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Secretariat, CFCS
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PREFACE

Honduras was the setting for the 32nd annual meeting of the Caribbean Food Crops Society. Although Honduras is physically, culturally, and historically an integral part of the Caribbean Basin, this was the first time the society convened in Central America. History shows us examples of this integration. Centuries ago the Mayans exported their trade and culture, as the ball games chronicled in the greater Caribbean islands testify. Over 500 years ago the Spaniards and the British fought territorial battles along the coast permanently embedding the two mayor languages used today in Central America. Two hundred years ago a large group of Afro-Caribbeans immigrated to the Atlantic coast of Central America and established the ethnic group known today as Garifunas. These two regions have been exchanging products, people, and ideas for over a thousand years. As part of that legacy a group of over 80 scientists from 15 countries made their way to Honduras to experience the lifestyles on the shores to the West.

Our 32nd annual meeting began at the Pan-American School of Agriculture, at Zamorano, Honduras. Zamorano is also a testimony to the regional integration. The technical college was created over 50 years ago with the help of the United Fruit Company to train young persons in tropical agriculture from throughout the Americas. During the annual meeting the CFCS delegates witnessed for themselves the degree of professionalism and technical capacity at Zamorano, which make it today a leading agricultural teaching institution in the tropical world.

A trip to Honduras is not complete without a visit to the Mayan Ruins at Copán. The remnants of this ancient city have been described as a dynasty frozen in stone. The CFCS delegates visited the precious art of a civilization that centuries ago marked the leading political, economical, and cultural leadership throughout the Caribbean.

Much of Central America's Caribbean coast is reminiscent of St. Johns, Antigua or Puerto Plata, Dominican Republic. It seems that the Caribbean islands and and the atlantic coast of Central America have a lot in common, particularly regarding climate, architecture, food, and lifestyles. Like its regional partners, today Honduras is striving to compete on the world market with the exportation of tropical fruits, lumber, vegetables, shrimps, and textiles.

This meeting provided its participants the opportunity to visit a region just an inch or so in distance on the map, but a world apart in terms of political integration. Although Central America lies just across the Caribbean sea, it is rarely explored by its neighbors to the East. Not only did this meeting create a forum of professional exchange, but perhaps more importantly it brought our professionals closer together and hopefully sparked new friendships. If this was achieved, and I personally feel it was, then our 32nd annual meeting was a great success.

Wilfredo Colón
President

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THE USE OF A GEOGRAPHIC INFORMATION SYSTEM IN DETERMINING HILLSIDE LAND USE DYNAMIC IN A SMALL WATERSHED IN CENTRAL HONDURAS

Johann Kammerbauer, Department of Natural Resources and Biological Conservation, Escuela Agrícola Panamericana, El Zamorano, Honduras.

From the landscape ecology perspective, hillside regions are quite exciting. Most high cultures in human history appeared in regions with enriched ecosystems. Rich ecosystems are mostly mountain valleys and downstream regions like river deltas which receive sediments and nutrients from the higher regions. This elevation change or physical gradient leads to an ecological gradient and creates rich and poor ecosystems within the landscape. However, also rich ecosystems have to pay the price for this privilege with periodic disturbances: destruction by floods, silting of channels and land slides. This ecological gradient in association with climatic factors and other natural variations produce the different patterns in vegetation that we can observe as part of our physical landscape, thus creating ecological diversity in landscape (Haber, 1992). And the physical landscapes helps determine the human landscape, or lifescape. So, from the agricultural and forestry perspective, this leads to different land use strategies based on the complexity within the land and lifescape.

In Honduras about 83 % of the country is hillside, and 75 % has an inclination greater than 25 % (SECPLAN, 1989). Most of the basic grains and coffee are produced on hillsides. Locally, this hillside landscape forms rich and poor ecosystems within the mountains and their respective valleys. This creates varied and diversified ecological zones, with their special opportunities for different land use. What we are lacking is information about the dynamics and patterns of forest loss and land use practices at this scale. What we don't know is how people manage their landscape, how farmers make their decisions in relation within the context of the physical and ecological conditions, and how sector policies influence on farmer's decisions.

A Geographic Information System (GIS) permits resource mapping and analysis. A GIS is a computerized program that develops spatial databases - points, lines and polygons with geographical references - which further permit the addition of attributes and the manipulation of this information for analytical purposes, for example, to make overlays of thematic maps, to make mathematical calculations and to develop models.

The general objective of this study was to develop communal resource mapping methods, in order to get a better understanding of the

land use dynamics and to help to find indicators through which we can better achieve sustainable land use at a community level. The idea of sustainable use was created in Germany during the last century as a concept employed in forest management and it is simply a normative goal: not to extract more than the regeneration capability that a natural renewable resources allows. Two aspects should be considered in the following part: first, the use of a GIS as an instrument for resource mapping and second, how GIS data can make contributions to develop sustainablity indicators. Further details are presented in Kammerbauer & Ardon (1996).

The area of influence of Zamorano, generally taken to be the Yeguare river watershed, comprises an area of about 276 km² with 54 villages. With the extension service of Zamorano the region was mapped based on its land use and potential environmental degradation. In a second step, a group of researchers visited preselected communities and in a final step we established a weighting matrix based on potential environmental degradation and community activity in response to this degradation. As a result, the small watershed of La Lima was selected because of a supposed high environmental degradation potential and a community activity above average.

The small watershed of La Lima has an area of about 9.5 km² and is 17 km from Tegucigalpa. The altitude varies between 1200 and 1668 m above sea level. Annual precipitation is between 885 and 1182 mm with an average temperature of 21.4°C, depending on altitude. The natural vegetation is pine forest up to about 1600 m, and above this altitude there is cloud forest with broadleaf trees like oaks. This broadleaf forest is characterized by a high diversity of mosses, bromeliads and orchids.

La Lima is the principal settlement (62 family units) in a dispersed community of smaller settlements comprising 119 family units in total. The principal economic activity is basic grain production for home consumption and horticultural crop production (onion, potato, garlic) for the Tegucigalpa market.

Obviously, management of the natural resources is a complex process influenced by physical, ecological, economic, cultural, and political factors. During the study period of 40 years from 1955 to 1995 the use of natural resources in the small watershed of La Lima has been modified and has transformed the landscape. There is a strong relationship between land uses and landscape patterns.

In 1955 more than half of the La Lima watershed was covered with forest. Between 1955 and 1975 the annual deforestation rate was about 1.2 %, and between 1975 and 1995 in the range of 0.6 %. Currently, only 36 % of the area is covered by forests. We can differentiate these two periods by classing the first as the forest clear-cutting period, while the

second one, starting from 1975, was more a degradation of forest density from a high density forest to a sparse forest, rather than a period of wholesale elimination of forest area.

What happened within the structure of the forest cover? Between 1955 and 1995, the number of forest patches decreased dramatically by more than 50 %. While the small forest plots were eliminated principally in the second, degradatory period between 1975 and 1995. For that reason the average size of the forest patches increased by 42 %, while the number of forest patches decreased by 40 %. This kind of analysis permits us to detect changes in landscape patterns, evaluate fragmentation processes and impacts on wildlife dynamics: for example, community members reported that species of wildlife animals are getting scarce in the communities.

We could identify six land use categories using aerial photos: broadleaf forest, pine forest, sparse pine forest with grassland, crops, pure pasture, and shrubs. If we ask the farmers what kind of land use categories they can identify on the aerial photos our impression achieves a higher resolution as together we can differentiate more land use categories. But let us relate land use to only one physical factor: the hillside slope. In areas with slopes less than 15 % we find mostly crops and pasture. Also, in slopes with 15 - 30 % inclination we find considerable areas of farming (especially the traditional corn and bean system) and grasslands, but most of them are lacking appropriate conservation measures. In a smaller proportion we can also observe crops in the slope range of 30 - 50 % and greater than 50 %. For example, if we look at the year 1955 we see that in the slope range of 0 - 15 %, we find a lot of forest plots, which later within the study period have been transformed to crops. Hillside agriculture has been developed from the early stage, but increased within the study period.

We observed a migration movement to La Lima in the last 60 years with a peak in 1968 to 1973. Main economic activities have been the production of corn and beans. The reason of this migration process has been population pressure in the flatter lands, which changed their traditional production system to a more intensive production system of basic grains and sugar cane and to animal husbandry. In the same manner a substitution process started replacing human labor by inputs like pesticides and mechanization. This induced a radical change in the production logic of small scale farmers, who started to migrate to the hillsides. The pressure on the production centers induced the occupation of the fragile and marginal areas of small upland valleys and the hillsides.

Within the small hillsides we can observe the same patterns. From the center, a relatively flat area, with fertile soils, there is a centrifugal force substituting forest areas by crop areas, especially for the production of corn and beans and for pasture. In general these are less fertile, fragile soils

located in the higher inclined parts on the periphery of the small watershed.

To better understand the management decision of the small scale farmer in using the natural resources, we have to include another corner stone: the governmental forest and agricultural policies and instruments that have impacted the community.

Honduras had no specific forest policy until 1974. In that year the governmental Honduran Forest Administration (COHDEFOR) was created to take over the control of the forests through nationalization, including of private property. Instead of a rational management of the forests, COHDEFOR transformed itself in a institution of cutting permits for private companies. For the small watershed of La Lima, that meant for cutting trees they needed to get the permission from COHDEFOR. So here we have the explanation for forest clearing until 1975. After that date, it implied a high transaction costs for the community members to get the permissions for clear cutting. The strategy of the community was to use the forest as a source for fuelwood and with induced forest fire to clear the smaller plots for crops and larger for grassland. This action resulted in a modification of the forests from dense pine forest to sparse pine forest with natural pasture. Environmental impacts are principally the reduction of the occurrence of wildlife for hunting purposes and the reduced availability of firewood.

From 1982 the Agricultural Ministry started a program of technology transfer in the La Lima watershed. The technological package included the application of fertilizers and pesticides, and the diversification of crops (potato, onions and garlic) for the local markets. This process of agricultural intensification reduced in some amount the pressure on the forests, but increased the pressure on crop soils. Problems that we can observe are: pesticide loads, erosion and landslides on hillside areas.

In conclusion, the use of a GIS-System permits us to establish and evaluate geographical process indicators related to the sustainability of a limited area like a small watershed at a local scale. In the case of the La Lima watershed we used changes in deforestation rates, landscape patterns and population densities.

Deforestation rate: The deforestation rate declined from 1.2 % in the period from 1955 to 1975 to 0.6 % during 1975 until 1995. The pressure of conversion of forest area to crop area declined due to the physical limitations imposed by the hillside slopes and agricultural intensification. Nevertheless, modification occurred in the forest density of the remaining area to more sparse composition, principally caused by the demand for fuelwood.

Landscape pattern: The number, size and perimeter of the land use patches permit us to evaluate the processes of fragmentation. In this

case study for example, we observe a dramatic decrease of forest patches, which means less refuges for wild animal and plant species.

Population densities: The population density in the study area is about 80 persons per km². The Honduran average is in the range of 47 persons per km² (Banco Central, 1994). With a population increase this means under *ceteris paribus* conditions, that the human support capacity may be reached within a relatively short period. Alternative sustainable development strategies have to be found.

Finally we can summarize that

- The use of a Geographic Information System permitted us to develop a spatial database to describe changes in land use and analyze the change of land use patterns in the small watershed of La Lima during a 40 year period. Aerial photos, mapping with groundtruthing and participatory mapping with community members have been the basic inputs to create this database.
- The combination of the GIS database with physical, ecological, social, and political factors allowed us to interpret and understand the land use dynamics in the community, and the impacts of different natural resource policies could be evaluated.
- Process indicators of sustainability could be derived from the geographical analysis, which can determine if a limited zone is maintaining the life support system and the use of the renewable natural resources is a lasting one.
- Recommendations can be drawn for the design of appropriate natural resource policies to improve sustainability of land use practices.

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USING THE INTERNET FOR AGRICULTURAL INFORMATION-CARIVAM, THE WORLD WIDE WEB AND THE MYCORRHIZAE RESEARCH GROUP AT THE UNIVERSITY OF THE WEST INDIES

L.E. Chinnery and S.B. Persad-Chinnery, Department of Biology, The University of the West Indies, POB 64, Bridgetown, Barbados.

ABSTRACT. The Caribbean Mycorrhizal Network (CARIVAM) was inaugurated at the last Annual Meeting of CFCS. Membership in the network is open to all scientists studying mycorrhizae in the Caribbean and agriculturalists interested in exploiting the benefits of mycorrhizal symbioses. The aims of the network are to encourage collaboration, to share research results and to provide access to relevant literature. Also, to educate agriculturalists, horticulturalists and the general public on the benefits of mycorrhizae and sustainable agriculture. In order to disseminate information on mycorrhizae, a CARIVAM home page has been established on the Internet with linked pages to the U.W.I. Mycorrhizae Research Group, including e-mail connections, pages of information on all types of mycorrhizae and links to information sources and other mycorrhizal laboratories world wide. The content of the pages are discussed as an example of how the Internet can be used for disseminating agricultural information.

THE INTERNET AND THE WORLD WIDE WEB

Computers are often connected together to form a network. This allows people in the same organisation (university, research institute, insurance company, etc.) to share information. An internet can be formed by connecting such networks together, e.g. departmental networks in a university. The Internet (with a capital I) is the collection of computers around the world that can communicate with each other. Thus, the Internet is not a place nor an organisation. Neither is it an information store although some computers on the Internet are.

The Internet can be compared to a telephone system - a system that helps telephones to connect to each other. In fact, many users of the Internet connect their computer via the phone line to an Internet service provider.

Internet users provide access to files. These files contain links (references) to other files on the same or a different computer. The sum

total of all the interlinked files around the world is called the World Wide Web (WWW).

The information in a book is one dimensional - it is read from start to finish. However, the information on the WWW is multidimensional. This is because it uses hypertext. This provides links from any part of a document to any part of any other document. The links are highlighted and enable the reader to navigate through the information. The standard format for Internet documents is called **HTML** - HyperText Markup Language. The source code looks like a word-processed document with all the formatting codes. HTML can display richly formatted text including graphics. **HTTP** - HyperText Transport Protocol is the Internet protocol for fetching HTML files from remote computers. It also allows two way communication which can be utilised to create interactive services, e.g. WWW searches.

The Uniform Resource Locator (URL) is a string of letters and symbols that uniquely identifies a file on a computer on the Internet. The URL provides several pieces of information - the Internet protocol, the Internet name of the server computer, the directory and the file name. For example, the CARIVAM page has the following URL:- *http://users.caribnet.net/ ~lec/index.html*. This indicates the http protocol, the users computer at CaribNet (the Internet provider), directory (~lec) and the file index written in html. In this case the file name could be omitted since index is the default name for a start file.

A good WWW source for information on the Internet is the Internet Information Center (*http://www.austria.eu.net/ic/*).

WWW BROWSERS:

A WWW browser is a program that can use Internet protocols to fetch HTML pages and display them. It can highlight hypertext links and when a link is selected using the mouse (or keyboard) it will load the referenced document. Netscape's Navigator and Microsoft's Internet Explorer are the most commonly used browsers.

CARIVAM:

The Caribbean Mycorrhizal Network (CARIVAM) was inaugurated at the 31st Annual Meeting of the Caribbean Food Crops Society, Barbados, 9-14 July 1995. CARIVAM is a network of Caribbean scientists studying mycorrhizae and agriculturalists interested in exploiting the benefits of mycorrhizal symbioses. The aims of the network are to encourage collaboration, to share research results and to provide access to relevant literature. Also, to educate agriculturalists, horticulturalists and

the general public on the benefits of mycorrhizae and sustainable agriculture.

CARIVAM is coordinated through the Department of Biology at The University of the West Indies (UWI) and periodic meetings will be held in association with future CFCS conferences and other regional meetings.

The web site (Fig. 1) was created to publicise the existence of CARIVAM and in conjunction with the Mycorrhizae Research Group at UWI to provide educational information about mycorrhizae and sustainable agriculture.

UWI MYCORRHIZAE SITE:

Including the CARIVAM page, as of July 1, 1996, this site contains 15 web pages of varying size. Information is provided on personnel in the research group, current research projects and recent publications. The largest group of pages provide information on all the different types of mycorrhizae. These were modified from a recent review article (Chinnery, 1995).

CARIBBEAN IPM WORKING GROUP:

This was formed at the CARDI/CTA Caribbean IPM Network Workshop held in Barbados during October 1994. At the time of writing, this only represents one page on the site. This contains the philosophy statement and provides links to two IPM resource pages at Cornell University.

STANDARD METHODS:

Often in research you need to know how to do something using a standard method. This type of information is available on the WWW. For example, the International Culture Collection of Arbuscular and VA Mycorrhizal Fungi (INVAM) at West Virginia University (*http://invam.caf.wvu.edu/invam.htm*) has pages of protocols for producing bulk cultures, and the establishment of monospecific cultures from species mixtures, methods of voucher preparation and recipes for reagents used in mycorrhizal research.

RESEARCH IN PROGRESS:

Research projects currently being pursued can be described on a web page. This allows a visitor to the page to have a current idea of what is

being done by a research group and they can be invited to comment. Our current research page is at *http://users.caribnet.net/~lec/ curres.html*.

The papers presented at a conference are often progress reports and they are only documented in the abstracts given to the participants. One way to make them more available is to publish them on the WWW. The organisers of the first International Conference on Mycorrhizae (ICOM) to be held at the University of California at Berkeley in August 1996 have done this. These will be available at *http://mendel.berkeley.edu/boletus/icom/abstracts.html* for one year after the conference.

When CFCS gets its own WWW site, it could publish the abstracts for the Annual conference. All it requires is a computer readable copy of each abstract.

OTHER INTERNET RESOURCES

There are number of other free Internet resources beyond the World Wide Web. Amongst these are:- e-mail, List serves, Usenet newsgroups, gophers, ftp and telnet.

e-mail: Electronic mail is rapidly replacing the fax machine because of speed and cost. It is also an informal communication medium. Providing that you know the personal e-mail address of the other person, you can send them a one or two line message or you can attach a large text or graphics file to your message.

List serves: These are e-mail discussion groups. Some are moderated to remove junk mail. Most others are policed by the group members themselves. Several of these are of relevance to the sustainable agriculture community. To join the sustainable agriculture list send the message Subscribe sanet-mg to almanac@ces.ncsu.edu and to become part of the mycorrhizae list 'micronet' e-mail the message subscribe micronet [your real name] to listserv@uoguelph.ca. In both cases the subject line is left blank.

Usenet newsgroups: To subscribe to these you need to be able to access an Internet news server through Netscape, Microsoft Internet News or other Internet browser that has a newsgroup reader. There are thousands of newsgroups, but it is easy to configure your news reader to only subscribe to those of interest. Amongst these groups you will find *alt.sustainable agriculture*, *bionet.agroforestry* and *sci.agriculture*. The noise to signal ratio is higher than the list serves with a considerable amount of irrelevant material but one can be selective of what one reads.

Gopher servers: Some useful documents can be accessed by visiting a gopher site. For example, the USDA National Agricultural Library produces a series of Quick Bibliographies many of which can be obtained from *gopher://gopher.nal.usda.gov/1/nalpub/qb*.

ftp sites: These are sources of computer software and ftp stands for file transfer protocol. The software library of the Ziff-Davis magazine group can be found at *http://206.66.184.152/index.html*. Even Microsoft provides a site to download free software including Internet Explorer (*http://www.microsoft.com/msdownload/*).

telnet: Telnet connections allow your computer to function as a terminal connected to a distant computer. One use that this can be put to is searching university library catalogues and some data bases. The University of Florida library catalogue can be reached by using your telnet program to connect to *luis.nerdc.ufl.edu*.

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POSTSCRIPT

The CARIVAM site is currently available via a commercial Internet provider (CaribNet in Barbados). However, as soon as the University of the West Indies, Cave Hill Campus' Internet facilities are fully operational, it will be moved to *http://www.uwichill.edu.bb*. Therefor if the URL above doesn't work, it may mean the move has taken place.

CARIVAM

CARIVAM - The Caribbean Mycorrhizal Network was inaugurated at the 31st Annual Meeting of the CFCS, Barbados, 9-14 July 1995.
CARIVAM is a network of Caribbean scientists studying mycorrhizae and agriculturalits interested in exploiting the benefits of mycorrhizal symbiosis.

Coordination

CARIVAM is coordinated through the Department of Biology at the University of the West Indies and periodic meetings will be held in association with future CFCS conferences and other regional meetings.

Aims

The aims of the network are to encourage collaboration, to share research results and to provide access to relevant literature. Also, to educate agriculturalists, horticulturalist and the general public on the benefits of mycorrhizae and sustainable agriculture.

Information and Registration

For more information and registration form contact:-

Dr. L.E. Chinnery (lec@caribnet.net) or **Dr. S.B. Persad-Chinnery** (spc@uwichill.edu.bb).

Send mail to *CARIVAM, c/o Dr. L.E. Chinnery, Department of Biology, The University of the West Indies, P.O. Box 64, Bridgetown, Barbados.*
For additional information see: Mycorrhizae Research Group at the UWI. Other Mycorrhizal/Mycological Web Sites.

This page last updated 29 June 1996

Figure 1. The CARIVAM home page.

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ELICITIVE TRAINING: CATALYZING THE MOVEMENT OF INFORMATION BETWEEN CULTURES TO HELP FARMERS INCREASE THEIR KNOWLEDGE TO IMPROVE THEIR AGRICULTURE

Stephen Sherwood, Cornell International Institute for Food, Agriculture and Development, Central American Program/Zamorano Collaboration, Apártado Postal 93, Tegucigalpa, DC Honduras 11207.

