statistics center was established. With the help of the State, S&T Commission, the State Educational Commission and the State Statistics Bureau, we have been performing periodic surveys in R&D institutions attached to government departments, universities, and large or medium sized enterprises. Reports are regularly published.

The State S&T Commission of China started to publish "S&T Statistics Collection" in 1985, which has published recently the 1989 report, and "Statistics on Science and Technology" began to be published in 1986, the 1988 issue being published recently.

3. "CHINA's S & T INDICATORS", 1989.

Entrusted by the State S & T Commission of China, the National Research Center for S & T for Development and Beijing Institute of Information for Management, a research group was created which has the task of editing a report entitled "China's S & T Indicators". This research report gives an objective description of S & T activities, their scale and level in China through carefully selected indicators and reliable data. It reflects the development of China's science and technology and the role science and technology have to play in the progress of our national economy. This report also exmines China's position in science and technology in the world.

The "Indicators" report include six parts:

PART 1. RESOURCE FOR SCIENCE AND TECHNOLOGY

S&T input factors including personnel, expenditures, equipments, information, documentation, etc.

PART 2. ADMINISTRATIVE DEPARTMENTS FOR SCIENTIFIC RESEARCH AND TECHNOLOGICAL DEVELOPMENT

According to the Chinese situation, administrative R&D departments are divided into four parts: government departments, enterprises, universities, and other R&D institutions. This part mainly discusses their respective roles in our national S&T system. For the first time, the S&T information and documentation institutions examined separately, as is required by UNESCO, and statistics on them were independently collected in 1988.

PART 3. BASIC RESEARCH.

PART 4. OUTPUTS OF S & T ACTIVITIES AND THEIR IMPACT ON ECONOMY AND SOCIETY

This part includes the following main topics: important scientific and technological awarded achievements, academic literature output including reports and working papers,patents,technology transfer, technology import and export, trade in technology intensive products, labour productivity, value added of manufacturing industries, etc.

Indicators on the relations between Science, Technology and Society include: education level, average life span, medical conditions, quality of life, environmental protection, etc.

PART 5. POLICIES OF THE CHINESE GOVERNMENT FOR SCIENCE AND TECHNOLOGY

Most scientific research and technological development institutions in China belong to the government departments. Thus, governmental policies will definitely play a significant role. Since 1985, the Chinese government has taken a series of reforms in the Science and Technology areas such as funds allocation, personnel management and the opening and development of the technical market etc.This chapter deals with the content, performance and resultst of these measures.

PART 6. INTERNATIONAL COOPERATION AND EXCHANCE

4. RESEARCH IN RELATION TO THE S & T INDICATORS

During the editing of the "Indicators" report, we felt it necessary to strengthen our research on *output indicators,* such as the number of academic papers and their quoted percentage. We have so far examined the SCI, ISR, ISTP and EI systems and made broad estimations. But the four index systems are not complete, so we are considering enlarging our sources of data. Moreover, difficulties in language and communication in the past years definitely affected the spread of Chinese articles throughout the world. International comparisons were not included in this "Indicators" report, because of data limitations. These issues are examined now and will soon be solved. In addition, research on R&D expenditures is quite complicated in China and more research on this topic is needed.

In1984, research about "total productivity factors " was started in China. The evaluation is made through the residual value method of production functions. Nowadays many people have diverging opinions on the method, and the practical applications of this indicator are not fully supported.

With the development of China's export oriented economy and the increase of technical exchange between China and foreign countries, more people are interested in an international competitiveness indicator. We are doing some research in this field, and willing to cooperate and exchange our views with our colleagues all over the world.

Conférence Internationale sur les INDICATEURS DE SCIENCE POUR LES PAYS EN DEVELOPPEMENT

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Liste des travaux empiriques présentés lors de la Conférence Internationale sur les Indicateurs de Science dans les PED.

Cette liste de travaux tente de formaliser le contenu des principales études empiriques qui ont été présentés en October 1990. Pour chaque type de recherche nous avons tenté d'identifier systématiquement la source utilisée, le ou les pays concernés, la période et les domaines scientifiques couverts. Nous avons tenté d'établir une liste des indicateurs utilisés et de l'objectif de l'étude. Certaines communications donnent lieu à plusieurs fiches, car elles présentent des travaux empiriques différents. Les communications non empiriques ne sont évidemment pas inclues dans cette liste. Malgré son caractère très littéraire, cette recension permet d'entrevoir les tendances dans notre domaine.

Type de travail	**Fiches**
Description de l'effort de recherche d'un pays	8
Méthode	3
Visibilité de la science des pays en développement, soit sur un domaine particulier soit à partir d'une analyse du contenu des bases de données	11
Politique éditoriale des revues scientifiques	2
Stratégies de publication ou de citation des auteurs	6
Evaluation productivité de laboratoires ou d'institutions	3
Evaluation des collaborations scientifiques internationationales	6
Politique de recherche et son impact sur la recherche produite, structuration des milieux scientifiques	4

Comme on le remarquer, la grande majorité des travaux, d'ordre bibliométrique, s'intéressent à la visibilité de tel ou tel domaine. C'était le débat central de la Conférence; c'était aussi le débat de la Conférence de Philadelphie: on ne s'en étonnera donc pas.

Viennent ensuite les travaux qui tentent d'effectuer une description de l'effort de recherche soit d'un domaine, soit encore de l'ensemble d'un pays. Ces travaux sont les plus descriptifs. Plus rares, toujours dans cette même veine, sont les travaux qui traitent des collaborations scientifiques internationales, très difficiles à saisir au niveau des publications finales. Enfin quelques travaux se penchent sur le cas particulier des revues scientifiques. Nous pouvons dire que l'ensemble de ces fiches répertorient une bibliométrie dont le principal utilisateur est le décideur, l'homme politique, les ministres de la recherche ou les responsables des organismes de recherche. Il s'agit dans tous les cas de répondre aux questions: qui fait quoi.

Une très faible part de fiches sont des travaux de recherche de “bibliométriciens”, qui cherchent au contraire à répondre à la question du comment s'effectue la recherche, comment se structure-t-elle, quels sont les déterminants des stratégies de publication ou, de manière plus globale, des stratégies de recherche. Egalement, les travaux de recherche sur les impacts des politiques scientifiques, voir de la politique tout court sur la recherche, sont rares. Il nous semble que ceytte ligne de reflexion doit se renforcer dans le futur. Nous gagnerons en crédibilité à mesure que nous avancerons dans la compréhension profonde des mécanismes qui régissent le fonctionnement des communautés scientifiques. L'effort qui doit être fourni pour convaincre de l'utilité de ces travaux sera bien sûr supérieur que celui pour des travaux plus descritpifs, d'une utilisation plus directe par les décideurs. Mais c'est là un effort essentiel et nécessaire que nous devons faire. En un mot, il faut transfomer notre domaine en véritable domaine de recherche à part entière, et non le considérer comme un simple outil pour les décideurs.

Un rapide examen sur les sources employées est aussi très instructif. Au total, parmi les 39 fiches qui utilisent des données bibliographiques, 21 travaux emploient le SCI ou ses dérivés, mais seuls 6 travaux se limitent au seul SCI. Si le Science Citation Index demeure la source privilégiée, elle n'est plus exclusive. Les biais dénoncés sont maintenant beaucoup plus documentés. La maladie de jeunesse, se traduisant pour certains par un rejet pur et simple du SCI, est dépassée. De nombreux travaux s'effectuent sur la base de listes bibliographiques spécifiques (ou *ad hoc*), de listes de projets de recherche, de bases de données spécialisées. La grande majorité des travaux combinent plusieurs sources: le SCI avec des bases de données ou des bibliographies ad hoc, essentiellement. Il semble donc que le SCI est véritablement utilisé pour effectuer non plus les comptages mais ce qu'il sert à faire le mieux: des analyses de citations, voir des mesures de visibilité internationale (auqeul cas on se limite à une définition restrictive du "mainstream"). Les fiches qui présentent des travaux utilisant des bases de données bibliographiques indiquent aussi que l'on tente de plus en plus à se limiter à une seule base de donnée, quitte à la comparer au SCI (11 fiches indiquent l'utilisation d'une seule base de donnée soit seule, soit conjointement au SCI, et 6 fiches présentent des utilisation simultanées de plusieurs bases de données).

Par contre encore trop peu d'enquêtes sont effectuées. Nous gagnerions probablement à renforcer l'effort de recherche en scientométrie vers des voies peu explorées de l'analyse sociologique, de la sociométrie, de la combinaison de sources différentes, de l'analyse conjointe de données d'input avec celles de l'output. Notons par exemple que personne encore n'a fourni de travaux sur les brevets pour les PED. Serait-ce là le domaine trop exclusif des économistes ? Seules deux fiches traitent de données d'input, et seule l'une des deux est un effort réel d'exploitation intelligente des données. Enfin une seule analyse compare des données bibliométriques avec une évaluation par des experts (et conclue d'ailleurs à l'impossibilité d'évaluer un domaine scientifique hors du mainstream de manière efficace au moyen d'un seul de ces instruments).