ABSTRACT. Our agricultural training efforts arguably limit sustainable agriculture and rural development. Farmers and scientists live in unique cultural contexts that shape distinct world views and knowledge. Nevertheless, agricultural extension tends to view information and technology as culturally neutral. For the sake of analysis, I present the lessons of Zamorano's disease management course for Central American farmers in the context of two extreme training models: the prescriptive approach that is content-centered and relies on information and technology transfer, and the elicitive approach that is process-centered and relies on local discovery, creation and action. Through an open-ended experiential learning process directed at the biology and ecology of plants and pathogens, Zamorano's Plant Protection Department helped farmers learn how to diagnose key diseases and conceive numerous management alternatives. While the course used both prescriptive and elicitive techniques, the elicitive elements provided the opportunity for farmers to discover new ideas for themselves, gain more confidence, and build analytical tools that should help them deal with future problems more independently. This quality of learning would not have occurred if extensionists had simply told farmers what to do. We need to examine more carefully and in greater depth the approach of farmer training programs, so that we may more effectively catalyze the movement of information between cultures and help farmers improve their agriculture.

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FARMER'S FIELD SCHOOLS: INFORMATION SERVING FARMER EXPERTS IN THEIR FIELDS

P.C. Matteson, Escuela Agricola Panamericana, P.O. Box 93, Tegucigalpa, Honduras.
P.E. Kenmore, FAO Inter-Country Programme for IPC in Rice in South and Southeast Asia, P.O. Box 1864, Manila, the Philippines.

ABSTRACT. The Indonesian National Programme for the Development and Training of IPM in Rice-based Cropping Systems and the Asian FAO Rice IPM Programme developed a Farmer's Field School extension model that makes experts of farmers by strengthening their ability to prioritize, apply and generate crop management information. A Farmer-centered "learn by doing" process, facilitated by the trainer as collaborator, is the focus of a series of classes held in participants' fields over an entire cropping cycle. A group of farmers repeatedly observe and analyze their agroecosystem and experiment in order to make appropriate crop management decisions. The trainer introduces new information as necessary and at the appropriate moment. The interest, motivation and confidence of both farmers and trainer grow as they apply their respective knowledge and experience to address relevant questions.

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IPGRI'S INFORMATION ACTIVITIES: EMPHASIS ON GERMPLASM COLLECTIONS DATA

T.L. Franco, IPGRI Regional Office for the Americas c/o CIAT, A.A. 6713, Cali, Colombia.

ABSTRACT. Current attention is focused on the management and utilization of the germplasm materials held in the collections. The International Plant Genetic Resources Institute (IPGRI) seeks to provide a comprehensive information service and build up its information resources to facilitate dissemination of information on germplasm collections. IPGRI surveys and assesses the information resources of others and provides a referral service where in-house information is not available. Major IPGRI activities in this field are: a) to collect and disseminate data on existing germplasm collections, b) to promote the use of technical standards for handling germplasm information, c) to promote methods to facilitate the

gathering and sharing of characterization and evaluation data, and d) to provide training on documentation of plant genetic resources. Increasingly, genetic resources activities are being coordinated on a global scale, leading toward the realization of a comprehensive worldwide genetic resources network. Eventually, this will facilitate the allocation of financial resources available for plant genetic resources work. This can only be done successfully if information on existing germplasm collections is both available and complete.

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AGRICULTURAL PRACTICES MINIMISE THE BENEFITS FROM VESICULAR-ARBUSCULAR MYCORRHIZA FORMATION

L.F. Robertson, L.E. Chinnery and S.B. Persad-Chinnery, Department of Biology, The University of the West Indies, POB 64, Bridgetown, Barbados.

ABSTRACT. Plants colonised by vesicular-arbuscular mycorrhizal (VAM) fungi have been shown to be more efficient in nutrient uptake, to be more drought resistant and to have enhanced resistance to pests and diseases than non-mycorrhizal plants. VAM fungal spore populations were determined for each of the soil associations in Barbados. Non-mycorrhizal corn (*Zea mays*), pepper (*Capsicum annuum*) and bean (*Phaseolus vulgaris*) seedlings were transplanted into soil sampled from each association. The numbers of spores and the levels of mycorrhizal colonisation of the roots of the transplants were greater in the non-agricultural soils. This suggests that agricultural practices are reducing the mycorrhizal potential of soils. These results are discussed in relation to the development of sustainable agricultural practices.

INTRODUCTION

Vesicular-arbuscular (VA) mycorrhizae are mutualistic symbiotic relationships formed between most crop plants, except Brassicaceae, and soil fungi classified into six genera within three families of the order Glomales (*Entrophospora* and *Acaulospora* - Acaulosporaceae; *Scutellospora* and *Gigaspora* - Gigasporaceae; *Glomus* and *Sclerocystis* - Glomaceae) (Morton and Benny, 1990). On the basis of presumed homology between their spores and the azygospore found in the Mucoraceae, the Glomales were classified in class Zygomycetes. However, Rosendahl and Dodd (1995) and others now believe that the resting structures found in the Glomales may represent structures that are not homologous to those found in the Zygomycetes and that these structures can not be used to link the Glomales to the true fungi. Further, information from sequences of the 18S ribosomal genes of Glomales indicate that they form an ancient group, arising before the Ascomycetes and the Basidiomycetes (Rosendahl and Dodd, 1995).

To date less than 200 species of vesicular-arbuscular mycorrhizal (VAM) fungi have been identified. However, Morton *et al.*, (1995) have suggested that there may be as many as 2592 species in the genus *Glomus* alone. Their calculation is based on combinations of the morphological

characters of the spore wall on which the taxonomy of the Glomales is founded.

Plants colonised by VAM fungi have been shown to have enhanced nutrient uptake, especially of phosphorus (Harley and Smith, 1983), and fewer incidences of micronutrient deficiencies (Abbott and Robson, 1984; Persad-Chinnery and Chinnery, 1996). Such plants show increases in growth (Smith, 1980; Gianinazzi-Pearson *et al.*, 1989; Nielsen, 1990), plant disease resistance (Morandi *et al.*, 1984; Feldmann *et al.*, 1989; Caron, 1989), drought tolerance (Mosse and Hayman, 1971; Davis *et al.*, 1992), and reproduction (Koide *et al.*, 1988).

The growth promoting effect of VAM fungi can be attributed to enhanced phosphorus availability to the host plant, especially when these plants are grown in P-limited soils. Baas and Kuiper (1989) found the physiological effects on plants as a result of VA mycorrhiza formation similar to those of P additions to soils low in this mineral. Conversely, soils with high P levels do not promote VA mycorrhiza formation (e.g. Menge, 1978). Phosphorus diffuses slowly in soil (Buckman and Brady, 1960) and depletion zones develop around roots especially in soils with low P concentrations. VAM fungi extend the surface area of the roots and as such, the mycorrhizal root system can explore a greater volume of soil beyond the depletion zone for P, and other nutrients. The small diameter of the hyphae allows the fungus to explore smaller pore spaces than roots. There have been studies suggesting that VAM fungi can transform unusable forms of P (i.e. adsorbed and organic phosphates) and make them available to the plant (Brundrett, 1991).

In natural ecosystems VAM fungal populations vary due to plant growth stage, season and soil factors (e.g. pH, salinity). Such fluctuations are measured either by quantifying the number and species of asexual spores or by determining the intensity of VAM fungal colonisation within roots during a growing season. The use of pesticides, some cropping practices (e.g. tillage, monoculture) and fertilization also promote such changes and may decrease the diversity of VAM fungi and reduce the beneficial effects that these fungi have on plant growth (Sieverding, 1989; Rabatin and Stinner, 1989). The use of pesticides, fertilizers and farming practices in Barbados and the effects that these agro-chemicals and practices may have on native VAM fungal populations and mycorrhizal associations was reviewed by Persad-Chinnery *et al.*, (1992).

In this study the mycorrhizal potential of soils in Barbados was assessed by determining VAM fungal spore density and assessing the colonisation of roots of phytometers by VAM fungi.

METHODS

Soil samples were collected from sites (Table 1) within each of the ten soil associations, including both variants of the grey brown association, recognised in Barbados (Vernon and Carroll, 1966). At each site three subsamples were collected. One was placed in a plastic bag for subsequent extraction of spores. The other two were transferred to 15.5 cm plant pots with as little disturbance as possible. The soil sampling was accomplished in a single day.

Seedlings to be used as phytometers were prepared by germinating seeds in an autoclave sterilised mixture of equal volumes of soil, sand and vermiculite in 96 well seedling trays. Three unrelated species were used - corn (*Zea mays* L.), pepper (*Capsicum annuum* L.) and bean (*Phaseolus vulgaris* L.). In order to have seedlings of suitable size of each species, the pepper seeds were germinated first, after the first two leaves had unfolded the beans were planted. Two days later the corn was planted.

Three seedlings of each species were transplanted into one set of pots. Four corn achenes soaked in aerated water for 24 hr were planted into the second set of pots.

One plant of each species was carefully removed from each of the first set of pots and a corn seedling from each of the second set of pots at 2, 3 and 4wk after planting. The roots were cleared in KOH, stained with Chlorazol black E (Brundrett *et al.*, 1994), and examined for VAM fungal colonisation. This was quantified by the method used by Brundrett and Abbott (1995). The length of the colonies (mm) was measured with a compound microscope. These values were converted to a percentage of the root portion examined. Brundrett and Abbott (1995) found this method to be particularly suitable when colonisation levels were low.

Spores were extracted from two 50g samples of each soil by wet sieving, decanting and sucrose centrifugation (Brundrett *et al.*, 1994). The bottom sieve was 45µm to ensure collection of the small spores of some *Glomus* spp. The spores were examined and counted under a dissecting microscope (x40).

Table 1. Locations of soil samples collected from each soil association (1-9 Coral region formation; 10 Scotland district formation).

Sample Number	Association	Location
1	Red Brown Association (60s)	Easy Hall, St.Joseph
2	Yellow Brown Association (50s)	Groves, St.George
3a	Grey Brown Association (Sandy Variant) (40s)	Porters, St.James
3b	Grey Brown Association (Leeward Coast Variant)(40s)	Rock Dundo, St.James
4	Black Association (30s)	Content, St.Lucy
5	St.John's Valley Association (64s and 65s)	Wakefield, St.John
6	St.George's Valley Association (20s)	Carmichael, St.George
7	St.Philip Plain Association (10s)	Lowlands, St.Lucy
8	Red Sand Association (70s)	Allmens, St.Lucy
9	Coastal Association (80s)	Hope, St.Lucy
10	Scotland District Soils	Greenland, St.Andrew

RESULTS

The highest spore populations were found in the Scotland District soils (SDS) and the Coastal Association (80s) and these were significantly greater than that of the sandy variant of the Grey Brown Association (40s) (Fig.1).

The seedlings transplanted into the first set of pots showed increased colonisation over time (Fig. 2). The overall % colonisation being 9.3, 19.6 and 21.6 in weeks 2, 3 and 4 respectively. At all sample dates for all soil samples, the corn plants were more highly colonised than either beans or pepper (Fig. 2). The highest mycorrhizal potential was exhibited by the soils of the Scotland District (10) and the Coastal Association (9). The soils with low mycorrhizal potential were mainly those in agricultural areas, e.g. Yellow Brown (2) and Grey Brown (3a) associations.

The corn plants in the second set of pots were all mycorrhizal after two weeks and those planted in the soils of the Scotland District and the Coastal Association were the most highly colonised at all three sample dates. There was much more variation between root samples in these pots

than in the other set and statistical differences between soils were not detected.

DISCUSSION

All three methods of assessing the mycorrhizal potential of the soils gave similar results with the non-agricultural soils of the Scotland District and the Coastal Association having more resting spores and higher levels of VAM fungal colonisation of the phytometers. This suggests that agricultural practises may be minimising the benefits from mycorrhiza formation.

The strong correlation between spore numbers and root colonisation was unexpected, since colonisation is commonly from hyphal fragments which contribute most of the inoculum in many soils. Otherwise, the data clearly show that three weeks growth of the transplanted phytometers was sufficient to obtain useful results and that the transplanted plants, with their developed root systems, were more informative than those derived from the soaked corn achenes. That the corn phytometers became more highly colonised than those of the other two species does not necessarily mean that corn is the best species to use.

VAM fungi are not only affected by the soil and the host plant when grown in an agricultural field, they are also subject to agricultural practices. Among those practices that may be detrimental are tillage, crop rotation, and the use of organic manure, inorganic fertilizers and other agricultural chemicals.

Recently there has been emphasis on cropping with reduced tillage. This has been advocated mainly because tillage promotes soil erosion, reduces soil moisture and promotes the prolific growth of saprophytic bacteria rather than fungi. Dibb *et al.*, (1990) reported that tillage alters the distribution of VAM fungi in the soil profile and can lead to reduced VA mycorrhiza efficiency and lower spore densities. Due to the predominance of clay in the agricultural soils of Barbados there is a tendency for the soil to compact and self-decompact. Compaction too, can alter the occurrence of VAM fungi in the field hence, a balance of tillage and compaction must be sought to minimize their negative effects on VAM fungi.

Crop rotation where a VAM fungal host is alternated with a non-host species is very likely to lead to a reduction in the number and species diversity of VAM fungi in the soil. Rotating crops that are mycorrhizal is suggested if the population of VAM fungi is to exert a significantly beneficial effect on agricultural production. Harinikumar and Bagyaraj (1989) reported stimulated mycorrhizal root colonization and sporulation when a suitable crop rotation was carried out.

Continuous monoculture has been shown to have a decreasing effect on the abundance of VAM propagules in the soil while intercropping supports a diversity of VAM fungal types (Sieverding, 1991). However, in Barbados continuous monoculture of sugarcane does not seem to have caused a reduction in the formation of VA mycorrhizae (Chinnery *et al.*, 1987). This contradictory finding indicates that further studies need to be conducted since different species of VAM fungi may react differently when associated with particular crops. A fallow period is normally necessary for fields that have been extensively monocultured as a means of replenishing the diversity of VAM fungal populations. Fallow, or lay aside, is not normally practiced in Barbadian agriculture.

Brechelt (1989) found that increased amounts of fresh organic manure led to a decrease in mycorrhizal efficiency due to the increased P levels in the soil. Composted manure has been shown to improve the effectiveness of VAM fungi (Sieverding, 1991). In Barbados, de Boer (1992) reported that compost consisting of filter-press mud, bagasse and fly-ash leads to an increase in sugarcane yields when compared to N-K fertilizer application. It is possible that the compost promotes VA mycorrhizal associations and thus better yields.

Intensive use of inorganic fertilizers may decrease the quantity of VA mycorrhizal fungi in some tropical soils and it has been consistently shown that increased P levels tend to demote the formation of mycorrhizae. For example, Sieverding (1989) found that P fertilizers applied to fields at concentrations greater than 50 kg P ha^{-1} reduced the formation of VA mycorrhizae. Abbott and Robson (1984) reported that high P and N levels decreased VAM infection within roots. Addition of fertilizers, especially phosphates, to soil creates situations where the crop plants depend less on VAM fungi for growth and, at very high phosphorus levels, root systems are normally sparsely infected. Ellis *et al.*, (1992) found that root colonization of soybean and sorghum by VAM fungi was greatest when fertilizer was not applied to the soil. In Barbados, no P fertilizer is used on the main crop - sugarcane. Persad-Chinnery *et al.*, (1992) calculated that the average amount of P fertilizer applied to non-sugar agro-ecosystems was approximately 40 kg phosphate per hectare per year. This value is approaching the levels that will impact negatively on VAM fungi.

There have been few studies on the effects of pesticides on VAM fungi and the formation of VA mycorrhizae, a topic last reviewed by Trappe *et al.*, in 1984. Results from greenhouse pot culture experiments and to a lesser extent, field experiments suggest that agricultural chemicals, used at recommended doses could have effects upon VAM fungi ranging from minor to severe (Trappe *et al.*, 1984). Many pesticides exert effects on non-target organisms. For example, an insecticide may kill non-

target insects, including biological control agents, or may have deleterious effects on beneficial fungi and bacteria.

VAM fungi, as non-target organisms, may be affected by fungicides which may inhibit spore germination, mycelial development or sporulation. Rabatin and Stinner (1989) found that triazole fungicides suppress root colonisation and sporulation. Nemec (1980) tested eleven fungicides on two *Glomus* species. Amongst these captafol at rates of 2.2, 4.5 and 9.0 kg ha^{-1} and captan at rates exceeding 9.0 kg ha^{-1} reduced both colonisation and sporulation. All rates of benomyl, whether applied to seeds or mixed into soil, were toxic to VAM fungi (Nemec, 1980) as are most systemic fungicides (Jalali and Domsch, 1975). Maneb and chlorothalonil at rates of 11.2 and 22.4 kg ha^{-1} reduced sporulation of *G. mosseae*. Copper based fungicides, used to control phycomycetes and downy mildews, have also been reported to have a growth reducing effect on VAM fungi (Graham *et al.*, 1986; Nemec, 1980; Menge, 1982). All of the fungicides mentioned have been approved for use in Barbadian agro-ecosystems.

Herbicides are used to control the presence of undesirable plants and may have indirect harmful effects on VAM fungi. When a plant is killed its mycorrhizal association breaks down and the extraradical mycelium has to infect another plant. If there are few or no plants remaining after the herbicide treatment then the survival of these fungi may be threatened. Alternatively the herbicide may lead to a shift in the dominant vegetation such that the dominant plant species is non-mycorrhizal or weakly mycorrhizal and this too may threaten the survival of VAM fungi.

Bellamy (1993) found that sugarcane growth in Barbados was reduced when 2,4-D or Dowpon were used to control weeds compared to manual weeding. This effect could have resulted from negative effects on VAM formation or other beneficial organisms (e.g. nitrogen-fixing bacteria). Chinnery *et al.*, (1987) previously showed that sugarcane is highly mycorrhizal. Paraquat (gramoxone) has been found to reduce VAM fungal colonisation of roots and sporulation but generally herbicides do not have fatal effects on VAM fungi (Rabatin and Stinner, 1989). Dehn *et al.*, (1990) tested the effects of herbicides on hyphal growth and VAM fungal infection. Alachlor used at recommended rates depressed hyphal growth of *G. fasciculatum*, *G. etunicatum*, and *G. mosseae*.

Insecticides may have no effect or either cause promotory or inhibitory effects on growth and sporulation of VAM fungi. Trappe *et al.*, (1984) reported that carbofuran at 22 kg ha^{-1} and oxamyl as a foliar spray did not have any effect on sporulation of VAM fungi. A promotory effect may be realized if the insecticide eliminates predators of these fungi. If soil organisms like collembola and nematodes that graze VAM fungal hyphae

and spores are killed, increased fungal growth and sporulation may result. Alternatively, insecticides that kill soil organisms responsible for dispersing spores may contribute to changes in species diversity in a field. Generally most insecticides are applied to foliar parts of the plant and when used at recommended rates should not affect VAM fungi. However, they may be used at concentrations above the recommended rate or at a frequency greater than that recommended (Ferdinand, 1988; Chinnery and Gibbs, 1991). Buildup of insecticide residues in the soil could lead to deleterious effects on VAM fungi. Most insecticides, especially the newer types, have not been tested to evaluate their effects on VAM fungi and VA mycorrhizae. However, we have recently started a series of experiments at the University of the West Indies.

There is no way of knowing which of the above caused the results obtained. However, they are cause for concern. If sustainable agriculture is to be achieved, we need more information on the effects of agricultural practices on VAM fungi and VA mycorrhizae. Also, the indigenous VAM fungal populations need to be investigated. The effectiveness and competitive ability of each species must be evaluated and the most effective VAM fungi for a particular crop determined. Then, seedlings can be colonised in the nursery before introduction into the field or it may be possible to inoculate entire fields with suitable species of VAM fungi. VAM fungi if managed as a biofertilizer can lead to a reduction in fertilizer inputs to agro-ecosystems and yet maintain high crop yields. Disease resistance, drought tolerance and the other benefits listed above should also stimulate interest in managing and effectively utilizing VAM fungi in agro-ecosystems. Savings on production costs and thus the potential for increased profits are reasons why farmers may well be interested in maintaining the benefits of these fungi.

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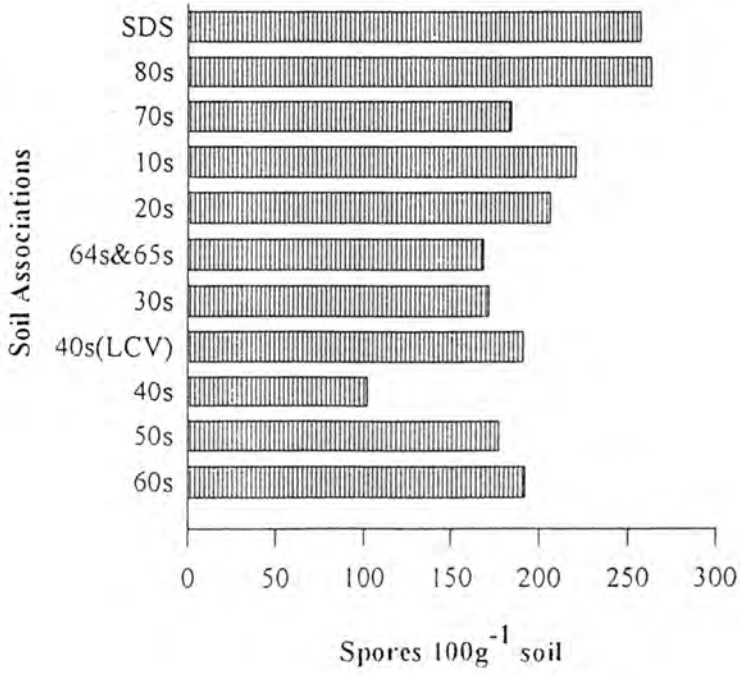

Fig. 1: Number of VAM fungal spores in soil samples from each association.