Nombre total d'items utilisés comme source d'information

ITEMS UTILISES	Nombre
Bibliographie ad hoc	16
Une ou + Bases de données	17
Science Citation Index	21
Données enquête	7
Données input	3
Evaluation experts	1

Utilisation d'un seul item

ITEMS UTILISES SEULS	Nombre
Bibliographie ad hoc	8
Bases de données	7
Science Citation Index	6
Données enquête	2
Données input	1

Utilisations combinées de deux items

COMBINAISON ITEMS	Nombre
SCI + Biblios ad hoc	4
SCI + Bases de données	8
SCI + Enquête	3
SCI + Input	
Enquête et biblios ou BDD	3

Quant aux indicateurs utilisés il faut noter que les comptages simples de publications prédominent. Les ratios élémentaires sont semblent-il encore la règle, et peu de travaux apportent des innovations en matière de méthode. Là aussi nous avons le sentiment que cela provient de l'usage qui est fait de nos travaux. Dans de très nombreux cas, en voulant répondre vite aux questions des décideurs nous nous sommes très peu interrogés sur les significations sous-jacentes des indicateurs. Parmi les travaux pour le futur, peut-être y a-t-il là matière à un renouveau de notre reflexion. Nous devons, en tout cas, en faire le pari.

STRUCTURATION DES CHAMPS SCIENTIFIQUES, EVALUATION ET CONDITIONS DE DEVELOPPEMENT SCIENTIFIQUE

Auteurs: Thomas
Type: Bibliométrie, évaluation par les pairs, évaluation par un expert, enquête.
Source: 84 projets selectionnés par bases de données, répertoires sur -energie et biomasse et répertoires de recherche, littérature spécialisée, contacts personnels. Enquête par questionnaire.
Pays: Australie, Nouvelle-Zélande, Japon, Thaïlande, Inde, Brésil, Argentine, Costa-Rica, Jamaïque
Période: projets récents
Domaines: production de biomasse végétale
Indicateurs: production totale (articles, conférences et littérature grise). Evaluation par les pairs (notation de qualité, utilité; mention d'équipes de recherche; familiarité déclarée d'une liste préalable d'équipes de recherche au niveau mondial. Correlation publications totales (tous types) avec variables issues du questionnaire: trois corréaltions significatives: expérience internationale, montant du financement, participation à des conférences. Pas de corrélation avec: type d'institution, poste du chercheur interrogé, durée du projet, source de financement, nombre de chercheurs dans le projet, nombre de techniciens, collaboration avce l'industrie, collaboration avec d'autres institutions de recherche, collaboration avec instituts de recherche à l'étranger, utilisation de réseaux de recherche, perception de manque d'équipements, services, pièces de rechange, expertise, information.
Objectif: Evaluer les équipes de recherche sur la production biomasse végétale hors des USA et CEE.

Auteurs: Waast & Gaillard
Type: Enquête sur des projets de recherche
Source: enquête par questionnaire
Pays: France "tropicale" (DOM-TOM)
Période: environ 1985-1990
Domaines: tous domaines
Indicateurs: 19 variables portant sur durée des projets, financement, champs scientifique, type d'institution, nombre de chercheurs par projet, intentions des chercheurs (type de recherche), nombre de publications, de rapports, de communications, formations (étudiants et practiciens), formulation de recommandations, utilisation des recommandations, coopération avec acteurs non scientifiques, intérêt public local, expertises), traitées par AFC

Objectif: Evaluer les stratégies scientifiques à travers l'analyse d'un fonds de financement de la recherche.

Auteurs: Delgado & Russell
Type: Bibliométrie
Source: BIBLAT et comparaison avec SCI
Pays: Mexique
Domaines: toutes disciplines représentées à l'UNAM (Université Nationale Autonome de Mexico): Physique, Chimie, Médecine, Biologie, Sciences de l'ingénieur, Sciences de la Terre, Psychologie et Sciences agricoles
Indicateurs: Distributions par domaines, citations, visibilité par les citations, étude des facteurs d'impact des revues où publient les chercheurs de l'UNAM.
Objectif: évaluer la visibilité internationale et nationale de la production des chercheurs de l'UNAM.

Auteurs: Krauskopf
Type: bibliométrie et inputs (diplômés et financements)
Source: SCI, statistiques officielles de diplômés
Pays: Chili
Domaines: tous domaines
Indicateurs: indicateurs standardisés: Nb de diplomés, Nb de Master et PhD, Nb de mainstream publications. Dénominateur commun: fonds reçus par l'université données divisé par fonds totaux attribués aux universités (financement relatif). Pourcentage de collaborations à travers co-auteurs.
Objectif: mesurer la performance de recherche des universités chiliennes.