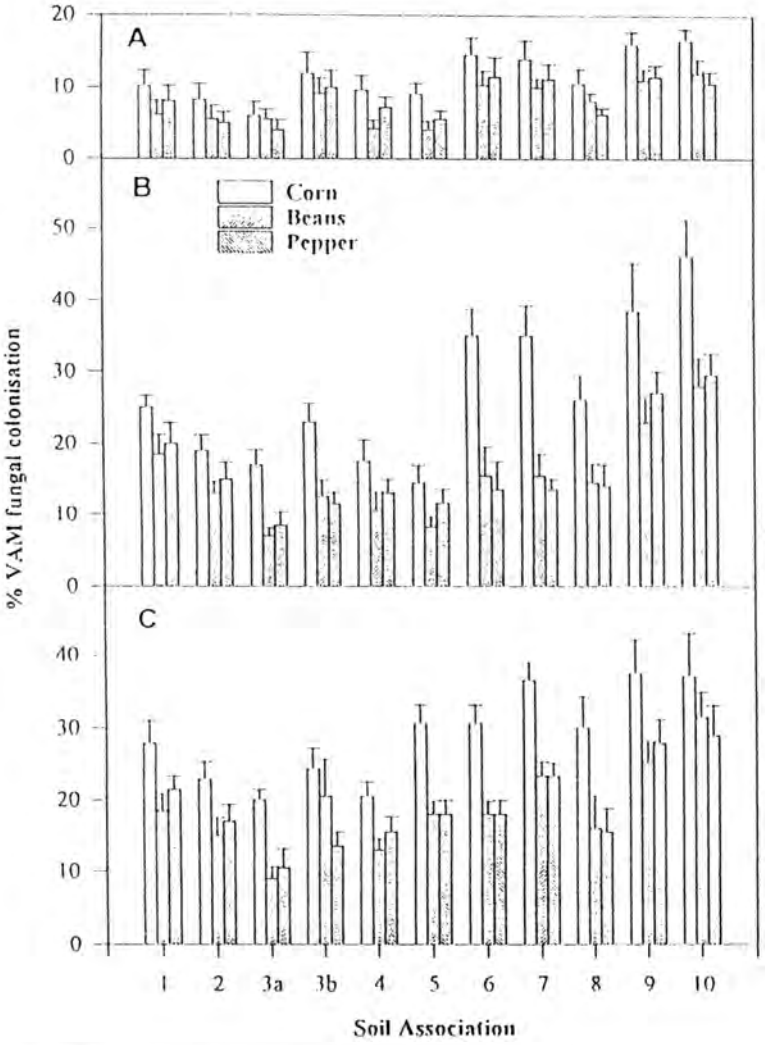

Fig. 2: Percentage VAM fungal colonisation of phytometers grown in each of the soils sampled. (Harvested at A 2, B 3 and C 4 wks)(Error bars are standard errors).

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LEAF AREA DEVELOPMENT OF INTERSPECIFIC HYBRIDS OF *Phaseolus vulgaris* X *Phaseolus acutifolius* UNDER VARYING IRRIGATION REGIMES

W. Colón, O. I. Varela, and J.C. Rosas, Department of Agronomy, Escuela Agricola Panamericana, Zamorano, P.O. Box 93, Tegucigalpa, Honduras.

ABSTRACT. Eight lines of interspecific crosses between *Phaseolus vulgaris* (line DOR 362) and *Phaseolus acutifolius* (89F50-18), were produced by the Bean Breeding Program at the Department of Agronomy. The interspecific hybrids were produced by in vitro embryo rescue technique and one generation of backcrossing towards the *P. vulgaris* parent line. These hybrid lines were grown under four applications of irrigation and total rainfall consisting of 232, 212, 193, and 172 mm for the entire growing season. Under the high irrigation regime (232 mm) the leaf area index (LAI) of each hybrid was the same at 20 and 35 days after planting (DAP). At 61 DAP only three hybrids differed from the parent *P. vulgaris* which had obtained the lowest LAI value (2.46). In the 212 mm irrigation treatment all hybrids obtained similar LAI both at 21 and 40 DAP. At 68 DAP, LAI values ranged from 2.51 to 4.01. In the 193 mm irrigation treatment LAI values were similar both at 21 and 39 DAP. At 75 DAP two hybrids obtained higher LAI values than *P. vulgaris* which had obtained the lowest LAI value (2.13). In the lowest irrigation treatment (172 mm) LAI values were drastically reduced. However four materials obtained LAI values that ranged from 2.42 to 2.60, comparable to some hybrids grown in the higher irrigation treatments. Breeding lines had a significant effect on final yield, while the irrigation regimes had a highly significant effect. In general all lines produced 36% more yield in the 212 mm irrigation treatment than the highest irrigation treatment (232 mm). Yield was reduced by 89 and 85% in the 193 mm and 172 mm irrigation treatments respectively, when compared to the 212 mm irrigation treatment. Leaf area index (LAI) was not an effective indicator for predicting yield performance of interspecific hybrids under low irrigation treatments. When a comparison was made between the 212 mm and 172 mm irrigation treatments, one hybrid's yield was reduced by only 38% while the rest were reduced by more than 76%. The use of interspecific hybrids did not prove capable of producing new lines adapted to lower water requirements.

INTRODUCTION

The common bean, *Phaseolus vulgaris*, comprises over 85 percent of the total food legume consumed in Latin America. Common beans are cultivated by small farmers in many parts of the tropics and sub-tropics in addition to temperate regions. On the other hand, tepary beans, *Phaseolus acutifolius*, are cultivated mostly in the arid regions of Central America (Redhead, 1989). Both of these species are used entirely for human consumption in Central America (CIAT, 1989). There are many limitations to obtaining high bean yields in Central America. White and Izquierdo (1991) have pointed out a close correlation between water availability and yield in which bean yields can decrease up to 30% with a decrease from 300 to 100 mm of applied irrigation. At CIAT (1991) drought tolerant materials have been identified, therefore, similar research should examine other varieties and or breeding lines from Central America to determine if they can also express this characteristic.

For the past ten years the Department of Agronomy at Zamorano in collaboration with other institutions has been working on biotic and abiotic constraints to bean production. Singh (1991) has pointed out that interspecific crosses of *P. vulgaris* with *P. acutifolius* can be used to transfer resistance to drought. Besides using conventional plant breeding techniques the program has implemented a breeding strategy creating interspecific hybrids (Haghighi and Ascher, 1988) with varying degree of success.

This study describes an effort to validate the yield potential of new breeding lines of interspecific hybrids under optimum and limiting irrigation regimes.

MATERIALS AND METHODS

Interspecific hybrids between *P. vulgaris* (line DOR 364) and *P. acutifolius* (line 89F50-18) were obtained using embryo rescue technique as described in Thomas and Waines, (1984) and by backcrossing with one of the *P. vulgaris* original parent for one generation, followed by two generations of selfing, until F3 populations were obtained.

All hybrid lines were planted on 14 of February of 1996 in 2 m rows, spaced at 60 cm between rows and 10 cm between plants. Four individual irrigation plots containing all the breeding lines were placed at a distance (>20 m) far enough to avoid any overlap in the sprinkler irrigation delivery systems. Each plot was irrigation with a specific amount of irrigation water plus seasonal rainfall (232, 212, 193, and 172 mm per growing season). Four replications of each breeding line were randomly distributed in each irrigation treatment. All four field irrigation plots were

fertilized at planting with 200 kg/ha of 18-46-0 and at 15 days after planting (DAP) with 45 kg/ha of urea (46% N). Weeds were controlled manually while insects were controlled by applying the insecticide Perfection at 15, 21, and 35 DAP.

Leaf area measurements were made with a Laser Area Meter (CI-203, CID, Inc., Vancouver, WA, USA). Four plants were sampled from each replication on three sampling dates in each irrigation plot. Plants were chosen from within the 2 m row directly adjacent to the border plants. In order to facilitate the leaf area reading, plants were destructively sampled and individual leaves were passed through the leaf area meter. Due to the laboriousness of this method, leaf area measurements were not taken on the same sampling dates for each breeding line in each irrigation treatment. Therefore, leaf area measurements were taken at 20, 35, and 61 DAP in the 232 mm irrigation treatment, at 21, 40, and 68 in the 212 irrigation treatment, at 21, 39, and 75 DAP in the 193 mm irrigation treatment, and finally at 22, 36, and 64 DAP in the 172 mm irrigation treatment.

Individual rain gauges were placed in each irrigation plot to register both the total sprinkler irrigation water applied and occasional precipitation that occurred throughout the growing season.

Pods were harvested at physiological maturity from plants within a 1.5 m linear section within each row. Seeds were dried to 14% humidity and weight and total yield (kg/ha) was calculated and analyzed by the SPSS Standard Version statistical package.

RESULTS AND DISCUSSION

All the irrigation plots received the same amount of irrigation water and rainfall up to 20 DAP, after which the amount of water applied was altered accordingly. Figure 1 shows the accumulation of the irrigation treatments and occasional rainfall registered in each plot throughout the total growing season.

Leaf area index values did not vary in the 232 mm irrigation treatment at 20 DAP, however differences were apparent at 35 and 61 DAP (Table 1). At 35 DAP only one plant material proved to have a higher LAI value than the lowest value registered (94RP-15-9 versus 94RP-15-57). At 61 DAP two plant material obtained the highest LAI values (94RP-15-19 and 94RP-15-14). The LAI values ranged from 2.46 to 4.77, however, only one material (94RP-15-5) obtained the highest final yield (Table 6). There was no linear (r^2=0.15) or quadratic (r^2=0.15) relationship between LAI at 61 DAP and final yield (Table 6).

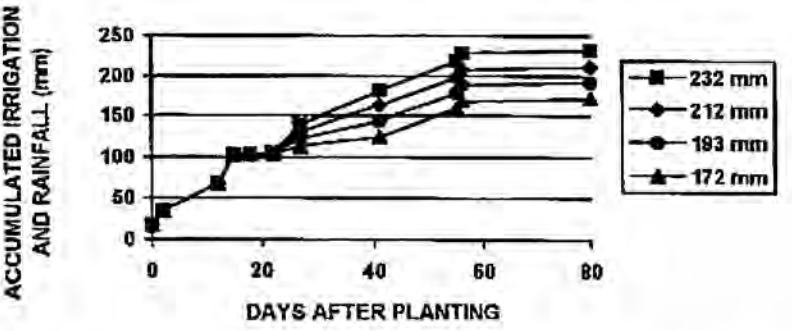

Figure 1. Total accumulated irrigation and rainfall (mm) for the total growing season for each irrigation treatment of 232, 212, 193, and 172 mm.

Table 1. Leaf area index (LAI) of 8 interspecific hybrids and Dorado variety at 20, 35, and 61 days after planting (DAP) under an irrigation treatment of 232 mm per growing season in Zamorano, Honduras.

Plant material	20 DAP	Plant material	35 DAP	Plant material	61 DAP
94RP-15-9	0.09a[2]	94RP-15-9	0.62a	DORADO	2.46a
94RP-15-51	0.10a	94RP-15-52	0.65ab	94RP-15-51	2.54a
94RP-15-14	0.10a	94RP-15-19	0.66ab	94RP-15-57	2.74ab
DORADO	0.11a	94RP-15-5	0.75ab	94RP-15-9	3.15ab
94RP-15-52	0.12a	94RP-15-35	0.93ab	94RP-15-52	3.55abc
94RP-15-35	0.13a	94RP-15-51	0.97ab	94RP-15-35	3.58abc
94RP-15-5	0.17a	DORADO	1.00ab	94RP-15-5	3.92 bcd
94RP-15-57	0.17a	94RP-15-14	1.06ab	94RP-15-19	4.38 cd
94RP-15-19	0.17a	94RP-15-57	1.07 b	94RP-15-14	4.77 d

[2] Means followed by the same letter within a column are not significantly different by Duncan's multiple range test at $P \leq 0.05$.

There were no differences in LAI in the 212 mm irrigation treatment at 21 and 40 DAP, however differences were apparent at 68 DAP (Table 2). Three hybrids obtained the highest LAI compared to the lowest value registered. There was no linear (r^2=0.25) or quadratic (r^2=0.26) relationship between LAI at 68 DAP and final yield (Table 6).

Table 2. Leaf area index (LAI) of 8 interspecific hybrids and Dorado variety at 21, 40, and 68 days after planting (DAP) under an irrigation treatment of 212 mm per growing season in Zamorano, Honduras.

Plant material	21 DAP	Plant material	40 DAP	Plant material	68 DAP
94RP-15-51	0.23a[z]	94RP-15-57	1.25a	94RP-15-5	2.51a
94RP-15-35	0.24a	94RP-15-19	1.36a	94RP-15-19	2.84ab
94RP-15-52	0.27a	94RP-15-5	1.57a	94RP-15-52	2.85ab
DORADO	0.27a	94RP-15-14	1.64a	DORADO	3.33abc
94RP-15-57	0.29a	DORADO	1.66a	94RP-15-57	3.51abc
94RP-15-5	0.30a	94RP-15-51	1.82a	94RP-15-51	3.58abc
94RP-15-9	0.31a	94RP-15-9	1.89a	94RP-15-9	3.72 bc
94RP-15-19	0.31a	94RP-15-52	1.95a	94RP-15-35	3.94 c
94RP-15-14	0.33a	94RP-15-35	1.95a	94RP-15-14	4.01 c

[z] Means followed by the same letter within a column are not significantly different by Duncan's multiple range test at $P \leq 0.05$.

There were no differences in LAI in the 193 mm irrigation treatment at 21 and 39 DAP, however differences were apparent at 75 DAP (Table 3). Two hybrids obtained the highest LAI compared to the lowest value registered. There was a positive linear (r^2=0.76) and quadratic (r^2=0.77) relationship between LAI at 75 DAP and final yield (Table 6).

Table 3. Leaf area index (LAI) of 8 interspecific hybrids and Dorado variety at 21, 39, and 75 days after planting (DAP) under an irrigation treatment of 193 mm per growing season in Zamorano, Honduras.

Plant material	21 DAP	Plant material	39 DAP	Plant material	75 DAP
DORADO	0.15a[z]	94RP-15-35	0.58a	DORADO	2.13a
94RP-15-57	0.16a	DORADO	0.62a	94RP-15-9	2.25ab
94RP-15-52	0.17a	94RP-15-14	0.67a	94RP-15-14	2.32ab
94RP-15-35	0.17a	94RP-15-9	0.69a	94RP-15-51	2.58abc
94RP-15-14	0.18a	94RP-15-52	0.76a	94RP-15-19	2.68abc
94RP-15-51	0.19a	94RP-15-57	0.81a	94RP-15-57	2.75abc
94RP-15-5	0.20a	94RP-15-5	0.82a	94RP-15-5	2.83abc
94RP-15-9	0.21a	94RP-15-51	0.90a	94RP-15-52	3.20 bc
94RP-15-19	0.23a	94RP-15-19	0.95a	94RP-15-35	3.38 c

[z] Means followed by the same letter within a column are not significantly different by Duncan's multiple range test $P \leq 0.05$.

There was no difference in LAI in the 172 mm irrigation treatment at 36 DAP, however differences were apparent at 22 and 64 DAP (Table 3). Two hybrids obtained the highest LAI compared to the lowest value registered. There was no linear (r^2=0.23) relationship between LAI at 68 DAP and final yield (Table 6).

Table 4. Leaf area index (LAI) of 8 interspecific hybrids and Dorado variety at 22, 36, and 64 days after planting (DAP) under an irrigation treatment of 172 mm per growing season in Zamorano, Honduras.

Plant material	22 DAP	Plant material	36 DAP	Plant material	64 DAP
94RP-15-51	0.23a[z]	DORADO	0.54a	94RP-15-57	1.64a
DORADO	0.30ab	94RP-15-19	0.67a	94RP-15-19	1.95ab
94RP-15-35	0.31abc	94RP-15-35	0.68a	94RP-15-9	1.95ab
94RP-15-9	0.33abc	94RP-15-52	0.74a	94RP-15-35	1.97ab
94RP-15-14	0.35abc	94RP-15-9	0.81a	DORADO	2.17ab
94RP-15-19	0.37abc	94RP-15-5	0.82a	94RP-15-5	2.42ab
94RP-15-52	0.42 bc	94RP-15-57	0.82a	94RP-15-52	2.47ab
94RP-15-57	0.43 bc	94RP-15-51	0.89a	94RP-15-14	2.59 b
94RP-15-5	0.44 c	94RP-15-14	0.97a	94RP-15-51	2.60 b

[z] Means followed by the same letter within a column are not significantly different by Duncan's multiple range test at $P \leq 0.05$.

A general linear model (GLM) could not be used to determine the effect of the breeding lines and irrigation treatment on LAI since leaf area determination were conducted on different dates in each treatment. However all hybrids were harvested on the same date. Table 5 shows that breeding lines and irrigation treatments had a significant and highly significant effect on final yield, respectively.

Table 5. F values from GLM of breeding lines and irrigation treatment on yield (kg/ha)

Factor	df	F value
Breeding lines	8	1.98*
Irrigation Treatment	3	84.45**
Breeding lines X Irrigation Treatment	24	3.26**

*,** Significant at $P \leq 0.05$ or 0.01, respectively

Seven out of the eight plant materials tested produced higher yields in the 212 mm irrigation treatment than in the 232 mm (Table 6). This discrepancy was due to two rainfalls of 35.5 and 9.4 mm on 55 and 56 DAP, respectively, that came after the programmed irrigation treatment at 41 DAP (Figure 1). These rainfalls caused waterlogging in the 232 mm irrigation plot. Although the 212 mm irrigation treatment was below the requirements of 250 to 450 mm for this crop (Doorenbos and Pruitt, 1977), final yields were probably affected in the 232 mm irrigation treatment due to oxygen deficiencies in the root zone area (Robertson and Frazier, 1982).

Table 6. Grain yield (kg/ha) of 8 interspecific hybrids and Dorado variety under four irrigation treatments of 172, 193, 212, and 232 mm per growing season in Zamorano, Honduras.

Plant material	232 mm	212 mm	193 mm	172 mm	% change in yield between irrigation treatments within the same plant material		
					212 vs 232	212 vs 193	212 vs 172
94RP-15-35	158a[z]	756bcd	105ab	48a	79	-86	-94
94RP-15-19	273a	956cd	70a	56a	71	-93	-94
94RP-15-57	358a	373ab	83a	238b	4	-78	-36
DORADO	434ab	1040d	35a	121ab	58	-97	-88
94RP-15-51	454ab	596abc	65a	123ab	24	-89	-79
94RP-15-52	514ab	904cd	196b	141ab	43	-78	-84
94RP-15-9	520ab	850cd	46a	68a	39	-95	-92
94RP-15-14	560ab	320a	43a	77ab	-43	-87	-76
94RP-15-5	830b	537abc	50a	95ab	-35	-91	-82
Means	456	704	77	107	36	-89	-85

[z] Means followed by the same letter within a column are not significantly different by Duncan's multiple range test at $P \leq 0.05$.

The hybrid lines evaluated in this study did not surpass in yield other materials evaluated under similar conditions by others researchers. Mean grain yields of the hybrids were 77 and 107 kg/ha in the lowest irrigation treatments (Table 6). These results are similar to Zuluaga *et al.*, (1988) who obtained 80 kg/ha from 25 different genotypes evaluated in Zamorano under low water conditions.

In conclusion, under limiting water conditions, no hybrid line was shown to be promising in terms of yield potential. Leaf area index was not an effective indicator of the final yield performance of the lines tested. Other variables such as leaf thickness index have shown to be better correlated with yield (White and Izquierdo, 1991). In future evaluations on the effects of water stress on final yield, leaf thickness index should be determined.

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STUDIES ON THE EFFECT OF THE GROWTH HORMONE CERONE 720 ON THE YIELD OF RICE (var. Rustic) IN GUYANA

Azim Hosein, CARDI, Guyana.
Compton Paul, Technical Programmes, CARDI Headquarters, Trinidad.

ABSTRACT. A series of trials was carried out with the growth hormone CERONE 720 (active ingredient ethephon) on rice (var. Rustic) in Guyana during the Autumn cycle of 1995 and Spring cycle of 1996. In 1995, there was three experiments while in 1996 there was a larger scale on-farm experiment. The result were as follows: Experiment 1 - in which twelve CERONE 720 application rates ranging from 0 to 51.20 g a.i./L of water were administered to seed under 10 cm simulated flooded condition. The 0.16-0.32g a.i./L range of treatments increased ($P \leq 0.001$) seedling emergence above the flood water level 42% to 80%. The CERONE 720, therefore, increased the rate of elongation of the rice seedling leaves under flood. Experiment 2 - in which CERONE 720 was found to increase rice yield in a farmer's field by approximately 6% when applied as a seed treatment at the rate of 1.44g a.i./L of water. This trial also indicated that a seedling rate of 100 kg ha^{-1} could leap to a significantly ($P \leq 0.05$) higher yield than the normal rate of 150 kg ha^{-1} if CERONE 720 was applied to seed at the lower seedling rate; this gave a saving of 50 kg ha^{-1} of seed while at the same time providing an additional 0.24 t ha^{-1} of grain. Experiment 3 - in which CERONE 720 was applied to experiment station plots as a foliar spray just prior to panicle initiation at the rate of 300 g a.i. ha^{-1}. Grain yield was increased by approximately 13% while grain quality was improved. Experiment 4 - in 1996 six large scale plots were selected in four commercial farmer's field along the coastal belt of Guyana and CERONE 720 was applied at the recommended rate of 300 g a.i. ha^{-1} as a foliar spray just prior to panicle initiation to one-half of each plot; the other half was untreated. The treatment led to an average increase in grain yield of 620 kg ha^{-1} or 12.5% of the variety Rustic which occupied about 70% of the total area under rice production in Guyana. This yield increase translated to a net profit increase of approximately US$88 ha^{-1} (Guy $12496 ha^{-1}) and confirmed on a large scale what was achieved on experiment station plots in the previous crop cycle.

INTRODUCTION

CERONE 720 which contains 720 g of the active ingredient 2-chloroethyl phosphoric acid, called ethephon, per litre, is an organic

phosphorus compound used on a number of crops as a growth regulator. Depending upon plant species, chemical concentration, and timing of application to one or more of the customary growth sites (roots, leaves, stems, flowers or fruit) the ethylene released to these tissues produces numerous physiological effects and can be utilized to regulate various phases of plant metabolism, growth, and development (Thomson, 1981).