Auteurs: B.K.Sen
Type: bibliométrie
Source: liste de publication du Council for Scientific and Industrial Research (CSIR)
Pays: Inde
Période: 1986
Domaines: domaines de recherche appliquée financés par le CSIR: sciences physiques, sciences biomédicales, chimie, sciences de l'ingénieur, recherche industrielle.
Indicateurs: Facteur d'impact total d'un laboratoire, facteur d'impact moyen d'un article pour chaque laboratoire, facteur d'impact moyen d'un article pour chaque chercheur de chaque laboratoire, facteur d'impact total de tous les laboratoires (donc du CSIR), facteur d'impact moyen d'un article du CSIR. Mêmes indicateur en utilisant une procédure de normalisation du facteur d'impact. Distribution spectrale (concentration de papiers en fonction des rangs des facteurs d'impact et facteurs d'impact normalisés).

Objectif: Evaluation de laboratoires de recherche par des méthodes bibliométriques.

Auteurs: Chatelin & Arvanitis
Type: Bibliométrie
Source: bibliographie spécifique sur la Côte d'Ivoire
Pays: Côte d'Ivoire
Période: 1884-1968
Domaines: toutes disciplines sauf sciences sociales, physique et chimie
Indicateurs: huit indicateurs relatifs: associativité (nombre moyen de co-auteurs), prestige (part des CR de l'Académie des sciences et articles dans des livres collectifs de synthèse), internationalité (part des publications en anglais), insertion régionale (part des publications à couverture mondiale ou régional par opposition aux publications localisé à la seule côte d'Ivoire), dispersion de publication (nombre d'articles par rapport au nombre de revues), mobilité (part des communications à des colloques), identité (part des papiers signé par opposition aux documents anonymes, essentiellement rapports et documents officiels), disponibilité (part des articles dans des revues régulières par opposition aux documents à parution irrégulière ou occasionnelle).
Objectif: représentation synthétique de domaines scientifiques par des indicateurs bibliométriques

Auteurs: Arvanitis & Bardini (1)
Type: bibliométrie, co-auteurs
Source: résumés de recherche d'un programme de recherche spécifique
Pays: Venezuela
Période: 1980-1987
Domaines: divers aspects autour de l'exploitation d'une plante, **Canavalia ensiformis** (alimentation animale, biochimie, agronomie)
Indicateurs: nombre de coauteurs, force relative des liens entre coauteurs
Objectif: évaluer la configuration interne d'un réseau de chercheurs à partir de leurs résumés de recherche

Auteurs: Arvanitis & Bardini (2)
Type: réseau sociométrique
Source: enquête par questionnaire
Pays: Venezuela
Période: 1989
Domaines: divers aspects autour de l'exploitation d'une plante, **Canavalia ensiformis** (alimentation animale, biochimie, agronomie)
Indicateurs: noms cités en référence (analyse sociométrique) et indicateurs de relation entre les noms

Objectif: évaluer à partir d'une enquête légère un large réseau de recherche.

Auteurs: Macias-Chapula
Type: bibliométrie analyse de thèmes par les mots-clés
Source: revue "Educación médica y salud" (257 documents)
Pays: Amérique latine
Période: 1979-1988
Domaines: Education médicale
Indicateurs: fréquence des termes indéxés, fréquence des noms de pays indexés, fréquence du pays d'origine des documents, relations entre pays d'orgine et pays mentionné.
Objectif: étudier les thèmes en éducation médicale en Amérique latine et les pays mentionnés dans les travaux indexés

Auteurs: Cagnin
Type: Enquête par questionnaire, échantillon de 168 chercheurs
Source: Enquête d'opinion et données officielles sur les financements, bourses de recherche et corps professoral.
Pays: Brésil
Domaines: Chimie
Indicateurs: distribution de l'échantillon par domaines de la chimie, niveau des diplômes, régions, institutions. Réponses à des questions à choix ordonné (échelles de valeurs). Tris croisés. Réponses concernant l'opinion des chercheurs sur le capital intellectuel, niveau de financement, niveau de l'enseignement, infrastructure, relations de travail etc...
Objectif: déterminer les facteurs intellectuels, d'infrastructure et sociaux qui favorisent ou au contraire sont un obstacle au développement de la recherche scientifique en Chimie au Brésil.

Auteurs: Abdullah
Type: Enquête par questionnaire complétée par des données bibliométriques
Source: échantillon 200 chercheurs; base SCI (pour les citations), base AGRIS (pour la production).
Pays: Malaisie
Période: enquête 1990; 1975-1981 pour AGRIS; 1984 pour SCI
Domaines: Sciences agricoles
Indicateurs: perception des chercheurs sur les facteurs favorisant la recherche, le % de temps en recherche, utilisation des sources d'information et bases de données par les chercheurs
Objectif: caractériser la recherche agricole en Malaisie et l'utilisation de l'information par les chercheurs

COLLABORATIONS SCIENTIFIQUES ET GEOSTRATEGIE

Auteurs: Lancaster & Abdullah (1)
Type: Bibliométrie, analyse de citations
Source: analyse primaire (20 revues locales) et échantillonage aléatoire dans SCI et WIPS
Pays: Cuba
Période: 1950-1983
Domaines: tous domaines
Indicateurs: part des citations vers différentes régions du monde (pays de l'Est, pays de l'OTAN, autres pays). Analyses statistiques.
Objectif: Evaluation de l'influence politique sur les sources citées par les auteurs cubains.