In rice, CERONE 720 has been found to increase tillering, induce earlier and more uniform flowering, hasten maturity and harvest, increase the number and weight of grains per panicle and improve grain quality. Overall, yield was found to increase by approximately 15 to 20% in Ecuador and Brazil (Rhone-Poulenc, 1994). Several other researchers have reported yield increases from the application of ethephon to rice (Kundu and Biswas, 1985; Fang *et al.*, 1983; Rao and Fritz, 1989; Wescott *et al.*, 1985; and, Barros, 1991).

In Brazil, CERONE 720 is applied to rice just prior to the initiation of the reproductive phase when the growing point is just about to differentiate into a floral bud. The success of CERONE 720 depends on the appropriate timing of its application and the recommended dose. A dose of 300 g a.i. ha^{-1} has been recommended for rice (Rhone-Poulenc, 1994).

The present study evaluated CERONE 720 on grain yields of the variety Rustic, the major variety (70% of total area) cultivated in Guyana's 350,000 ha of rice cultivation per year. The investigation was done in collaboration with the Guyana Rice Development Board (GRDB) and private farmers during the period 1995 to 1996. In 1995 the study (Experiments 1 to 3) concentrated on laboratory and on-station trials as a preliminary stage of the investigations. One on farm trial was also conducted. The results then led to large scale studies (Experiment 4) located in farmers' fields along Guyana's coastal rice belt. The plots were selected after the farmers had sown and the treatment was superimposed on the farmer's practices.

2.0 EXPERIMENTATION

2.1 Experiment 1: To study the effect of CERONE 720 as a seed treatment on rice seedling emergence under flooded conditions.

MATERIALS AND METHODS

The first investigation consisted of 12 rates of CERONE 720 (0, 0.04, 0.08, 0.16, 0.32, 0.48, 0.64, 0.96, 1.28, 2.56, 5.12, and 51.20g a.i./L of water) replicated twice and laid down in a completely randomized design. The variety was Rustic. Imbibition was accomplished by soaking

300 seeds for 24 hours in the respective concentrations. The seeds were then pre-germinated for two additional days on paper towels that were kept damp. Germination was considered as the emergence of the coleptile and counts were taken 48 and 72 hours after soaking.

The experiment continued into a second investigation of seedling emergence under food. There were two treatments (CERONE 720 treated and untreated seeds sown in water 10 cm deep) by using the 12 CERONE 720 rates that were replicated twice in a randomized complete block factorial design, making a total of 48 plots. The flooded treatment consisted of a plastic cup filled to 10 cm of water into which the germinated seedlings were placed. Each of the 48 cups (plots) were sown with fifty seedlings (3-days old). Seedling emergence was evaluated 12 days after sowing. Seedling emergence percentage was measured.

RESULTS AND DISCUSSION

It was observed that pre-germination of the CERONE 720 treated seeds, at all levels between 0.04 to 0.96 g a.i./L occurred with 24 hours after being removed from the soaking phase compared to the control treatment. Above 0.96 g a.i./L there was no sign of germination at day 3.

Significant differences were observed for the main effect of CERONE 720 seed treatment ($P \leq 0.001$) on seedling emergence and are presented to Table 1. The CERONE 720 treatments are divided into four ranges that were statistically similar, namely, 0.00 or the control plot, 0.04 to 0.08, 0.16 to 0.32 and ≥ 0.48 g a.i./L of water.

Table 1. The effect of CERONE 720 concentration on seedling emergence under a 10 cm flood. Emergence above the flood water level was measured 12 days after flooding.

CERONE 720 concentration g a.i./L of water (treatment ranges)	% emergence
0.00	42
0.04 - 0.08	70
0.16 - 0.32	80
≥ 0.48	70
Mean (12 treatments)	62

S.E.M. = $\pm$ 5.6 for the 12 treatment means

Conclusion: Without CERONE 720 there was poor emergence above the water surface under flooding. The CERONE 720 rate of 0.16 to 0.32 g a.i./L of water applied as a seed treatment increased seedling emergence above the flood water level from 42% to 80% after a period of 12 days.

This indicated that CERONE 720 increased the rate of elongation of the rice seedling leaves under flood.

2.2 Experiment 2: To evaluate the effect of CERONE 720 as a seed treatment on rice yield in plots in a farmer's field.

MATERIALS AND METHODS

There were 3 treatments laid down in a 3 x 3 latin square design, namely:

(i) 100 kg/ha seeding rate + 1.44 g a.i. CERONE 720 per litre
(ii) 150 kg/ha seeding rate with no seed treatment
(iii) 150 kg/ha seeding + rate 1.44 g a.i. CERONE 720 per litre

The treatments were replicated 3 times and carried out at Blackbush Polder for the rice season of Spring 1995.

The rice seeds for all treatments were allowed to imbibe water for 24 h and then pre-germinated for 2 days in the cool before sowing in the field. Plots were sown on 16 December 1994 and harvested on 19 April 1995.

RESULTS AND DISCUSSION

Table 2. The effect of seeding rate and CERONE 720 seed treatment on yield components of direct seeded rice at Blackbush Polder, Guyana, Spring 1995.

Yield Component	Seedling rate			
	100 kg ha^{-1} +CERONE 720 seed treatment	150 kg ha^{-1} no seed treatment	150 kg ha^{-1} +CERONE 720 seed treatment	S.E.M ±
Grains/panicle	61	51	69	2.6
Panicles/m^2	683	779	726	34
Yield, t ha^{-1}	5.45	5.21	5.51	0.27

The results are shown in Table 2. CERONE 720 was found to increase the number of grains per panicle and total grain yield at the normal seeding rate of 150 kg ha^{-1}. CERONE 720 treated seed at a lower seeding rate of 100 kg ha^{-1} increased grains/panicle and total grain yield above ($P \leq 0.05$) the untreated normal seeding rate of 150 kg ha^{-1}. This

meant that farmers could sow 50 kg less seed per hectare and also obtain 0.24 t ha^{-1} more grain if they treated the seeds with CERONE 720.

Conclusions:

1. CERONE 720 increased rice yield by approximately 6% when applied as a seed treatment.
2. A seeding rate of 100 kg ha^{-1} can lead to a significantly ($P \leq 0.05$) higher yield than a rate of 150 kg ha^{-1} if CERONE 720 is applied to the lower seeding rate.
3. CERONE 720 did not increase the number of panicles in this experiment.

2.3 Experiment 3: The effect of different rates of CERONE 720 applied just prior to panicle initiation on rice yield under experiment station conditions.

MATERIALS AND METHODS

There were 3 rates of CERONE 720, namely, 0, 240 and 300 g a.i. ha^{-1}. The test was laid down in a randomized block design with four replicates. The plot size was 1000 m^2.

The variety Rustic was used and the trial was planted on 17 June 1995 at the Burma Experiment Station in Guyana. A seeding rate of 140 kg ha^{-1} was applied as a foliar spray just prior to panicle initiation.

RESULTS AND DISCUSSION

Results are presented in Table 3. CERONE 720 applied at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation increased ($P \leq 0.05$) grain yield by approximately 13%. However, an application rate of 240 g a.i. ha^{-1} showed no effect and this could not be explained.

There was strong evidence to show that harvested grains from CERONE 720 treated plots had a higher ($P \leq 0.01$) percentage of cleaned grains than paddy from untreated plots.

Conclusion: CERONE 720 applied at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation increased ($P \leq 0.05$) grain yield by approximately 13% under experiment station conditions.

Table 3. The effect of different rates of CERONE 720 applied just prior to panicle initiation on rice (var. Rustic) yields at Burma Experiment Station, Guyana 1995.

Treatment (g a.i. ha^{-1})	*Yield (t ha^{-1})	% cleaned grains
0	5.22	77.8
240	5.21	93.8
300	5.89	85.3
S.E.M $\pm$	0.16	3.8

*At 14% moisture content

2.4 Experiment 4: The effect of CERONE 720 on rice grain yield in farmers' fields on the coastal belt of Guyana.

MATERIALS AND METHODS

Four farms were selected along the coastal belt of Guyana during the 1996 Spring Cycle. The farms were located at East Bank Essequibo (Farmer Samand), West Demerara (Farmer Baker), Mahaicony (Farmer Bhajan) and Corentyne (Farmer Rambridge) and planted by the farmers with the variety Rustic. On each farm an area of 2000 m^2 was isolated and CERONE 720 was applied at the rate of 300 g a.i. ha^{-1} as a foliar spray just prior to panicle initiation to one half of the isolated area. The other half was left untreated for comparison. At both the West Demerara and Corentyne farms, a second 2000 m^2 area was included. This gave a total of six plots left untreated (Fig. 1). Panicle initiation was determined by visual examination of the cross section of the main culm of 10 plants chosen at random in the field. Harvesting was carried out in April 1996. The statistical analysis was carried out for a randomized block experiment.

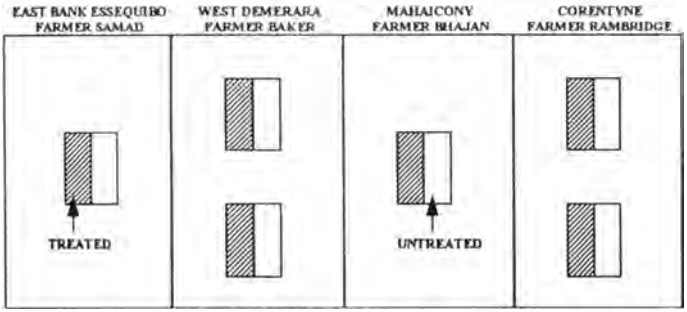

Figure 1. Schematic view of experimental layout of treated and untreated plots on the farmer's fields.

RESULTS AND DISCUSSION

The results are shown in Table 4.

Table 4. The effect of CERONE 720 (300 g a.i. ha^{-1}) on grain yield (t ha^{-1}) of rice variety Rustic on four farms, Spring 1996. (Names of farmers in parentheses)

Location of farms	Expt. area	WITH CERONE 720	WITHOUT CERONE 720	Yield increase due to CERONE 720 (kg ha^{-1})	% increase due to CERONE 720
East Bank Essequibo (Samad)	1	5.73	5.05	680	13.5
West Demerara (Baker)	1	5.59	5.42	170	3.1
	2	5.3	5.49	440	9.6
Mahaicony (Bhajan)	1	6.06	4.92	1140	23.2
	1	6.55	5.44	1110	20.4
Corentyne (Rambridge)	2	4.82	4.64	180	4.9
Mean		5.63	5.01	620	12.5

S.E.M.= $\pm$0.16 for % increase due to CERONE 720 treatment.

The ANOVA showed that CERONE 720 consistently improved ($P \leq 0.10$) yields on all farms with an average increase of 620 kg ha^{-1} (12.5%) which was similar to a 13% increase obtained from the previous season's field trials (Experiment 3 above). The increase amounted to approximately 9.8 bags of paddy per hectare. These results support findings from India (Anon, 1988) for CERONE 720 applied as a foliar spray at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation.

The percentage yield increase due to CERONE 720 varied from 3.1% at one of the sites at West Demerara to 23.2% at Mahaicony. But the yield differences among sites were not significant because there were large differences due to the treatment even on the same farm (3.1 and 9.6% at the two sites on the Baker farm and 4.9 and 20.4% at the two sites on the Rambridge farm as shown in Table 4). Also, experimental error could have been reduced drastically if there were at least three sites on each farm. A repetition of the experiment during another crop cycle would definitely increase accuracy of the measurements.

The cost of application (materials and labour) of CERONE 720 at the rate of 300 g a.i. ha^{-1} was US$28.47 per hectare. Since this application led to an average yield increase of 9.8 bags of paddy per hectare (that is, US$116.50 ha^{-1}) the net return per hectare was US$88.03.

Conclusions:

1. CERONE 720 applied as a foliar spray at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation in farmers' fields increased grain yield of the variety Rustic by an average of 620 kg ha^{-1} or 12.5% across four farms along Guyana's coastal belt.
2. The increase in rice yield due to CERONE 720 gave a net return of approximately US$88 per hectare.

3.0 FUTURE WORK

The foregoing studies have demonstrated that CERONE 720 has increased grain yield in rice when used as a foliar spray just prior to panicle initiation at the rate of 300 g a.i. ha^{-1}. It would have been useful to include at least three repetitions of the treatment on each farm. This would have provided a greater number of degrees of freedom for the CERONE 720 treatment and also for the farm x CERONE 720 interaction, leading to greater accuracy in the results. It would also have been useful to investigate the effects of other rates such as 200, 250, 350 and 400 g a.i. ha^{-1} farmers' fields.

It was suggested that perhaps CERONE 720 could reduce lodging and blast and have varying effects depending on variety. If the hormone increases the quality of the grain, then, perhaps it also has a carry-over effect on seed quality and viability. These hypotheses are certainly worth investigating.

If farmers decide to use CERONE 720 in their rice cultivation, a monitoring and feedback arrangement should be put in place so that the effects of the product could be evaluated over wider space and time dimension. This would yield valuable information on how CERONE 720 affects the returns to be obtained by farmers using various levels of resource inputs and management practices.

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YIELD AND DRY MATTER AND NUTRIENTS OF KING GRASS (*Pennisetum purpureum* x *P. typhoides*) IN TWO ECOZONES IN CENTRAL JAMAICA

F.H. Asiedu and A.L. Fearon, CARDI, P.O. Box 113, Mona Campus, Kingston 7, Jamaica.

ABSTRACT. Dry matter (DM) yield, *in vitro* organic matter digestibility (IVOMD) and contents of protein (CP) and fibre (NDF) of King grass (*Pennisetum purpureum* x *P. typhoides*) were evaluated in two ecozones in central Jamaica - mid Clarendon/Manchester (mCM) and southern Manchester/St. Elizabeth (sME) - in order to determine its suitability as fodder crop for goat production. The parameters were determined on 6-wk (mCM_6 and sME_6) or 9-wk (sME_9) regrowth in a randomized block design with four replicates, and treatment means tested as designed orthogonal contrasts: mCM_6 v sME_6, sME_9 and sME_6 v sME_9. Goat manure was applied at the rate of 10-25 t/ha/yr. CP% (mCM_6 = 16.5; sME_6 = 11.3; sME_9 = 10.8), IVOMD% (61.5; 54.8; 56.2), and yield (t/ha/yr) of DM (30.2; 2.4; 14.3), CP (4.90; 0.27; 1.72) and DOM (18.5; 1.3; 8.1) were all significantly lower ($P<0.05$) and NDF% (64.4; 68.6; 67.8) significantly higher ($P<0.05$) for southern Manchester/St. Elizabeth compared with mid Clarendon/Manchester. Harvesting at 9-wk compared with 6-wk interval in southern Manchester/St. Elizabeth appeared to improve the yield components, but the differences were not significant ($P>0.05$). Nutrient contents were also similar for the two harvesting intervals. It was concluded that under rainfed conditions and low input regime King grass should not be recommended for southern Manchester/St. Elizabeth.

INTRODUCTION

In 1990 the Caribbean Agricultural Research and Development Institute (CARDI) began a multi-facet project - CARDI/Technology Transfer and Applied Research Project (CARDI/TTARP) - in six territories (Antigua, Barbados, Dominica, Guyana, Jamaica, and Trinidad) in the CARICOM region. The project was conceptualized with emphasis on the transfer of known appropriate technologies in selected agricultural commodities and services of interest to the region. The CARDI Unit in Jamaica was involved in the Sheep and Goat Development Sub-project - one of the six constituent sub-projects of CARDI/TTARP.

About 95% of goat producers in Jamaica are classified as small producers (herd size 1 - 19, MINAG, 1991). They operate on small parcels of land (<2 ha, Robertson, 1991) which are devoted primarily to crop production. At the commencement of CARDI/TTARP the feeding systems employed by producers in the target area were free grazing and tethering (Robertson, 1991), which did not facilitate high levels of productivity. However, owing to land constraint it was determined that the development and/or transfer of any improved feeding technology should emphasize materials which accumulate a great amount of biomass vertically. King grass, Sugar cane and Leucaena are some of the crops which satisfy this requirement.

King grass (*Pennisetum purpureum* x *P. typhoides*) was introduced, along with other *Pennisetum* hybrids into Jamaica in 1983 (Logan 1986). However at the commencement of CARDI/TTARP there had not been any evaluation on it, although it had been determined (Motta, 1950; 1951) that forage yield of *P. purpureum* - one of the parents of King grass - was high from June-November and low from February-May. On the other hand, King grass has been evaluated in several other countries. In Venezuela the minimum yield of King grass in dry locations was 5.41 t/ha/yr and that in wet locations was 37.9 t/ha/yr (Guzman, 1983). In China King grass has been found to tolerate dry conditions (Bai *et al.*, 1994) and in Cuba the dry matter yield of the grass is reported to reach 50 t/ha/yr (Ramos *et al.*, 1979, cited by Garcia-Trujillo and Cáceres, 1982) with good yields even during the dry season (Hernández *et al.*, 1979, cited by García-Trujillo and Cáceres, 1982). These reviews suggested positive production attributes for King grass and on the strength of that it was posited that King grass production and utilization technology could be transferred to the farmers serviced under the CARDI/TTARP.

In the autumn of 1991 the project started to assist farmers with the establishment of King grass fodder banks. The grass was maintained under rainfed conditions and without any additional input. However, empirical assessment during the first year revealed apparent low production in the dry project areas. A study was, therefore, initiated in 1993 to undertake a mechanistic evaluation of the grass in the two principal ecozones in which CARDI/TTARP was located.

MATERIALS AND METHODS

The study was undertaken on six farms in the parishes of Clarendon, Manchester and St.Elizabeth in the central region of Jamaica. Three farms were located in the mid section of Clarendon and Manchester (mCM, average rainfall 1750 mm/yr) while the other three were in southern Manchester and St. Elizabeth (sME, average rainfall 980 mm/yr,

Figure 1). Rainfall distribution is bimodal in both ecozones (April - June and September - November). The soils in the two zones vary from St. Ann Clay Loam (over limestone) to Four Paths Loam and Agualta Sandy Loam, both alluvial soils (Stark, 1963).

Experimental design and forage sampling:

Sampling plots in the established King grass pastures were demarcated and cut back in the spring of 1993, and for the next two years forage yield and nutritive value were determined on the regrowth. In mCM the evaluation was done on six weeks regrowth (mCM_6) while in sME the samples were cut at six weeks (sME_6) and nine weeks (sME_9) intervals. Sample size ranged from 4 to 12 m^2 depending on the area sown in King grass. Goat manure was applied to the sampling sites at the rate of 25 t/ha/yr in mCM and 10 t/ha/yr in sME because there were fewer rainy days.

The experiment was structured as designed orthogonal contrast and set up as a randomized block design with four replications. The two sets of contrasts were: mCM_6 v sME_6, sME_9 and sME_6 v sME_9. On each sampling date (Table 1) the forage on each plot was cut to leave a stubble with one node above ground level, and the total forage weighed. Subsamples 200-500 g were taken and oven-dried at 65°C for 48 hours for dry matter (DM) determination.

Chemical analyses:

The dried subsamples were milled through a 1 mm mesh screen and analysed for crude protein (CP, AOAC, 1984), *in vitro* organic matter digestibility (IVOMD, Moore and Mott, 1974) and neutral detergent fibre (NDF, Goering and Van Soest, 1970).

Statistical analyses:

The data for forage yield and nutritive value were subjected to analyses of variance using MINITAB (MINITAB Inc., 1992) and the means for the contrasts, mCM_6 v sME_6, sME_9 and sME_6 v sME_9 were tested by t-test for designed orthogonal contrasts (Gill, 1978).

Table 1. Sampling dates

Sampling Dates		mCM_6 and sME_6	sME_9
1993/94	Cut 1	June 4	June 7
	Cut 2	July 16	August 9
	Cut 3	August 27	October 11
	Cut 4	October 8	December 13
	Cut 5	November 19	February 14
	Cut 6	December 31	April 18
	Cut 7	February 11	June 20
	Cut 8	March 25	August 22
	Cut 9	May 6	October 24
1994/95	Cut 10	June 17	December 26
	Cut 11	July 29	February 27
	Cut 12	September 9	May 1
	Cut 13	October 21	
	Cut 14	December 2	
	Cut 15	January 13	
	Cut 16	February 24	
	Cut 17	April 7	
	Cut 18	May 19	

RESULTS AND DISCUSSION

Nutritive value (CP%, IVOMD% and NDF%) and the yield of dry matter, crude protein and digestible organic matter (DOM) are shown in Table 2. Figure 2 shows the distribution of the dry matter yield over the two experimental years.

Crude protein content (% DM), IVOMD% and yield of DM, CP and DOM were all significantly lower ($P<0.05$) and NDF (% DM) significantly higher ($P<0.05$) for sME compared with mCM (Table 2). Harvesting the grass at 9-week intervals compared with 6-week intervals in sME appeared to improve the yield components (Table 2) but the differences were not significant ($P>0.05$). Nutrient contents were also similar for the two harvesting intervals in sME. These site-specific similarities between six-week and nine-week harvesting intervals for yield and nutrient content appear to be characteristic of King grass. At the Bodles Agricultural Research Station in Jamaica (17 56'N, 77 06'W, average rainfall 1070 mm/yr, Figure 1) Thompson (1992) noted that the number of tillers per King grass plant was seven for both six-week and nine-week harvesting intervals. The percent leaf, CP (% DM), IVOMD% and NDF (% DM) were 45.4 v 41.9, 10.3 v 9.6, 62.3 v 60.9 and 69.4 v

68.8, for six- and nine-week cutting intervals respectively (Thompson, 1992).

Table 2. Nutrient content, and yield of dry matter and nutrients of King grass, mean of two years.

	mCM	sME	sME	SE[1]		EDF[2]
	6 wk	6 wk	9 wk	mCM_6 v sME_6, sME_9	sME_6 v sME_9	
Manure (t/ha/yr)	25	10	10			
CP (% DM)	16.5	11.3	10.8	1.29	1.49	150
IVOMD (%)	61.5	54.8	56.2	1.68	1.95	150
NDF (% DM)	64.4	68.6	67.8	0.84	0.98	150
DM yield (t/ha/yr)	30.2	2.4	14.3	9.13	10.53	186
CP yield (t/ha/yr)	4.90	0.27	1.72	1.595	1.842	186
DOM yield (t/ha/yr)	18.5	1.3	8.1	6.52	7.54	186

[1]SE = standard error for comparing contrast means differences
[2]EDF = error degrees of freedom

In mCM dry matter accumulation tended to be greatest during the period April-July (1120 kg/ha/d, Figure 2, cuts 1-3, 9-10 and 17-18), and it was maintained at an average rate of 360 kg/ha/d during the dry season (December-March). This is in agreement with the observation by Cuban workers (Hernández *et al.*, 1979) that where moisture is not very limiting King grass has good yields even during the dry season. On the contrary for sME, apart from the spike in December 1994 due to exceptionally heavy rainfall in November of that year (sME_9, cut 10), dry matter accumulated at an average rate of 140 kg/ha/d. This was lower than even the accumulation rate for mCM during the dry season.

The low productivity of King grass in the southern ecozone could be attributed to the rainfall pattern *per se* of the zone, as well as its effect on the manure applied. The amount of rainfall in the area is low and this generally results in slow crop growth and productivity. Additionally, because of the low rainfall regime only relatively small amount of manure

could be applied, and even this small amount appeared to have decomposed slowly leading to slow mobilization and uptake of nutrients by the grass.

The negative effect of the low dry matter yield of King grass in the southern ecozone on stocking rate is quite obvious. It is estimated that in the southern ecozone 1 ha of King grass may provide dry matter for only 1.78 Animal Units per year, compared with 6.61 AU/yr for the mid parish ecozone (assuming dry matter intake = 3% body weight, 20% additional allowance for selection and King grass accounting for 85% of the daily dry matter intake). The other negative dimension is the effect of low nutrient content on the intake of animals. There is a clear positive relationship between forage intake and crude protein and digestibility contents (Van Soest, 1965; Minson, 1980) and a negative association with fibre content (Van Soest, 1965). Therefore it can be extrapolated that goats offered King grass in sME may not be able to consume as much as those in mCM.

CONCLUSION

The results of the study showed that under rainfed conditions and low input of manure the yield of DM, CP and DOM of King grass in southern Manchester/St. Elizabeth was low indicating that few goats could be fed from a given pasture/fodder bank area. The utilization of the relatively small quantities of nutrients would be further constrained by the limitation that would be imposed on intake by the relatively low content of CP and IVOMD, and high content of NDF. Therefore under these conditions King grass should not be recommended for pastures and fodder banks in southern Manchester/St. Elizabeth of Jamaica.

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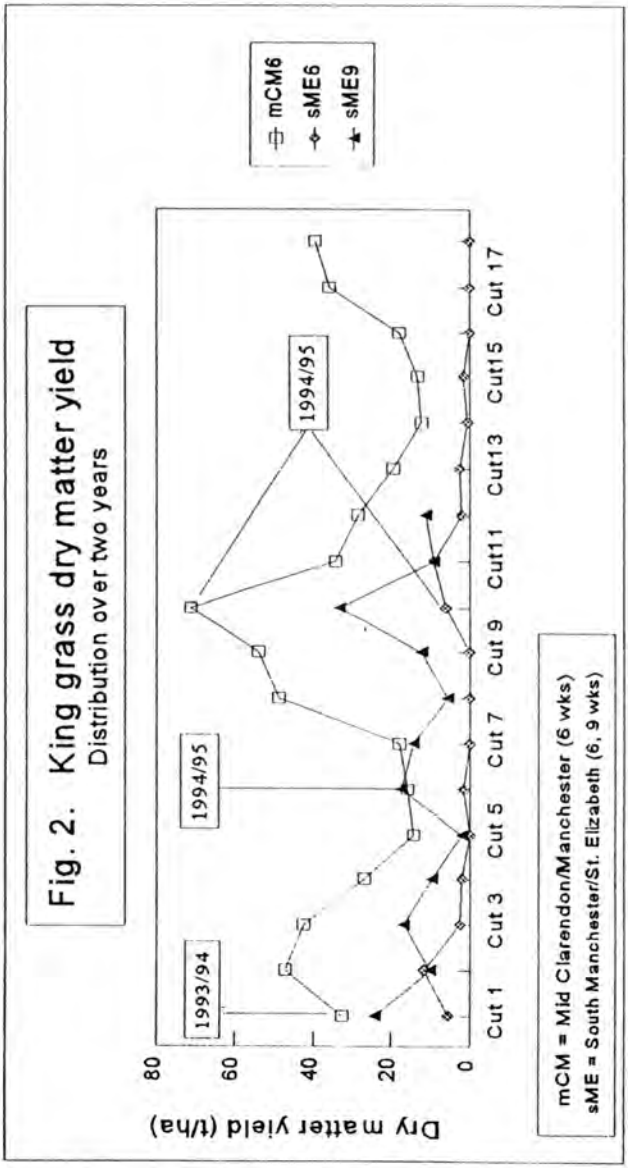

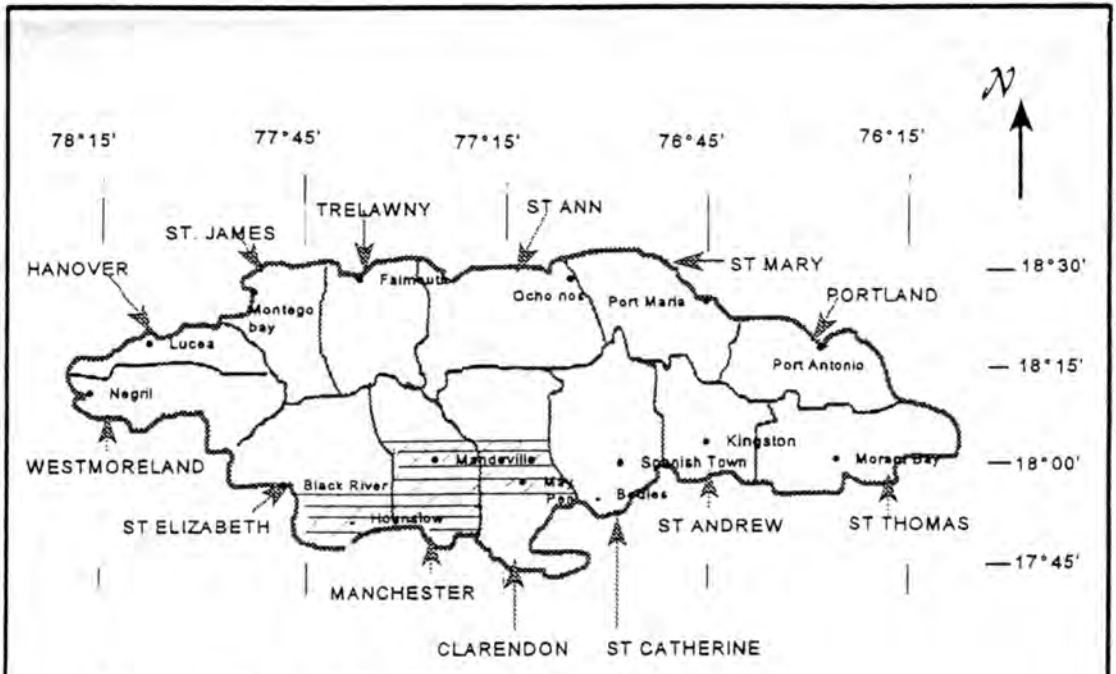

Fig. 1. Map of Jamaica showing experimental area

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GRAZING MANAGEMENT FOR IMPROVED GUINEA GRASS PERSISTENCE

M.B. Adjei, T.J. Gentry, and R.W. Godfrey, University of the Virgin Islands, Agricultural Experimental Station, RR2, 10,000 Kingshill, St. Croix, U.S.V.I. 00850.

ABSTRACT. Sustainable, tropical forage-livestock production systems must be based on maintenance of pasture botanical composition. Sheep were allowed to graze rotationally (14 d graze, 28 d rest) on a guinea grass (*Panicum maximum*) pasture at four levels of herbage-on-offer (HO) of 4, 7, 10, and 13% dry matter of animal body weight (BW). Rotational grazing was continued for three years and HO was regressed on forage and animal data to determine carrying capacity of the pasture. Mean, yearly stocking rate declined linearly from 775 to 540 kg BW ha^{-1} d^{-1} in response to increasing HO. Grass canopy heights for the pre-graze (0.35-0.65 m) and post-graze (0.20-0.45 m) pasture increased in a curvilinear pattern with HO. In both cases, the greatest increase in height occurred between the 4% and 7% HO, followed by marginal increments as HO was increased further. Pre-graze herbage mass increased linearly from 1.0 to 2.5 Mg ha^{-1} and post-graze herbage mass increased curvilinearly from 0.7 to 2.0 Mg ha^{-1} as HO was increased. The guinea grass frequency of occurrence on pasture prior to initiation of grazing was approximately 95%. Frequency remained unchanged during the first year of grazing but declined to 75% following three years of rotational grazing at the 4% HO compared to 85-95% at the remaining HO. The frequency of broad leaf weed occurrence which was 17%, initially, remained constant under 13% HO treatment but increased linearly to approximately 100% as HO was reduced to 4%. Sheep average daily gain ranged between 0.071 and 0.076 kg independently of HO, whereas, due to major differences in stocking rates, yearly liveweight gain increased from 630 kg ha^{-1} with 13% HO to 815 kg ha^{-1} with 4% HO treatments. These results indicate a direct link between high, short-term animal production potential at high stocking rates and rapid guinea grass pasture deterioration to undesirable plant associations. Our estimate of the optimum stocking rate under a rotational grazing management system for St. Croix ranged from 575 to 690 kg BW ha^{-1} da^{-1}, depending on the seasonal rainfall (1000-1200 mm).

INTRODUCTION

The ruminant livestock industry in the Virgin Islands and the Caribbean at large is supported primarily by grazing native pastures. These pastures are dominated by guinea grass (*Panicum maximum*) and the browse legume leucaena (*Leucaena leucocephala*) in productive sites. Native pastures also usually contain some herbaceous legumes such as desmanthus (*Desmanthus virgatus*) and teramnus (*Teramnus labialis*), and can, if properly managed, satisfy much of the nutritional requirement of ruminant livestock. However, guinea grass is not drought tolerant and its inability to produce forage in a cyclic dry season is perhaps its chief limitation.

Pasture overgrazing, especially during the dry season, has resulted in widespread range deterioration on the Virgin Islands to less productive associations of hurricane grass (*Bothriochloa pertusa*) and the spiny woody legume casha (*Acacia* spp.). Under conditions of extreme overgrazing a number of broad leaf weeds such as maran (*Croton astroites*), sida (*Sida carpiniifolia*), man-batter-man (*Achyranthes indica*), thistleroot (*Argenome mexicana*), physic nut (*Jatropha curcas*), Hollow stalk (*Leonotis nepetaefolia*), castor bean (*Ricinus communis*), stinging nettle (*Tragia volubilis*), and even bare ground become dominant.

This experiment was conducted to determine the carrying capacity of native, predominantly guinea grass, pasture for sustainable sheep production in the Caribbean based on an evaluation of (1) dynamics of pasture botanical composition and (2) animal performance.

MATERIAL AND METHODS

The experiment was conducted at the sheep research facility of the University of the Virgin Islands' Agricultural Experiment Station. Four levels of herbage-on-offer (HO) (4, 7, 10, and 13 kg DM 100-kg^{-1} body weight, BW) were assigned to three 0.2-ha fields each of renovated native pasture in a randomized complete block design. Each pasture replicate was subdivided into three 0.07 ha paddocks that were grazed in rotation of 14 d grazing, followed by 28 d rest to give a grazing cycle of 42 d. Two tester weaned lambs (approximately 16 kg initial BW) and additional grazer animals, to meet prescribed HO, were allowed to graze a pasture 24 h d^{-1}, beginning in February, 1992. All sheep were weighed at 14 d intervals in order to make adjustments in grazers to meet prescribed HO. Animals were given free access to shade, mineralized salt and water. Testers were replaced when their BW reached approximately 30 kg and grazing was maintained rotationally through 1993 and 1994. There were 9 grazing cycles in each season (378 d). Weight changes of testers were used to

calculate average daily gain (ADG) for each 42 d grazing cycle and also for the entire season. Stocking rate (kg BW ha^{-1} d^{-1}) was calculated using both tester and grazer animals. Gain ha^{-1} was calculated as the product of ADG, stocking rate adjusted for the average tester BW and the number of grazing days.

Herbage mass (HM), an instantaneous measure of total weight of herbage per unit area of ground at the start (pre-graze) and end (post-graze) of each grazing in a paddock was estimated by clipping forage in six 0.5 m^2 randomly selected plots to 7.5 cm stubble height. Subsamples were dried at 60°C to constant weight for dry HM ha^{-1}. Pre-graze and post-graze herbage canopy heights were measured for guinea grass and leucaena from six random spots in each paddock. Dried pre-graze herbage was composited across paddocks within a pasture for each 42 d grazing cycle, ground and analyzed for crude protein (CP) and in vitro organic matter digestion (IVOMD).

Frequency of plant species (guinea grass, hurricane grass, leucaena, desmanthus, teramnus, casha, and broadleaf weed) occurrence was measured at the beginning of the trial and then annually (June-July), using a modified line transect and point method. The point consisted of a 0.325 m square quadrant. Lines were laid at 5.0 in intervals across the width of a paddock and quadrant was dropped every 1.0 m along the line, making 1.0 x 5.0 girds on each paddock. Plants with canopy falling within the quadrant were recorded as present. Bare ground was also recorded when it covered more than 50% of quadrant.

Carrying capacity (stocking rate at optimum herbage allowance) of the native pasture was determined by regressing HA separately on ADG and botanical data using the REG procedure of SAS.

RESULTS AND DISCUSSION

The 2-yr mean seasonal stocking rate associated with prescribed levels of herbage allowance ranged from 540 to 775 kg BW ha^{-1} d^{-1} (Figure 1). Given that an average mature St. Croix White sheep weighs approximately 35 kg, these values corresponded with 15 to 22 mature sheep ha^{-1} for the lowest and highest HO, respectively. This represented a linear ($P<0.0001$) decline in SR with increasing HO.

Both the pre- and post-graze guinea grass canopy heights were positively related to HO. Pre-graze guinea grass canopy height increased in a curvilinear pattern ($P<0.001$) from 0.35 m to 0.65 m as HO was increased (Figure 2a). Post-graze grass canopy height increased from 0.2 m to 0.45 m with increasing HO (Figure 2b). In both cases, the greatest increase in canopy height occurred between the 4% and 7% HO, followed by marginal increments as HO was increased further.

Changes in leucaena canopy height were characterized by significant linear ($P<0.0001$), quadratic ($P<0.01$) and cubic ($P<0.03$) effects of HO (Figure 2c and 2d). Analysis conducted using orthogonal contrasts showed no statistical difference in pre- or post-graze canopy height between the 7% and 10% HO for any season.

Pre- and post-graze herbage mass provided the best overall relationship to HO across all grazing cycles (seasonal $R^2=0.61$, $P<0.0001$). Pre-graze herbage mass increased linearly from 1.0 to 2.5 Mg ha^{-1} as HO was increased from 4 to 13% (Figure 3a). Post-graze herbage mass increased curvilinearly from 0.7 to 2.0 Mg ha^{-1} with no statistical difference between values for the 7% and 10% HO (Figure 3b).

Guinea grass frequency of occurrence prior to initiation of grazing in 1992 was approximately 95%. This frequency remained practically unchanged under all HO during the first year of grazing. However, the frequency of guinea grass occurrence decreased to 75% following 2-yr rotational grazing at the 4% HO compared with 85%-95% at the remaining HO (Figure 4a). By contrast, the proportion of leucaena present in the original pasture decrease by 20-30% after 2-yr grazing, regardless of HO (Figure 4b). Visual observation indicated selective leucaena grazing by sheep and greater grass competition at the higher HO treatments which probably contributed to the lack of response of leucaena frequency to HO. Of the other important pasture legumes, the frequency of teramnus which initially was 12% decreased to 2.5%-7% in an inverse linear relationship to HO after 2-yr grazing (data not shown). Desmanthus was the only pasture legume that showed increased frequency of occurrence under heavier grazing pressure. Its initial frequency prior to 1992 grazing was 26%. Desmanthus frequency at the end of 2-yr grazing was 23%, 31%, 29%, and 39% for the 13, 10, 7 and 4% HO treatments, respectively.

Among the pasture weeds, the original frequency of hurricane grass occurrence was 3%. At the end of 2-yr grazing, the incidence of hurricane grass on pasture had increased to 15-24% (Figure 5a). However, the effect of HO on hurricane grass population dynamics was not clear-cut. This was partly due to the confounding effect from a large shade tree (*Swietenia mahagoni*) in one replicate of the 10% HO treatment. Sheep congregated in shaded areas and also in areas adjacent to alley-ways which created pockets of overgrazed sites even at the higher (7%-13%) HO treatments. Therefore, whereas the sixfold increase in hurricane grass incidence at the liberal HO was restricted to overgrazed micro-environments, the increase at the 4% HO was widespread throughout the entire pasture.

Casha (*Acacia* spp.) frequency of occurrence which initially stood at 1% increased independently of HO to 1.5-3% after 2-yr grazing (data not shown). However, HO had a negative linear effect on other broadleaf weed

(BLW) incidence following 2-yr grazing. The initial 1992 pre-grazing frequency of BLW occurrence was 17%. That value remained constant under 13% HO treatment but increased linearly to approximately 100% as HO was reduced to 4% (Fig. 5b).

Sheep average daily gain ranged between 0.071 and 0.076 kg and the effect of HO was not significant. However, as a result of major differences in animal stocking rates, sheep seasonal (378 d) liveweight gain increased from 660 kg ha^{-1} with 13% HA to 845 kg ha^{-1} with 4% HO treatment (Fig. 6).

CONCLUSIONS

Although short-term high animal production is obtainable with high stocking rates, the results from this experiment provide direct evidence of rapid guinea grass pasture deterioration to undesirable plant species under that type of management. Minor differences in botanical parameters between the 7% and 10% HO treatments seem to indicate the locus of an optimum range. For a rotational grazing management system, this optimum will correspond with varying the stocking rate between 575 and 690 kg BW ha^{-1} d^{-1} depending on the rainfall situation. The concentration of hurricane grass weed on repeatedly grazed pockets even at liberal HO suggest a lower carrying capacity for a continuously grazed system. Further experiments are being conducted to compare pasture performance under a faster rotation with a continuos grazing system.

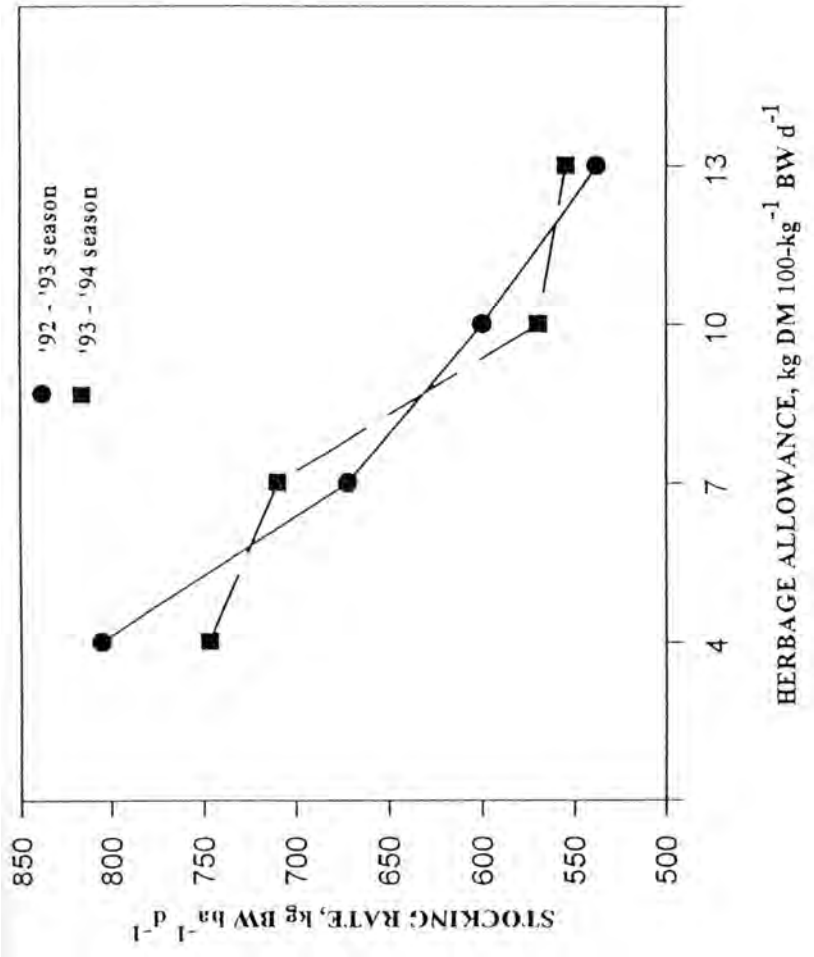

Figure 1. Annual stocking rate associated with grazing native pasture at different levels of herbage allowance.