Auteurs: .Lancaster & Abdullah (2)
Type: Bibliométrie, analyse de citations
Source: analyse primaire (6 revues locales) et échantillonage aléatoire dans SCI et WIPS
Pays: Egypte
Période: 1957-1983
Domaines: tous domaines
Indicateurs: part des citations vers différentes régions du monde (pays de l'Est, pays de l'OTAN, autres pays). Analyses statistiques.
Objectif: Evaluation de l'influence politique sur les sources citées par les auteurs égyptiens.

Auteurs: Lancaster & Abdullah (3)
Type: Bibliométrie
Source: analyses primaires dans CIS (Congressional Information Service), Magazine Index, Reader's Guide to Periodical Literature.
Pays: USA
Période:
Domaines: pluies acides
Indicateurs: analyse de citations selon types d'auteurs (scientifiques de réputation, scientifiques publiant dans des revues de vulgarisation, autres scientifiques)
Objectif: influence des scientifiques dans la définition des politiques publiques (expertise) et ceux choisissant d'écrire dans les revues de vulgarisation pour un domaine particulier.

Auteurs: Narvaez-Berthelemot, Frigoletto, Miquel (1)
Type: bibliométrie
Source: SCI (base de Computer Horizons Inc.)
Pays: Brésil, Mexique, Argentine, Venezuela, Chili, Colombie, Pérou, Cuba, Jamaïque
Période: 1981-1986
Domaines: tous domaines
Indicateurs: co-auteurs internationaux, part d'articles avec co-auteurs intenationaux dans production totale, distribution par pays d'origine des auteurs, distribution par discipline et pays d'origine des co-auteurs, indice du nombre de partenaires dans le champs de collaborations les plus diversifiées (champ pour lequel le nombre de pays partenaires publiant plus de 5 articles en collaboration est le plus élévé)
Objectif: évaluer les collaborations scientifiques des principaux pays d'Amérique latine.

Auteurs: Narvaez-Berthelemot, Frigoletto, Miquel (2)
Type: bibliométrie et et projets de collaboration scientifique entre la France et 6 pays d'Amérique latine
Source: BADIN, MAC-MEV (Bases spécifiques du CNRS)
Pays: Mexique, Chili, Argentine, Venezuela, Colombie, Pérou, France
Période:
Domaines: tous domaines
Indicateurs: idem que ci-dessus
Objectif: Observer la collaboration scientifique entre six pays d'Amérique latine et la France.

Auteurs: El Alami, Doré, Miquel (1)
Type: bibliométrie, analyse des co-auteurs (collaborations internationales)
Source: MEV-MAC (base spécifique du LEPI issues de base de collaborations scientifiques internationales du CNRS et de base de publication de CHI, issue de ISI)
Pays: 9 pays Arabes (Algérie, Arabie Saoudite, Egypte, Iraq, Jordanie, Koweit, Lybie, Maroc, Tunisie) et 8 plus grands producteurs scientifiques mondiaux (USA, Royaume Uni, Japon, France, Allemagne, Canada, Inde, URSS).
Période: 1981-1986
Domaines: tous domaines
Indicateurs: Nombre d'articles en collaboration par domaines, Relation du nombre d'articles en collaboration entre neuf pays arabes et 8 plus grands producteurs mondiaux. Proximité des disciplines et des pays (analyse AFC).
Objectif: identifier, mesurer et analyser les collaborations scientifiques entre pays arabes et principaux pays grands producteurs scientifiques mondiaux.

Auteurs: El Alami, Doré, Miquel (2)
Type: bibliométrie, analyse des collaborations internationales entre la Maroc et la France
Source: MEV-MAC (BDD spécifique du LEPI issue de CHI), CONVENTION (BDD marocaine)
Pays: Maroc, France
Période: 1984
Domaines: tous domaines
Indicateurs: Nombre de projets de recherche en collaboration, nombre d'articles issus de ces collaborations par domaines. Proportion d'articles co-signés par des marocains dans la littérature internationale qui n'apparaissent pas, proportion d'articles dans des revues locales.
Objectif: identifier les collaborations scientifiques entre le Maroc et la France. Mesurer visibilité des collaborations marocaines. Mesurer l'effet de la localisation géographique des laboratoires de recherche français et marocains entre lesquels il y a une collaboration. Comparaison avec une base de données marocaine ("Convention").