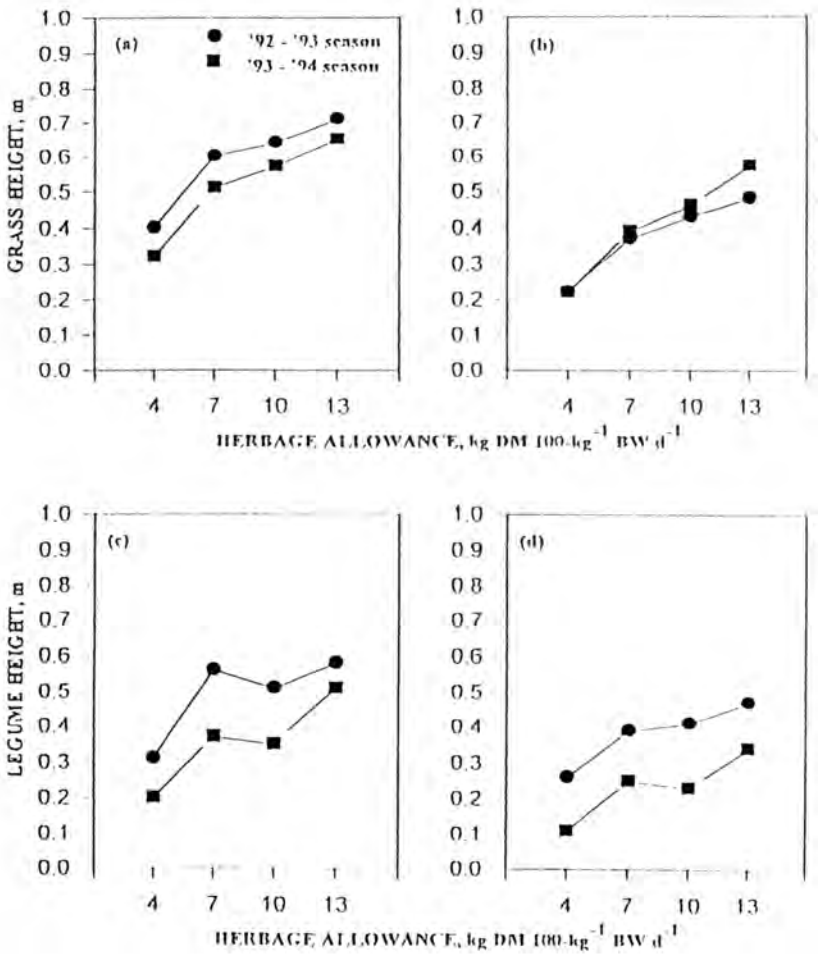

Figure 2. Pre- (a) and post- (b) graze guineagrass; and pre- (c) and post- (d) graze leucaena canopy heights as affected by levels of herbage allowance.

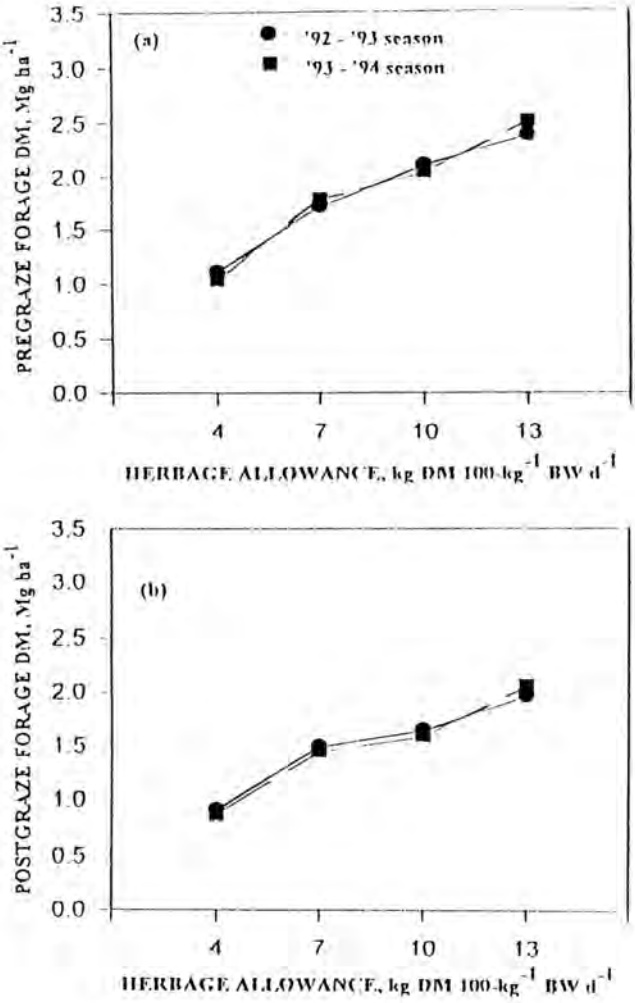

Figure 3. Forage dry matter on-offer at pre- (a) and post- (b) grazing as affected by levels of herbage allowance.

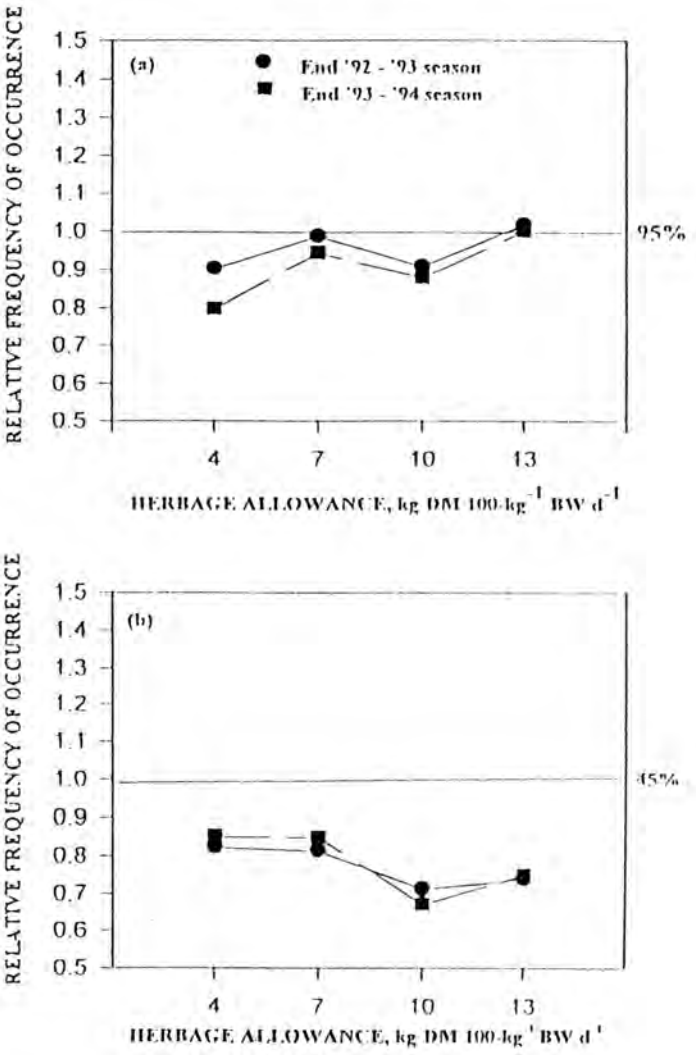

Figure 4. The frequency of occurrence of guineagrass (a) and leucaena (b) relative to their initial 1992 prograzing occurrences (95% and 45%, respectively) as affected by levels of herbage allowance.

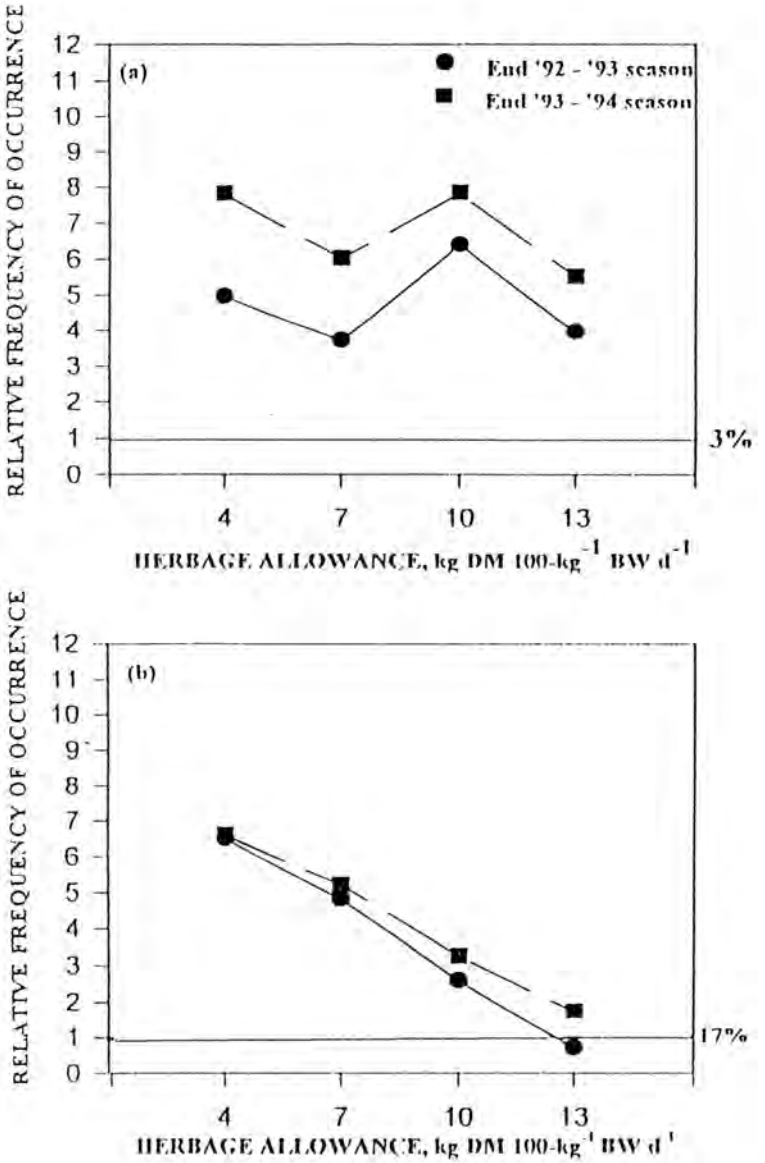

Figure 5. The frequency of occurrence of hurricane grass (a) and broad leaf weeds (b) relative to their initial 1992 pregrazing occurrences (3% and 17%, respectively) as affected by levels of herbage allowance.

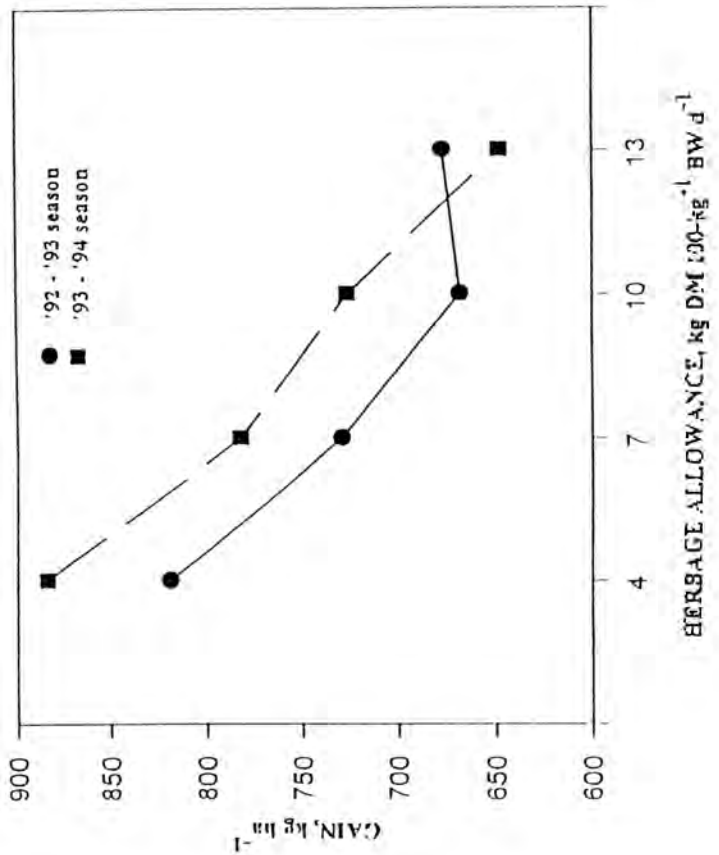

Figure 6. Annual sheep liveweight gain per ha as affected by herbage allowance.

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INFLUENCE OF HEDGEROW CANOPY GROWTH ON THE INTERCEPTION OF PHOTOSYNTHETICALLY ACTIVE RADIATION

J.J. O'Donnell and A. Bulbulla, Agricultural Experiment Station, University of the Virgin Islands, RR 2, Box 10,000, Kingshill, St. Croix, U.S.V.I. 00850.

ABSTRACT. Alley cropping is an agroforestry system in which alleys for crop production are formed by hedgerows of trees or shrubs. The hedgerows can be beneficial by cycling nutrients and providing mulch through their prunings. But, they can also compete with the crop resulting in reduced yields. Hedgerow-crop competition for light is one factor in yield reduction. The effect of canopy growth on light competition was analyzed by measuring photosynthetically active radiation (PAR) at ground level and calculating the fractional interception (FI) of PAR by three hedgerow species (*Gliricidia sepium, Leucaena leucocephala, and Moringa olifera*). Height and width growth and leaf area index (LAI) of the hedgerow canopies were also measured. In each of the four weekly measurements, *Leucaena* had the highest average FI. In general, FI by *Leucaena* was greatest nearest the hedgerow. Farther from the hedgerow there were no differences in FI between the three species. *Leucaena* and *Moringa* hedgerows were taller and the *Leucaena* hedgerow was the widest. *Gliricidia* had the lowest LAI in the first three measurements. There were no differences in LAI between the hedgerows in the final measurement. It appears that the *Leucaena* hedgerow is a stronger competitor for light following pruning. This may be due to its rapid regrowth after pruning, canopy geometry and higher LAI.

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YIELD AND QUALITY OF FOUR PANICUM HYBRIDS AND TWO GUINEAGRASS CULTIVARS AS AFFECTED BY THREE HARVEST INTERVALS

A. Sotomayor-Rios, A. Quiles-Bélen, and S. Torres-Cardona, USDA-ARS, Tropical Agriculture Research Station, P.O. Box 70, Mayagüez, Puerto Rico 00681-0070.

ABSTRACT. Lack of sexual female plants and the presence of apomixis make it difficult to develop superior *Panicum* hybrids. Four *Panicum* hybrids developed at TARS, H-101, H-102, H-103, and H-104, and two guineagrass (*P. maximum*) cvs, common guinea and Tobiatá of CIAT, were evaluated at 4-,6-, and 8-wk cutting intervals (CI). Across harvest, H-101 and Tobiatá were the tallest; Tobiatá had significantly the highest leaf area and leaf/stem ratio; H-101, the highest dry matter (DM) content; and H-104 and Tobiatá, the highest DM yield (common guinea had the lowest). Crude protein (CP) yield of H-101 and common guinea was significantly lower than that of the other genotypes. Overall DM yield was significantly higher at the 8-wk CI; no significant differences were observed between the 4-wk and 6-wk CI. The best genotypes in terms of total yield were H-104 and Tobiatá.

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EFFECTS OF DEFOLIATION AND DEFLORATION RATES ON GROWTH AND NET PHOTOSYNTHETIC RATE OF PEANUTS IN HYDROPONIC CULTURE

P.P. Davis, C.K. Bonsi, A.A. Trotman, and D.G. Mortley, Tuskegee University, Tuskegee, AL 36088 USA.

ABSTRACT. Peanut is an extremely valuable crop for tropical regions. It is a major source of protein (25%), phosphorous, iron, potassium, thiamin, and niacin. Peanut is one of three subsurface crops identified by National Aeronautics and Space Administration (NASA) for bioregenerative studies. The objective of which is to optimize growth conditions for adaptability for closed bioregenerative systems. The main objective of this study was to evaluate the effects of source-sink alteration on peanut production. The source was altered by 25, 50, or 75% defoliation of the main stem and one side branch during early flowering 50 days after planting (DAP), early

podding (80 DAP) and late pod filling (110 DAP). The sink was altered by removing reproductive structures, mainly flowers (defloration) 110 DAP and continuing thereafter until final harvest. Removal of leaves from the main stem and side branch did not significantly affect pod #, pod weight, shoot fresh weight, final leaf # or leaf area. In addition, alteration of the sink by defloration did not affect final pod yield or any other parameters measured. This suggests peanut may have the ability to compensate photosynthetically for defoliation. Net photosynthetic rates showed a slight decrease 10 minutes after defoliation but recovery was evident 24 hours after defoliation occurred. Transpiration and stomatal conductance rates also showed significant decreases immediately following defoliation.

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MOVILIZANDO INFORMACION Y APRENDIZAJE SOBRE EL USO DE CULTIVOS DE COBERTURA Y ABONOS VERDES: LA EXPERIENCIA DE CIDICCO

Milton Flores, *CIDICCO, Centro Internacional de Información Sobre Cultivos de Cobertura, Apartado 4443, Tegucigalpa, Honduras.*

RESUMEN. El uso de cultivos de cobertura, particularmente de plantas leguminosas, ha tomado gran interés en los últimos años debido a la contribución de estas plantas en los procesos de producción agrícola. Aunque en los países desarrollados el uso de leguminosas como mecanismo de mejoramiento del suelo se empleó durante largos años, en Centroamérica la información sobre los usos, manejos y costos del empleo de estas alternativas no circula adecuadamente. Sin embargo, en toda América existen numerosas experiencias que deben de ser conocidas por la comunidad que trabaja en el mejoramiento de las condiciones de vida del pequeño productor. La información sobre este tema se encuentra dispersa entre miles de agricultores grandes o pequeños; en centros académicos o de investigación formal o entre el creciente número de organismos no gubernamentales que existen hoy en día. Los poseedores o fuentes de esta información tienen razones para continuar obteniéndola. Estas razones van desde las meramente productivas (productores) hasta las de lograr el reconocimiento de la comunidad científica internacional (científicos). Y todos, de una manera u otra, desean que esa información sea de utilidad al desarrollo de la agricultura. Pero al querer hacer circular la información que cada uno posee, se enfrentan a restricciones que limitan la utilidad de la misma. Pero además se requiere hacer una labor de adaptación de esa información para que sea digerible por un mayor número de interesados

empleando una diversidad de mecanismos para hacerla circular. Este trabajo concluye en que, aunque existe un predominio de los medios escritos para transmitirla, deben activarse alternativas más personales como el intercambio de experiencias a niveles nacionales e internacional, talleres y métodos participativos para difundir la información y provocar el pensamiento independiente y analítico para enseñar, aprender y fomentar en los productores el sentido natural de la experimentación.

ABSTRACT. In the past years a great interest has occurred on the use of cover crops, specifically legumes, in crop production systems. Although cover crops have been used for quite some years in underdeveloped countries, the information available in Central America has not been disseminated properly. In all of the western hemisphere numerous experience on the use of cover crops has been documented. Unfortunately, this information is currently dispersed within a large population of small and large farmers, research centers, and non government organizations to name a few. Information continues to be gathered on this topic with different purposes. There are certain restrictions to the dissemination and utilization of this information. This information needs to be presented in a concise manner and some mechanisms has to be employed to increase it's circulation. We feel that although most of this information is in a written form, an alternative to increase its dissemination is to use a more personal approach. For example, we should foster workshops at the national and international level to exchange ideas and experiences. Also, more participation within the producers will stimulate a greater independent and analytic thought process that could lead to increase learning and use of this technology.

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SOIL FERTILITY AND THE EROSION PROCESS ON HILLSIDE FARMS

Robert Walle and Brian Sims, *Silsoe Research Institute, Wrest Park Silsoe, Bedford MK45 4HS England.*

ABSTRACT. Despite the availability of proven soil conservation practices, academic research continues and widespread adoption has not occurred. Farmer selection and evaluation of practices is essential to any soil and water conservation program. The principal soil conservation practices under evaluation are live barriers, cover crops and their interaction. The effect of erosion on soil fertility is being evaluated over

four years to determine the effectiveness of the conservation practices with regard to adaptability to the farmers needs and the forces that shape the hillside environments. The first phase of the project involved the installation of five live barriers and the selection of appropriate cover crop species based on farmer and researcher criteria. The current phase involves the interaction of live barriers and cover crops using on-farm trials. The installation of five live barriers has resulted in decreased soil erosion and the formation of a natural terrace system. The presence of soil fertility gradients within the natural terrace system have been documented and will be used to suggest alternative methods for utilizing cover crops in the second phase of the project.

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GERMPLASM EVALUATION PROJECT FOR TROPICAL LEAF VEGETABLES AT THE UNIVERSITY OF THE VIRGIN ISLANDS

M.C. Palada, S.M.A. Crossman, and J.A. Kowalski, University of the Virgin Islands Agricultural Experiment Station, RR 2, Box 10,000, Kingshill, St. Croix, U.S. Virgin Islands 00850.

ABSTRACT. The increased consumption of new and exotic vegetables of tropical origin such as dasheen (*Colocasia esculenta* L. Schott.) and amaranth (*Amaranthus spp.*) has stimulated great interest for research on these crops. Tropical and specialty green leaf vegetables are a major group of horticultural crops that have been the focus of attention in national symposia on new crops. The U.S. imported significant amounts of tropical green leaf vegetables during the past 5 to 8 years, and this trend will likely continue. Some of these crops can be grown in the U.S., but factors such as scarcity of seeds and planting materials coupled with inadequate information on cultural management practices limit the production of these crops in the U.S. The University of the Virgin Islands has initiated a research project to collect and evaluate germplasm of tropical leaf vegetables with market potential. The approach of this project includes: 1) germplasm collection and evaluation; 2) development of sustainable crop management and cropping systems and 3) conservation and maintenance of germplasm materials. Preliminary field evaluation trial indicates that Malabar spinach (*Basella spp.*); water spinach (*Ipomoea aquatica* Forsk.); potato greens (*Ipomoea batatas* L., Lam.); and jute mallow (*Corchorus olitorius* L.) showed potential yields comparable to yields of common leaf vegetables such as collard (*B. oleracea* L., Acephala); and mustard green (*B. juncea* L., Czerniak). Multiple harvests from these crops during the growing season resulted in fresh edible yields ranging from 3.22 to 52.0 g m^{-2} day^{-1}.