Auteurs: Fernández, Agis, Martín, Cabrero & Gómez
Type: Bibliométrie et enquête par questionnaire
Source: analyse de 94 programmes de coopération scientifique établis par des institutions de recherche affiliées au CSIC (Conseil national de la recherche en Espagne), base de l'ICYT (Institut d'information scientifique et technique espagnol) et base SCI
Pays: Espagne-Amérique latine (Argentine, Brésil, Chili, Colombie, Cuba, Mexique)
Période:1982-1990
Domaines: Technologie, physique, sciences de la vie, Terre et espace, chimie, agriculture, mathématique, sciences sociales, astronomie, médecine
Indicateurs: distribution de la production par domaines, par pays, par programme, par revues, par chercheur/an. Part de la production visible dans SCI, part produite nationalement.
Objectif: évaluer les impacts des programmes coopératifs entre l'Espagne et les partenaires latino-américains. Visibilité de ces programmes.

Auteurs: Schubert & Braun (2)
Type: bibliométrie, co-auteurs
Source: SCI, base traitée par CHI
Pays: 72 pays
Période: 1981-1985
Domaines: tous domaines

Indicateurs: nombre d'articles co-signés, force des cosignatures $r_{ik} = n_{ik} / (n_i . n_k)^{1/2}$, carte de collaborations internationales.
Objectif: évaluer les collaborations internationales entre PED et pays industrialisés (définir quel pays industrialisé est préféré par chaque PED)

VISIBILITE ET STRATEGIES DE PUBLICATION

Auteurs: Whitney
Type: bibliométrie / analyse des bases de données
Source: principales bases de données distribuées par DIALOG
Pays: tous pays, en particulier Inde, Kenya, Chine, Brésil dans MEDLINE.
Période: depuis la mise en ligne des bases étudiées (années 70)
Domaines: tous domaines
Indicateurs: proportion de documents en anglais, proportion de documents issus de chaque pays.
Objectif: évaluer la part des USA et des PED dans les bases de données internationales US. Comparaison de "l'internationalité" des bases de données.

Auteurs: Sancho (1)
Type: bibliométrie
Source: SCI sur CD-ROM, AGRIS, Chemical Abstracts, BIOSIS, INSPEC, CAB, Excerpta Medica recherche on-line (via Data-Star et ESA/IRS).
Pays: Singapour, Taiwan, Pérou, Brésil, Nigeria, Koweit, Malaisie, Cuba.
Période: 1985-1989
Domaines: tous domaines
Indicateurs: production totale
Objectif: déterminer l'importance de la production des pays périphériques selon les diverses bases de données et comparer avec les données de SCI.

Auteurs: Sancho (2)
Type: bibliométrie
Source: BIOSIS, PASCAL, COMPENDEX, FSTA, AGRIS et SCI.
Pays: Cuba.
Période: 1983-1987
Domaines: recherches sur les sous-produits de la canne à sucre
Indicateurs: production totale
Objectif: Comparaison de la présence de Cuba dans différentes bases de données pour un thème de recherche d'intérêt local

Auteurs: Sancho (3)
Type: bibliométrie
Source: Base de données locale: Revista de Información Científica y Técnica Cubana, RICTC.
Pays: Cuba
Période: 1985-1989
Domaines: tous domaines
Indicateurs: production totale par domaines
Objectif: Evaluer l'effort de recherche national cubain à partir d'une base de données locale.

Auteurs: Thorpe (1)
Type: analyse bibliométrique
Source: documents produits par un institut (IRA/RZ) (enquête)
Pays: Cameroun
Période: 1988-1990
Domaines: recherche agricole
Indicateurs: type de documents (articles locaux, articles internationaux, rapports, communications)
Objectif: évaluer le type de littérature produite par les chercheurs

Auteurs: Thorpe (2)
Type: examen des bases de données locales
Source: base del'IRA et IRZ (Format BABINAT), bibliographie des travaux ORSTOM sur le Cameroun
Pays: Cameroun
Domaines: recherche agricole, recherche tropicaliste (agriculture, médecine, hydrologie, linguistique)
Indicateurs: distribution des documents inclus dans les BDD par pays source des documents, langue, type de documents
Objectif: Evaluer le contenu des bases de données locales au Cameroun

Auteurs: Thorpe (3)
Type: bibliométrie
Source: CAB
Pays: Cameroun
Période: 1973-1982
Domaines: sciences végétale (agriculture)
Indicateurs: production totale science
Objectif: examiner l'évolution de la production répertoriée dans BDD internationale. En particulier rapport expatriés/nationaux.