INTRODUCTION

Tropical and specialty green leaf vegetables are one of the major groups of horticultural crops that have been featured in the new crops symposia during the past five years (Janick and Simon, 1990; 1993). The proceedings from these symposia indicate that new and exotic tropical horticultural crops including leaf vegetables are becoming important in the United States and will somewhat change the focus and emphasis of food production in the next decade.

Tropical leaf vegetables are commonly grown in the tropics and are rich sources of nutrients, particularly minerals and vitamins. A number of species and cultivars have been introduced in the U.S. on a limited scale, particularly in the southern region (Lamberts, 1993). The U.S. is a major market for tropical and specialty greens and most of the shipments come from the Caribbean and Latin America. For example, in 1988, total U.S. imports for dasheen leaves was over 90 metric tons. From this total, 70% came from Jamaica and 30% from the Dominican Republic (Pearrow, 1991). During the same year, the U.S. imported 27.4 metric tons of vegetable amaranth from the same countries. Additionally, shipments of Oriental, Mexican, tropical, and exotic produce including specialty leafy greens accounted for about 5% of fresh vegetable shipments, whereas in previous years the volumes had been too low to track (Cook, 1990; Lamberts, 1990; 1993).

There are several reasons for the increasing demand of tropical and specialty leafy greens in the U.S. One is that, growth in ethnic populations contributes to the demand for product diversity within the produce section (Cook, 1990). Food previously considered ethnic or regional in nature increasingly are being consumed by a broader portion of the population. This trend will likely continue as the ethnic population continues to grow, and more Americans become familiar with and develop the taste for the new crops.

Tropical leafy greens include plants with a wide variety of germplasm. Leaves of these plants are used mainly for culinary purposes or as pot herbs. Some species have medicinal value and are, therefore, used to remedy certain diseases. Their greatest contribution to human nutrition is their high contents of essential minerals and vitamins. When consumed daily, they provide adequate amounts of the daily requirement for vitamins and mineral for adults and young children.

Tropical leafy greens have their origin in tropical Africa, Asia, the Caribbean and Latin America. In these regions, they are grown in home gardens and on small to medium scale farms. Some of the popular tropical leafy greens include celosia (*Celosia argentia* L.), Malabar or Ceylon spinach, kangkong or water green, jute or jews mallow, moringa (*Moringa oleifera* Lam.) and chaya (*Cnidoscolus chayamansa* McVaugh) in addition to dasheen and amaranth mentioned above.

Research and development efforts on crop improvement and improved production practices for these crops have been minimal. These crops are considered minor vegetables and therefore, research studies are given low priority. As demand for tropical leafy greens increases, the need for information on crop production and post harvest practices will increase. This will be a great challenge for researchers as well as farmers. Also, there is a need for conserving the germplasm of these crops. One of the

factors limiting the production of these crops in the U.S. is the scarcity of seeds and planting materials.

The U.S. Virgin Islands has an ideal climate for growing tropical green leaf vegetables. Production of tropical, exotic and specialty green leafy vegetables offers economic opportunities and advantages and can contribute to the economic growth of the Virgin Islands. As alternative and new crops, tropical and specialty greens will have good market potential to meet increasing demands in the U.S. mainland. Growers will have a better market advantage in producing these crops and shipping them to specialty markets in the U.S. compared to growing traditional vegetables such as tomatoes, peppers, eggplant, since they cannot match the low market price of these vegetables coming from the U.S. mainland.

The objectives of this project are: 1) to collect and evaluate germplasm of minor tropical green leaf vegetables in terms of plant growth characteristics and yield potentials; 2) to evaluate response of germplasm materials to growing environmental conditions including pest and disease pressures; 3) to develop sustainable crop management practices and cropping systems for improving yields of tropical leaf vegetables with market potential in the U.S.; and 4) to maintain germplasm of promising species and cultivars of exotic tropical leaf vegetables for future studies on crop improvement and development.

PREVIOUS AND RELATED CURRENT RESEARCH

For the past 20 years, little research have been done on tropical and specialty leaf vegetables. Several books and manuals were published in the 70s and 80s covering information and literature on tropical leafy greens. Among the few relevant references are those published by Dupriez and De Leener (1989); Herklots (1972); Martin and Ruberte (1979); NAS (1975); Oomen and Grubben (1978); Stephens (1988); Tindall (1983); and Yamaguchi (1983). Most information covered in these publications deal with botanical description, cultivation and utilization of these crops. There are other valuable sources of information on tropical leaf vegetables prior to 1970 which were cited by above-mentioned authors. Few published journal articles exist dealing with research on crop improvement and cropping systems for tropical leaf vegetables. Recent interest on new crops in the U.S. will encourage and stimulate researchers to conduct more project studies on tropical leaf vegetables.

Germplasm: At present no single organization devotes its program solely for germplasm collection and evaluation of tropical leaf vegetables. The International Genetic Resources Institute (IPGRI) has published a directory of germplasm collection for vegetables including amaranths (Bettencourt

and Konopka, 1990), but does not include other minor tropical leaf vegetables. Availability of germplasm is limited for these crops and gene banks in the U.S. may have some collections of a few genera and species. Germplasm materials for specific tropical leaf vegetables are only available in countries where they are commonly grown. Oomen and Grubben (1978) listed about 50 genera and species, whereas, Martin and Ruberte (1979) reported more than 400 species. A large number of species exist in Africa, while in Southeast Asia, Indonesia is one of the richest sources of tropical leaf vegetables. In Africa, Dupriez and De Leener (1989) listed 25 popular species including cool season types.

Tropical leafy greens are classified according to plant type, use and importance (Martin and Ruberte, 1979). Based on plant type, they are described as herbaceous, viny, shrubby, arboraceous, annual and perennial. Classification by use includes salad, garnish, relish, pot herb, and condiment. Oomen and Grubben (1978) classified tropical leaf vegetables into four major groups: annual hot season, annual cool season, perennial, and leaves of food crops grown for other purposes. This classification is arbitrary since a given species can fall under two or more groups.

According to Oomen and Grubben (1978), good seeds of tropical leaf vegetables are hardly ever available in the tropics. They reported that only in India is a well-organized seed industry for important species has been set up. Market growers of tropical leaf vegetables must be advised to harvest their own seeds from the most vigorous and best quality plants and to clean and dry them well before use. Similarly, cuttings of vegetatively propagated vegetables such as bitterleaf (*Vernonia amygdalina* Del.), chaya, cassava (*Manihot esculenta* Crantz) and kangkong, are not commercially available, therefore, growers must acquire them from a local source.

Breeding for Crop Improvement: There has been little breeding work done for the improvement of minor topical leaf vegetables. Being a group of minor crops, less attention has been focused on improving plant types and cultivars. Traditional books and manuals only give general classification, including botanical names, origin, plant types, varieties, utilization and cultural management practices for tropical leaf vegetables (Martin and Ruberte, 1979; Oomen and Grubben, 1978). Vegetable breeding in the tropics has been focused on important crops like tomatoes, peppers and cabbages (Winters and Miskimen, 1967). Most of the vegetable improvement investigations has been conducted by agencies of various governments as well as international research centers and private corporations. Reviewing the past breeding programs of these agencies indicates that emphasis is given to major vegetable crops with economic importance. Like many vegetable crops, tropical leaf vegetables are also

subject to high pressures of pests and diseases. An extensive, coordinated vegetable breeding program is greatly needed for tropical leaf vegetables to develop cultivars with climatic adaptation that will resist the insects and diseases present in a particular agro-ecological region.

Most of the studies related to crop improvement for tropical leaf vegetables were related to cultivar evaluation, and a number of studies were carried out for vegetable amaranth (Grubben, 1980; Martin and Ruberte, 1977; Martin and Telek, 1984; Sealy *et al.*, 1990). Selection of cultivars for local conditions has been done in India, Puerto Rico, Benin, and Nigeria, but very little has been accomplished towards breeding for better cultivars (Martin and Telek, 1984). Not much has been done on cultivar screening for other leaf vegetables such as celosia, jute mallow and water spinach. Research has been done in the U.S. on cultivar evaluation for cool season Oriental greens such as Chinese cabbage, pak choy, and related species in the brassica family (Coffey and Disney, 1992; Fo *et al.*, 1993; Palada, 1984; Palada *et al.*, 1987). These studies have identified suitable cultivars for production in the northern and southern U.S.

Crop Management: A wealth of information on crop management practices for growing tropical leaf vegetables is available from several books and manuals (Dupriez and De Leener, 1989; Harrington, 1978; Herklots, 1972; Knott and Deanon, 1976; Martin and Ruberte, 1979; Oomen and Grubben, 1978; Stephens, 1988; Tindall, 1965; Winters and Miskemen, 1967; and Yamaguchi, 1983). These references provide excellent discussion on cultural practices from seedling establishment or vegetative propagation by stem cuttings to plant spacing, fertilizer application, and harvesting. Information is also given on climatic and soil requirements for each species and pest and disease associated with crops. Recommended cultural practices and yield of some tropical leaf vegetables have been reported by AVRDC (1985) and by Oomen and Grubben (1978). Although recommended crop management practices are mentioned for each crop, these recommendations are general and may not always apply to a specific location. Site specific studies are needed especially on plant population density, fertilizer levels, water use, cropping systems and pest management. Singh and Whitehead (1993) studied the effects of plant density and soil pH on vegetable amaranth production and concluded that yield increased quadratically as intra-row spacing decreased. Growth was adversely affected by soil pH below 6.4. There is also a need for research on developing sustainable crop management practices and cropping systems as most of these vegetables are grown under low-input management systems in the tropics.

Pest Management: The most common damage in tropical leaf vegetables is caused by insects feeding on leaves, generally caterpillars (Oomen and Grubben, 1978). These pests not only hamper growth and yield, but they also damage the leaves, reducing the quality, attractiveness and market value of the crop. The application of chemical insecticides is generally the most efficient way for market gardening, but their use implies risk to health and the environment. Studies on environmentally sound pest control methods for tropical leaf vegetables are needed, especially with recent availability of less toxic bio-organic pesticides. Wilting is a common disease of tropical leaf vegetables caused by fungi and bacteria while root knot nematodes frequently cause swellings and nodules on the roots resulting in retarded growth. Both diseases can be controlled by sound cultural practices such as good soil drainage, fertilizer application and crop rotation. So far, not much studies have been done on these practices for tropical leaf vegetables.

APPROACH

Germplasm Collection and Evaluation: The emphasis of germplasm collection and evaluation will be directed towards minor tropical leaf vegetables. Seeds or planting materials will be collected for the following groups as shown in Table 1a to 1d. Germplasm collection for these crops will be conducted in several ways: 1) local survey, inventory and collection, 2) orders through seed catalogs and seed companies carrying specialty vegetable crops, 3) sending requests to various seed/gene banks and repositories in the US and abroad, 4) sending requests to other institutions conducting studies on tropical greens, e.g. universities, private and non-governmental agencies, and international agricultural research centers including the IPGRI and Caribbean Agricultural Research Institute (CARDI). These organizations will be contacted via e-mail or through the internet.

Table 1a. Annual Warm Season Tropical Leaf Vegetables for Collection and Evaluation.

Botanical/Scientific Name	Common/English Name
Amaranthus spp.	Vegetable amaranth, amaranthus
Basella spp.	Ceylon spinach, Malabar spinach
Celosia argentia	Celosia
Colocasia esculenta	Taro, Calalou
Corchorus olitorius	Jute/Jews Mallow, Bush okra

Continuation Table 1a. Annual Warm Season Tropical Leaf Vegetables for Collection and Evaluation.

Botanical/Scientific Name	Common/English Name
Hibiscus sabdariffa	Roselle
Ipomoea aquatica	Kangkong, Water spinach
Ipomoea batatas	Sweetpotato greens
Rumex abyssinicus	Sorrel
Solanum nigrum	African eggplant, Nightshade
Spilanthes acmella	Paracress
Talinum triangulare	Water leaf

Table 1b. Annual Cool Season Tropical Leaf Vegetables for Collection and Evaluation.

Botanical/Scientific Name	Common/English Name
Brassica alboglabra	Chinese broccoli
Brassica campestris Chinensis Group	Pak Choi
Brassica carinata	African leaf cabbage
Brassica juncea var. rugosa	Chinese green mustard
Beta vulgaris	Spinach beet
Chenopodium album	Pigweed
Chrysanthemum coronarium	Garland chrysanthemum
Cichorium endiva	Endive
Nasturtium officinale	Watercress
Portulaca oleracea	Purslane
Spinacia oleracea	Spinach
Tetragonia expansa	New Zealand spinach

Table 1c. Perennial Tropical Leaf Vegetables for Collection and Evaluation.

Botanical/Scientific Name	Common/English Name
Cnidoscolus chayamansa	Chaya, Tree spinach
Gnetum gnemon	Gnetum
Manihot esculenta	Cassava
Morinda citrifolia	Indian mulberry
Moringa oleifera	Drumstick, horseradish
Nothopanax scutellarium	Nothopanax
Sauropus androgynus	Sauropus, katuk
Sesbania grandiflora	Sesbania
Telfairea occidentalis	Fluted Gourd
Vernonia amygdalina	Bitter leaf

Table 1d. Leaves of Tropical Vegetables Grown for Other Purposes.

Botanical/Scientific Name	Common/English Name
Capsicum annuum	Sweet pepper, bell pepper
Cucurbita moschata	Tropical pumpkin, calabaza
Momordica charantia	Bitter gourd, bitter cucumber/melon
Psophocarpus tetragonolobus	Winged bean
Sechium edule	Chayote
Vigna unguiculata var. sesquipedalis	Yard long bean

When seeds and planting materials are received they will be grown in the greenhouse and later planted in the field for observations. Data will be collected on growth habit, maturity, reaction to pest and diseases and potential yields. Some plants will be left in the field and observed for seed production. When enough seeds are collected, replicated plots will be established for further investigations. Field evaluation will be carried out for species with several cultivars in variety trials.

Development of Sustainable Crop Management and Cropping Systems:

Under this objective the following studies will be conducted. 1) effect of plant spacing and population density on yield; 2) growth and yield response to organic and synthetic fertilizers; 3) microirrigation for efficient water use; and 4) intercropping and crop rotation studies. Optimum plant spacing and density will be determined for selected species from each group. Plants will be planted at various row spacing and standard spacing suggested in books and manuals will be used as control. Trials will be conducted to determine optimum fertilizer requirement for these crops using animal manure and synthetic slow release fertilizers. Likewise, minimum water requirement for selected species will be determined using microirrigation. Field trials will be established to determine efficient water use for selected species. Crops will be drip-irrigated at various levels based on soil moisture tension. This will be combined with mulching to further determine the most efficient level of drip irrigation.

In small farm systems, tropical leaf vegetables are commonly grown in mixed and multiple cropping systems. There are many benefits in these systems and one important advantage is the maintenance of biological stability through crop diversity. Pest and disease levels are lower in polyculture systems than in monoculture. Selected species of annual leaf vegetables will be intercropped with perennial types and total productivity will be determined in terms of land equivalent ratio. Separate trials will be conducted on crop rotation involving legume cover crops and other green manures. In all studies, weeds, insects, and diseases associated with the crops will be monitored.

Conservation and Maintenance of Germplasm Materials:

The ultimate objective of this project is to conserve and maintain the germplasm materials of the most promising types and species of tropical leaf vegetables. Species and cultivars with desirable characteristics, e.g. high yields and resistance to pest and diseases will be selected and propagated by seed and vegetative materials. This will be accomplished initially in the nursery and greenhouse. When enough seeds are produced, large scale seed production and multiplication will be carried out in the field. A modest supply of seeds and planting materials will be maintained continuously and will be reserved for future research work.

YIELD PERFORMANCE OF SELECTED ANNUAL WARM SEASON TROPICAL LEAF VEGETABLES: PRELIMINARY OBSERVATIONS

An observational field trial was conducted in the spring season of 1996 to evaluate yield performance of eight annual warm season tropical leaf vegetables. The species evaluated were: amaranthus (*Amaranthus cruentus*), collard green (*Brassica oleracea Acephala* cv. Vates), Jute mallow (*Corchorus olitorius*), red and green Malabar spinach (*Basella spp.*), mustard green (*Brassica juncea* cv. Florida Broad Leaf), pak choi (*Brassica rapa Chinensis* cv. Lei Choy), water spinach (*Ipomoea aquatica*), and sweetpotato greens (*Ipomoea batatas*). Seedlings or stem cuttings were transplanted on unreplicated 2-row plots at 6 m long. Row spacing was 50 cm while plant spacing within rows was 30 cm. Plants were drip-irrigated to ensure good establishment. Plots were fertilized with 200 N, 100 P_2O_5 and 100 K_2O in kg ha^{-1}. Fifty percent of N applied was from cow manure (2% N).

Yield samples were harvested from a 5 m section of each row. For species with running vines or stems, samples were harvested by cutting stems 10-15 cm from the base of the plant. Leaves were separated from stems and weighed to obtain fresh edible yield. For all other species, mature leaves were sampled periodically.

Table 2 presents data on number of days to first harvest, number of harvests, fresh yield of edible leaves and productivity. As shown in Table 2, mustard green and jute mallow had the shortest number of days to first harvest (32 and 33 days, respectively), while collard green took 63 days from planting to first harvest. The highest yield of edible leaves was produced by Pak choi (3131 g m^{-2}), followed by mustard green (1269 g m^{-2}). These two species also have the highest productivity as expressed in yield per unit area per day. The lower yield and productivity of species with running vines or stems such as malabar spinach, water spinach, and sweetpotato compared to non-viny species (Pak choi, mustard and collard greens) can be attributed to smaller sized leaves and slower rate of growth.

All species showed little damage due to insect pest or disease which suggests that these crops may require low levels of crop protection. The preliminary data indicate that tropical leaf vegetables are adapted to the growing conditions of the Virgin Islands and produce fresh edible yields within 1 to 2 months.

Table 2. Yield and productivity of some tropical leaf vegetables in the Virgin Islands, Spring, 1966.

Common Name	Days to First Harvest	No. of Harvest	Fresh Yield of leaves (g m^{-2})	Productivity (g m^{-2}/day)
Amaranthus	42	1	365	8.70
Malabar (red)	57	1	385	6.75
Malabar (green)	57	1	344	6.04
Mustard	32	3	1269	25.9
Collard	63	1	532	8.44
Pak choi	42	3	3131	52.0
Jute mallow	33	1	106	3.22
Water spinach	57	1	412	7.23
Sweetpotato	42	2	821	14.7

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EFFECTS OF BLACK PLASTIC AND STRAW MULCH ON YIELD AND WATER USE EFFICIENCY OF CUCUMBER

S.M.A. Crossman, M.C. Palada and J.A. Kowalski, University of the Virgin Islands Agricultural Experiment Station, RR 2, Box 10,000, Kingshill, St. Croix, U.S. Virgin Islands 00850.

ABSTRACT. Field experiments were conducted during the 1995 and 1996 seasons to evaluate the yield and water use of cucumber (*Cucumis sativus* L. cv. 'Calypso', 1995 and 'Dasher II', 1996) grown with black plastic and grass straw mulch under 3 levels of drip irrigation. Cucumber was grown in replicated plots arranged in randomized complete block design and mulched with either black plastic (1.25 mil) or dry guinea grass (*Panicum maximum* L.) straw (5.0-6.5 cm thick). Plots were drip-irrigated at soil water tensions corresponding to 20, 40, and 60 kPa. Number of marketable fruits, fruit size, total weight of fruits and marketable yield were recorded for each harvest. In 1995, for all of the measures parameters, black plastic mulch resulted in significantly higher values than the straw mulch. Marketable yield (15.7 t ha^{-1}) in plots with black plastic mulch was significantly higher ($P<0.005$) than plots with straw mulch (11.9 t ha^{-1}). For both mulches, drip irrigation levels had no influence ($P>0.10$) on cucumber yield and yield components. Water use in straw-mulched plots was lower than plastic-mulched plots, but water use efficiency and economic returns to irrigation water were higher in plots with black plastic mulch. The incidence of fusarium wilt (*Fusarium* sp.) in plots with straw mulch was higher than plots with plastic mulch, a contributing factor for low yields in straw-mulched plots. In 1996, there were no significant differences observed between mulch treatments or irrigation regimes for any of the parameters measured. Production from the 'Dasher II' cultivar was much higher than the yields obtained in 1995 from 'Calypso'.

INTRODUCTION

The integration of mulch into microirrigation systems for vegetable production has gained popularity in the major vegetable growing regions in the U.S. and other parts of the world. The use of this technology has significantly increased yields and economic returns from vegetable production especially in areas where irrigation water is a scarce and limiting resource. In the Virgin Islands, drip irrigation has benefited the production of major vegetable crops by reducing water use, improving both

the quantity and quality of yield, and increasing economic returns (Navarro, 1987; Navarro and Newman, 1989; Palada *et al.*, 1995a).

Cucumber is one of the major vegetable crops popularly grown by local farmers. Many local growers do in fact produce cucumbers year-round under the tropical climate of the Virgin Islands. However, during the dry season, production is limited by availability of irrigation water. Growers always experience shortage of irrigation water and water sources are not dependable during this season. Furthermore, irrigation water use is high due to high temperature and evapotranspiration during the hot dry season.

Many growers employ mulching as an effective technique in reducing evapotranspiration and water use in vegetable production. Several reports have indicated that drip irrigation in combination with mulching has benefited the production of melons, squash, and cucumbers (Bhella, 1978; Bhella and Kwolek, 1984; Briones *et al.*, 1995; Collingwood *et al.*, 1989; Fipps and Perez, 1995; Paterson, 1980; Schales and Sheldrake, 1966). These studies demonstrated that plastic mulch in conjunction with drip irrigation resulted in earlier and higher overall yields, reduced evaporation, fewer weed problems, and reduced fertilizer leaching (Lamont, 1993).