Auteurs: Schubert & Braun (1)
Type: bibliométrie
Source: SCI, base traitée par CHI
Pays: cinquante pays
Période: 1981-1985
Domaines: tous domaines
Indicateurs: Nombre d'articles (équivalent au nombre d'auteurs scientifiques), potentiel de publication estimé par une distribution de Waring, part des auteurs dans le potentiel total estimé.
Objectif: évaluer le potentiel de publication des pays à partir de la base de donnée SCI

Auteurs: Eisemon et Davis (déjà publié dans Altbach ed, 1990)
Type: bibliométrie et enquête
Source: SCI et 25 revues locales (comparaison), 45 interviews de chercheurs
Pays: Corée du Sud, Taiwan, Singapore, Malaisie
Période: 1980, 1985
Domaines: tous domaines
Indicateurs: production totale repertoriée dans SCI et à partir de données locales, part d'auteurs publiant localement repérés dans les revues mainstream, part d'auteurs étrangers dans les revues locales, types de documents cités, langue des documents cités, taux de citation attendus (méthode des matrices de Price), matrices de citations et sources de citations par langue citant/ cité, age des citations, corrélations entre variables de la littérature et des citations.
Objectif: examiner les stratégies de publication des chercheurs des pays nouvellement industrialisés.

Auteurs: Gaillard
Type: bibliométrie
Source: listes de publication issues d'enquête (207 scientifiques)
Pays: 54 PED
Domaines: aquaculture, production animale, sciences végétales, foresterie, sciences de l'alimentation, produits naturels (pharmacie), technologie rurale
Indicateurs: productivité par chercheur, fréquence de publication nationale/internationale dans un PD ou dans un autre PED, distribution de production par domaine, fréquence des co-productions (co-auteurs), par discipline et par continent, distribution par langue, âge des références, croisement âge des références et lieu de publication.
Objectif: Evaluer la production des chercheurs des PED.

Auteurs: Meneghini
Type: bibliométrie / production et citations

Source: SCI
Pays: Brésil
Période: 1970-1985
Domaines: biochimie
Indicateurs:production totale, production dans des revues internationale, production en portugais, proportion d'articles dans la production internationale contenant des résultats de recherche effectuées hors du Brésil (production exogène), proportion d'articles dans la production internationale contenant des résultats de recherche effectuées entièrement ou partiellement au Brésil (production endogène), nombre de citations, rapport citations/publications (pour production internationale seulement), facteurs d'impact.
Objectif: évaluer la visibilité internationale de la production en biochimie du Brésil.

Auteurs: Galbán et Gómez repris en détail dans Sancho
Type: bibliométrie
Source: Chemical Abstracts
Pays: Cuba
Période: 1985-1987
Domaines: Chimie
Indicateurs: Production et indicateur d'activité
Objectif: Evaluation de l'effort de recherche cubain et la visibilité dans une discipline, à travers une base de données internationale.

Auteurs: Rabinovitch
Type: Bibliométrie, analyse de production d'articles et de citations
Source: primaires locales (25 revues nationales contenant des articles en écologie), base de données spécifique (gestionnaire: Dbase). Comparaison avec SCI 1988.
Pays: Argentine
Période: 1978-1988
Domaines: Ecologie
Indicateurs: indicateurs de 283 citations argentines contenues dans SCI, Variations annuelles production totale (1963-1988), production d'articles par auteur, Distributions par domaines, Fréquence des co-auteurs, Fréquence des citations, Visibilité écologie argentine dans SCI (part des chercheurs argentins de la base nationale mentionnés dans SCI).
Objectif: Evaluation de la visibilité de l'écologie argentine et des stratégies de citation et publications des chercheurs en écologie en Argentine.

Auteurs: Licea de Arenas
Type: bibliométrie

Source: BIOSIS, CAB, EMBASE, MEDLINE, SCI
Pays: Mexique
Période: 1982-1986
Domaines: science de la santé (biomédicale, clinique, sciences sociales, sciences alimentaires)
Indicateurs:Indice d'activité
Objectif: Evaluer la production de la recherche biomédicale et en sciences de la santé au Mexique par les publications.

Auteurs: Lubowa
Type: bibliométrie
Source: WIPIS, SCI Corporate Source Index, SCI, Ulrich's International Periodical Directory
Pays: Egypte, Kenya, Nigeria, Arabie Saoudite, Ouganda
Période: 1971-1978 (WIPIS), 1979 (Corporate Source Index) et 1979-1981 (SCI)
Domaines: tous domaines
Indicateurs: nombre d'auteurs ("publishing scientists"), revue de publication, production totale, citations.
Objectif: Evaluer l'activité scientifique des pays africains et leur visibilité par une analyse des citations.

Auteurs: Puerari
Type: bibliométrie
Source: 12 revues brésiliennes d'économie
Pays: Brésil
Période: 1980-1988
Domaines: sciences économiques
Indicateurs: publications par type de revues (dépendant de société savante ou d'institution de recherche), part de la publication d'articles endogènes à l'institution, productivité totale des auteurs, proportion d'articles co-signés et d'articles individuels, comparaison élite (gros producteurs) avec le total.
Objectif: évaluer les modes de publication des économistes brésiliens.

LE ROLE DES REVUES SCIENTIFIQUES

Auteurs: Cano
Type: Bibliométrie des revues
Source: The Serials Directory on CD-ROM
Pays: Amérique latine
Période: 1990 (une période de publication)

Domaines: tous domaines
Indicateurs: distribution des titres par domaines, fréquence de la présence d'éléments attestant la visibilité internationale des revues: ISSN, entreprise d'édition, éditeur académique nommé, chiffres de circulation, langue, indexation internationale, descriptif du domaine couvert par la revue.
Objectif: évaluer la visibilité des revues d'amérique latine à partir d'une base de donnée des titres de revues.

Auteurs: Moriconi Valerio
Type: analyse de la politique éditoriale de revues locales
Source: données propres sur 17 revues subventionnées par la FINEP
Pays: Brésil
Période: 1983-1988
Domaines: Sciences de la terre, sciences de l'ingénieur, sciences agricoles, biologie, santé, sciences humaines, sciences sociales, linguistique/littérature/arts
Indicateurs: circulation toatle, production d'articles, durée et périodicité, lieu de publication, organisme de publication, (société savante, institution d'enseignement supérieur), organisation du comité de rédaction et du comté éditoral, contenu, mécanisme de sélection des articles (nombre d'avis -referees-demandés avant publication)
Objectif: Evaluer l'impact du programme de soutien des revues scientifiques mené par la FINEP; examen de la politique éditoriale des revues.

Auteurs: Galles
Type: Etude historique de la politique éditoriale / bibliométrie (analyse de données secondaires)
Source: revues locales de physique et sources secondaires
Pays: Argentine
Période: 1914-1931
Domaines: physique
Indicateurs: production
Objectif: décrire la politique éditoriale et la situation de la physique en Argentine avant 1931. Situation de la physique aujourd'hui : comparaison avec données secondaires sur l'Amérique latine entre 1981 et 1985..

Auteurs: Maclean et Vega
Type: bibliométrie, analyse des citations
Source: deux revues locales (Kalikasan et Fisheries Research Journal of the Philippines). Comparaison avec articles d'auteurs philippins dans des revues mainsteam
Pays: Philippines
Période: 1972-1983 et 1976-1990

Domaines: biologie marine, océanographie biologique, aquaculture, pêche.
Indicateurs: production totale, citations, âge des citations, part des citations de moins de cinq ans, proportion d'auteurs nationaux dans des revues locales, distribution par type de reference citée.
Objectif: Examiner la production et citations des auteurs philippins. Proposer ces indicateurs pour le suivi de la recherche dans les PED.

LES SYSTEMES NATIONAUX DE RECHERCHE

Auteurs: Roseboom & Pardey
Type: Séries historiques d'inputs (personnel & financement)
Source: diverses sources ISNAR, sources secondaires, statistiques nationales
Pays: 154 pays
Période: 1960-1986
Domaines: Recherche agricole
Indicateurs: Déflateurs (deux algorithmes distincts de déflation); Volume de ressources pour la recherche agricole; personnel de recherche et dépenses réelles en recherche agricole; distributions régionales; dépenses par chercheur; intensité de recherche agricole (dépenses pour la recherche agricole en % de la production agricole) et intensité relative de recherche (dépenses de recherche dans le total des financements publics de recherche).
Objectif: évaluation de l'effort de recherche agricole à travers le monde

Auteurs: Schubert & Braun (3)
Type: bibliométrie (citations) et indicateurs socio-économiques
Source: Banque mondiale et SCI
Pays: 38 pays
Période: 1981-1985
Domaines: tous domaines
Indicateurs: citations (taux de citations par article, taux de citation moyen attendu, taux de citation relatif), analphabétisme, espérance de vie, telephones par habitants, PNB par habitants
Objectif: combiner des indicateurs socio-économiques et des indicateurs scientométriques en une seule représentation graphique multidimensionnelle (figures de Chernoff)

Auteurs: Díaz Polanco & Yero
Type: Données input et output (projets de recherche, enseignements de troisième et quatrième niveau, bourses de formation, publications). Séries historiques.
Source: Primaires et secondaires locales (base de donnée spécifique). Bibliométrie: Medline, Excerpta medica, Biosis, Biblat, Periodica.

Pays: Venezuela.
Période: 1979-1989 (variable selon l'indicateur).
Domaines: Santé (médecine, recherche biomédicale, psychologie, biologie, anthropologie médicale, nutrition, information, soins de santé)
Indicateurs: Distributions par variable (année et période, institution, type d'institution, sexe, discipline, type de recherche). Bibliométrie: distributions par années, discipline, lieu de publication.
Objectif: évaluation de l'effort de recherche dans le domaine de la santé.

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