Although plastic mulch offers many advantages and benefits, it also has limitations. For example, removal and disposal are a problem in areas where waste disposal is restricted. Furthermore, the use of plastic mulch in vegetable production entails greater initial cost, which could be an economic burden to small-scale and limited-resource growers. An alternative to plastic mulch is an organic mulch such as grass straw or dry leaves. These materials are locally available and inexpensive. In the Virgin Islands, organic mulches such as grass straw and compost have been used in culinary herb production and resulted in yields comparable to or higher than herbs grown with synthetic (plastic) mulches (Palada *et al.*, 1995b). Few studies have been conducted on the effect of synthetic and organic mulches on cucumber yield in the Virgin Islands. The objective of this study is to compare the influence of black plastic and grass straw mulch on cucumber production in terms of total and marketable yield, fruit size, and water use efficiency under three regimes (levels) of drip irrigation.

MATERIALS AND METHODS

This study was conducted at the Agricultural Experiment Station, University of the Virgin Islands in St. Croix, USVI (lat. 17°42'N and long. 64°48W). The soil was a Fredensborg clay (loamy, fine carbonatic, isohyperthermic, shallow calciustolls). The average rainfall is 1015 mm, but evaporation exceeds precipitation 10 months of the year resulting in a

negative water balance. The field experiments were conducted from 17 March to 5 June, 1995, and 26 March to 21 June, 1996.

Plots were established measuring 4.57 m wide and 4.06 m long. Each plot contained 3 rows spaced at 1.5 m. Cucumber cv 'Calypso' (1995) and 'Dasher II' (1996) was direct-seeded on 17 March using 2-3 seeds per hole at a spacing of 40.6 cm along the row. Treatments consisted of black plastic mulch and grass straw mulch. The black plastic mulch (21.35 m) was installed in plots after the final land preparation, whereas the straw mulch (dry guinea grass) was applied at 5.0-6.5 cm thick on 11 April (1995) and 16 April (1996) about 3 weeks after seeding. Plots were arranged in a randomized complete block design with 4 replications.

For each mulch treatment, plots were drip-irrigated at three regimes corresponding to soil water tensions of 20, 40, and 60 kPa. The irrigation system consisted of main and sub-main lines made of 15 mm black polyethylene hose. The laterals were made of 15 mm New Hardie Tape (Hardie Irrigation, CA) with laser-drilled orifice 40.6 cm (16 inch) apart. Soil tensiometers (Irrometer Co., Riverside, CA) were installed at 15 cm depth in each treatment on 2 replications to monitor soil water tension. The tensiometers were read daily and readings were used to initiate an irrigation cycle when soil moisture tension exceeded the specified regime. A flow meter and a timer were installed in the irrigation system for each treatment. Water use was determined from weekly flow meter readings. Total irrigation water use was calculated over a period of 10 weeks (1995) and 11 weeks (1996).

In 1995, all plots were fertilized with 12-12-12 NPK fertilizer at the rate of 200 kg ha^{-1} each of N, P_2O_5, and K_2O. The fertilizer was banded and split-applied on 11 April and 16 May. Insect pests and diseases were controlled by alternate spray applications of dipel, malathion, kocide, diazinon, M-Pede, rotenone and pyrethrum. In 1996, all plots were fertilized on 18 April with triple superphosphate and sulfate of potash to supply 120 and 60 kg ha^{-1} of P_2O_5 and K_2O, respectively. Nitrogen was applied in 5 equal fertigations using ammonium sulfate for a total rate of 100 kg ha^{-1}. Weeds were controlled by hand-weeding when necessary during both years.

Cucumbers were harvested starting on 3 May and ending on 5 June for a total of 11 harvests during 1995 and from 29 March to 21 June for a total of 10 harvests in 1996. Fruits were harvested from all 3 rows per plot. For each harvest, fruits were counted, weighed and sorted into marketable and non-marketable size. Fruits with insect and/or disease damage were classified as non-marketable. Data were analyzed using the General Linear Models (GLM) procedures by Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

Fruit Number and Weight by Harvest:

Cultivar 'Calypso' - 1995 Trial. During the first four harvests, more fruits were harvested from the straw mulch compared to black plastic mulch, however, differences were small (Fig. 1). Starting at the fifth harvest, plants grown with black plastic mulch produced more fruits than plant under grass straw mulch. The highest number of fruits was recorded in plastic-mulched plots during the tenth harvest (Fig. 1). For each harvest, differences in fruit number between irrigation regimes were insignificant. This result does not agree with those previously reported, where black plastic mulch resulted in early harvest. In terms of earliness, straw mulch is as good as or comparable to plastic mulch in cucumber production. Similar result was observed in fruit weight, except that cucumber grown with plastic mulch produced heavier fruits than those under grass straw mulch starting on the fifth harvest (Fig. 2). This also resulted in a significantly higher ($P<0.0047$) cumulative total yield in plots with black plastic mulch compared to straw mulch (Table 1). The data would suggest that the harvest and productive season for cucumber can be extended with the use of black plastic mulch resulting in maximum yields.

Cultivar 'Dasher II' - 1996 Trial. The grass straw mulch treatment produced significantly more marketable cucumber fruits and higher yields than the black plastic mulch for the first three harvests (Fig. 3-4). The number of marketable fruits harvested and the yield from both treatments were statistically similar for all other harvests except the tenth harvest, when significantly more fruits and a higher yield were produced by the black plastic mulch treatment. The pattern of the grass mulch treatment producing more marketable cucumber fruits during the early harvests is similar to the results obtained for the 'Calypso' cultivar in 1995.

Cultivar 'Calypso' - 1995 Trial. Data in Table 1 show that fruits harvested from plots with black plastic mulch were larger than those grown with straw mulch. Average fruit size (306 g) from plots with black plastic mulch was significantly larger ($P<0.0554$) than fruits harvested from grass straw-mulch plots (261 g). The effect of irrigation regime on fruit size was not significant (Table 1). This result indicates that cucumber fruit quality is improved with the use of black plastic mulch and is consistent with results previously reported (Lamont, 1993).

Table 1. Cucumber (cv. 'Calypso') yield and yield components grown with black plastic and grass straw mulch under three drip irrigation regimes. UVI/AES, 1995.

Mulch	Irrigation Regime (kPa)	Total no. of fruits per plot	Fruit size (g)	Total fruit yield ($t\ ha^{-1}$)*	Marketable fruit yield ($t\ ha^{-1}$)*
Plastic	20	92	284	16.8	14.4
	40	107	270	18.8	15.9
	60	113	363	19.2	16.9
	Mean	104	306	18.3	15.9
Straw	20	94	265	16.1	13.7
	40	81	255	13.7	11.4
	60	74	264	13.1	10.5
	Mean	83	261	14.3	11.9

*Metric tons per hectare

Analysis of Variance by General Linear Model Procedure (Values for Prob.>F)

Parameter	No. of Fruits	Fruit Size	Total Yield	Marketable Yield
Replication	0.2727	0.5235	0.2204	0.2521
Mulch	0.0047**	0.0554*	0.0126**	0.0052**
Regime	0.9872	0.3765	0.9859	0.9582
Mulch x Regime	0.0590	0.8125	0.2692	0.1605

Fruit Size:

Cultivar 'Dasher II' - 1996 Trial. The mulch treatments did not significantly affect the fruit size of 'Dasher II' cucumber in 1996 (Table 3). The average size of 359 g from the black plastic mulch treatment was not significantly different from the 364 g fruit size in the grass straw-mulched plots. This result indicates that with cultivar 'Dasher II' both mulch type (organic vs. synthetic) has similar effect on yield.

Table 2. Estimated irrigation water use and efficiency by cucumber (cv. 'Calypso') grown under black plastic and grass straw mulch at three drip irrigation regimes. UVI/AES, 1995.

Mulch	IR[1] (kPa)	TWU[2] (l/plt)	TWU (cu.m/ha)	IWC[3] ($/ha)	WUE[4] (l/kg)	WCE[5] ($/kg)	RIW[6] ($/$)
Plastic	20	41.9	677	2864	47	0.20	11.06
	40	49.0	793	3354	50	0.21	10.43
	60	40.1	648	2741	38	0.16	13.56
	Mean	43.7	706	2986	45	0.19	11.71
Straw	20	48.6	786	3325	57	0.24	9.06
	40	41.7	674	2851	59	0.25	8.80
	60	35.6	576	2436	55	0.23	9.48
	Mean	42.0	679	2871	57	0.24	9.11

[1]Irrigation regime. [2]Total water use.
[3]Irrigation water costs, estimates based on irrigation water cost of $4.23/cu.m.
[4]Water Use Efficiency=lts of water used to produce a kg of fresh cucumber.
[5]Water Cost Efficiency=cost of irrigation water to produce a kg of fresh cucumber.
[6]Returns to irrigation water, calculated from gross returns divided by irrigation water cost using $2200/ton market value of cucumber.

Total Fruit Yield and Marketable Yield:

Cultivar 'Calypso' - 1995 Trial. The effect of mulch on total and marketable fruit yield was highly significant, but irrigation regime did not significantly influence fruit yield (Table 1). Total fruit yield from plots with black plastic mulch was significantly greater ($P<0.0126$) than those obtained from grass straw mulch. Black plastic mulch resulted in 22% more yield than grass straw mulch. Similar result was obtained for marketable fruits where plots under black plastic mulch produced yields which were significantly higher ($P<0.0052$) than plots with grass straw mulch. Overall, the average marketable fruit yield in plots with black plastic mulch was 25% higher than the grass straw mulch (Table 1). These data agree with those reported by Collingwood *et al.*, (1989) and Paterson (1980) where cucumber overall yields were much improved under black plastic mulch.

Table 3. Cucumber (cv. 'Dasher II') yield and yield components grown with black plastic and grass straw mulch under three drip irrigation regimes. UVI/AES, 1996.

Mulch	Irrigation Regime (kPa)	Total no. fruits per plot	Fruit size (g)	Total fruit yield (t ha^{-1})*	Marketable fruit yield (t ha^{-1})
Plastic	20	272	370	57.9	54.9
	40	263	353	54.4	51.2
	60	266	356	56.0	51.8
	Mean	267	359	56.1	52.6
Straw	20	295	352	63.1	57.6
	40	249	374	58.2	50.9
	60	247	367	55.4	49.8
	Mean	264	364	58.9	52.8

*Metric tons per hectare

Analysis of Variance by General Linear Model Procedure (Values for Prob.>F)

Parameter	No. of Fruits	Fruit Size	Total Yield	Marketable Yield
Block	0.0099**	0.9609	0.0192*	0.0314*
Mulch	0.867	0.6059	0.5644	0.9707
Regime	0.4666	0.9671	0.673	0.5826
Mulch x Regime	0.6531	0.2202	0.8715	0.9224

Cultivar 'Dasher II' - 1996 Trial. Yield of 'Dasher II' was not significantly influenced by either the type of mulch or the soil moisture level under which the crop was grown (Table 3). The yields from the black plastic mulch treatment were 56.1 and 52.6 t ha^{-1} for total and marketable yield, respectively, while from the grass straw mulch, the yields were 58.9 and 52.8 t ha^{-1} for total and marketable yield, respectively.

The incidence of fusarium wilt (*Fusarium sp.*) became apparent in plots with straw mulch during the latter part of the 1995 season. More plants under straw mulch were affected by this soil-borne fungal disease

resulting in poor quality fruits and reduced yields. The disease is believed to spread rapidly after a heavy rainfall and plants under straw mulch might have been more susceptible. The black plastic mulch may have prevented the spread of the fungus by acting as a better barrier between the soil and the plants. Lamont (1993) stated that plastic mulch prevents rain splashing that may carry disease organisms from the soil during heavy rainfall, thereby improving the quality of fruits. Furthermore, the edible product from mulched crop is clean and less subject to rots, because the soil is not splashed on the plants or fruits.

During the latter part of the growing season in 1996, it was also observed that plants under grass straw mulch were more susceptible to infestation by thrips compared to plants under plastic mulch, suggesting that straw mulch may provide a microenvironment which favors increased pest population.

Water Use, Efficiency and Economic Returns to Irrigation Water:

1995 Trial - Cultivar 'Calypso'. Total water use varied among irrigation regimes (Table 2). For a given mulch, water used decreased with increasing water tension regime. However, under plastic mulch treatment, highest water use was observed at the 40 kPa irrigation regime (Table 1). In general, water use of cucumber under grass straw mulch was lower than those under black plastic mulch. Examining weekly water consumption (data not shown), it was found that during the first 3 to 4 weeks, plots under plastic mulch utilized more irrigation water than those in straw mulch. During the last 3 weeks of the season, plots with straw mulch used slightly lower irrigation water than in plastic mulch. The amount of rainfall received during the season was 178 mm and was concentrated during the last 4 to 6 weeks. This partially explains for the lower irrigation water use in plots with straw mulch compared to plastic mulch. Straw mulch is permeable to rain water allowing water to penetrate below the soil surface. In contrast, plastic mulch is impermeable to rain water, thereby blocking water infiltration through the soil.

In spite of high irrigation water use in plots with plastic mulch, water use efficiency (WUE) is generally higher than plots with straw mulch (Table 2). On the average, plants grown in plastic mulch used only 45 liters of irrigation water to produce a kilogram of fresh cucumber compared to 57 liters in plots with straw mulch. This translates into reduced water cost in producing a kilogram of cucumber ($0.19 for plastic mulch vs. $0.24 for straw mulch). Thus, water cost efficiency (WCE) is much better with plastic than with straw mulch.

Economic returns to irrigation water were generally higher in plots with plastic mulch compared to straw mulch (Table 2). Because of

relatively high yields, gross returns were higher in plastic mulch than in straw mulch. Using cucumber retail market price of $2.20 per kg ($1.00/lb), returns to irrigation water in plots with plastic mulch are higher than those in straw mulch. On the average, for every dollar spent on irrigation water, the grower gets $11.71 in return for using plastic mulch compared with only $9.11 with straw mulch (Table 2). This suggests that it is more profitable to produce cucumber using black plastic mulch in terms of returns to irrigation water. This is important for the economy of the Virgin Islands, since cost of irrigation water is one of the highest in the Caribbean. Use of irrigation water and plastic mulch is therefore justified by producing high value crops such as cucumbers.

1996 Trial - Cultivar 'Dasher II'. Overall, there was a tendency for the plastic mulch treatment to use more water than the grass straw mulch (Table 4). The only exception was the 40 kPa treatment where the grass straw mulch used more water than the plastic mulch. On a per plant basis the 20 kPa regime had the highest water use for both mulches (55.3 and 50.6 liters, respectively). The amounts used for both the 40 and 60 kPa regimes were similar. The water use efficiency (liters water used to produce a kg cucumber) followed a pattern that was similar to the water use data. Economic returns to irrigation water show that irrigation regimes which maintain higher soil water tension (40 and 50 kPa) gave better returns than treatment where irrigation regime was maintained at 20 kPa (Table 4). When mulches were compared, the returns from the grass straw mulch ($39.41 for every dollar spent for irrigation water) were higher than from the plastic mulch ($37.65). A factor which might have contributed to the better returns from the grass straw mulch is the fact that rainfall can be better utilized by this permeable mulch, but not by the plastic mulch which is impermeable to rainfall.

CONCLUSIONS

The two-year study has shown that the response of cucumber to black plastic and grass straw mulch depended on the cultivar. Using 'Calypso' in 1995, black plastic mulch increased yield, improved water use efficiency and increased economic returns to irrigation water. Cucumber grown in plots with black plastic mulch produced higher number of fruits, larger fruit size, and higher total and marketable fruit yields compared to those grown with grass straw mulch. The improved yields in plots with black plastic mulch resulted in more efficient water use and profitable returns to irrigation water than the straw mulch. The benefit of using straw mulch is shown by reduced total irrigation water use due to rain water infiltration, but this is offset by high incidence of soil-borne fungal disease,

reducing total yield and crop quality. The 1996 study utilizing cultivar 'Dasher II', indicates that cucumber production is not affected by both types of mulch or irrigation regimes. Despite an infestation of thrips, cultivar 'Dasher II' continued to be more productive compared to cultivar 'Calypso'.

Table 4. Estimated irrigation water use and efficiency by cucumber (cv. 'Dasher II') grown under black plastic and grass straw mulch at three drip irrigation regimes. UVI/AES. 1996.

Mulch	IR[1] (kPa)	TWU[2] (l/plt)	TWU (cu.m/ha)	IWC[3] ($/ha)	WUE[4] (l/kg)	WCE[5] ($/kg)	RIW[6] ($/$)
Plastic	20	55.3	893	3778	16.5	0.07	31.97
	40	39.1	631	2671	12.5	0.05	42.14
	60	42.9	693	2931	13.6	0.06	38.84
	Mean	45.7	739	3127	14.2	0.06	37.65
Straw	20	50.6	817	3457	14.4	0.06	36.66
	40	40.5	654	2768	13.1	0.06	40.48
	60	39.0	630	2666	12.9	0.06	41.09
	Mean	43.3	701	2964	13.5	0.06	39.41

[1]Irrigation regime. [2]Total water use.
[3]Irrigation water costs, estimates based on irrigation water cost of $4.23/cu.m.
[4]Water Use Efficiency=lts of water used to produce a kg of fresh cucumber.
[5]Water Cost Efficiency=cost of irrigation water to produce a kg of fresh cucumber.
[6]Returns to irrigation water, calculated from gross returns divided by irrigation water cost using $2200/ton market value of cucumber.

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YIELD CHARACTERISTICS OF PARVIN AND TOMMY ATKINS MANGOS GRAFTED ON DWARFING ROOTSTOCKS

Arturo Cedeño Maldonado, Ismael Reyes Soto, and Alvaro Acosta, Department of Horticulture, Agricultural Experiment Station, College of Agricultural Sciences, University of Puerto Rico, Mayagüez, P.R. 00681.

ABSTRACT. A study was conducted at the Fortuna Agricultural Substation to determine the effect of tree size-controlling rootstocks on yield of commercial mango cultivars Parvin and Tommy Atkins. These varieties were cleft grafted on Eldon, Colombo Kidney, Mayagüezano/ Turpentine, Cubano, Malda, and Julie as rootstocks. Data on number and weight of fruits were collected during five consecutive crops starting two and three years after Tommy Atkins and Parvin trees, respectively, were planted in the orchard. Yield increased significantly during the first three crop years. Yield per tree was significantly higher for Parvin than for Tommy Atkins. Yields were higher for Parvin grafted on Julie and Malda and for Tommy Atkins grafted on Turpentine, Cubano and Julie. Yields were significantly lower on Eldon as rootstock irrespective of grafted variety.

RESUMEN. Se realizaron estudios en la Subestación Experimental Agrícola de Fortuna para determinar los efectos de patrones de mango que reducen la altura sobre el rendimiento de las variedades comerciales de mango Parvin y Tommy Atkins. Estas se injertaron sobre los patrones Eldon, Colombo Kidney, Mayagüezano/Turpentine, Cubano, Malda y Julie. Se tomaron datos del número y peso de las frutas durante cinco años consecutivos después que las variedades Tommy Atkins y Parvin tenían dos y tres años de establecidas en el huerto, respectivamente. El rendimiento de Parvin fue significativamente mayor que el de Tommy Atkins. Se obtuvieron mejores rendimientos con Parvin injertado en patrones de Julie o Malda; y con Tommy Atkins sobre Turpentine, Cubano o Julie. Los rendimientos fueron inferiores cuando se utilizó la variedad Eldon como patrón.

INTRODUCTION

Mango is one of the most important fruit crops produced in Puerto Rico. There are approximately 1,000 hectares of land planted to this crop. During 1991-94 the farm value of the crop was approximately $9.25

million dollars (Anonymous). Most of the production is exported to the United States mainland and European Markets.

Mango fruits are borne on tall trees; thus harvest is difficult under conditions in Puerto Rico if trees are not appropriately pruned mechanically, which is an expensive practice. Since hand labor and arable land are scarce, and land values and wages are continuously increasing, there is a direct need to increase fruit yield per unit area of cultivated land. This increase could be accomplished by planting systems. This practice would also reduce production cost since, harvesting and cultural operations would be easier under such systems.

The purpose of this study was to determine the effect of tree size-controlling mango rootstocks on yield of two commercial mango varieties.

MATERIAL AND METHODS

Seeds of the rootstock varieties Colombo Kidney, Cubano, Eldon, Julie, Malda, Mayagüezano and Turpentine were germinated in sand seedbeds. Seedlings were maintained is a saran covered greenhouse, planted in 4 L containers filled with 1:1 soil-filter press mixture. After proper development they were cleft-grafted with scion wood of Parvin and Tommy Atkins cultivars. The grafted trees obtained were planted in the field for the experiments herein reported.

The orchard was established at the Fortuna Agricultural Experiment Station on the southern coast of Puerto Rico. The region has an annual average precipitation of 1020 mm and mean maximum and minimum temperatures of 30°C and 20°C. The soil type is San Anton Fine loam (Mollisol) with a pH of 7.4. Parvin trees were grafted in June 1986 and planted in the field in January 1987 whereas Tommy Atkins trees were grafted in 1987, and planted in February 1988.

A factorial completely randomized block design including 12 treatments (six rootstocks and two scions and three replications) was used. Each replication consisted of a group of four trees for a total of 144 trees included in the experiment. Planting distance was 7.6 X 7.6 m. Fertilizer application, irrigation, and weed control practices were performed following the recommendations of the University of Puerto Rico Agricultural Experiment Station (1985).

Tree height and trunk and canopy diameter were measured yearly and fruit number and weight were determined at time of harvest. Data herein presented include the first five years of fruit production.

RESULTS AND DISCUSSION

Fruit production increased significantly during the first three crop years as expected from young developing trees (Table 1). Amounts of fruits produced per tree at this early stage compared favorably with findings in previous reports (Cedeño *et al.*, 1987, Perez *et al.*, 1988; 1987). A significant reduction in fruit number and yield was observed during the fifth crop year, the significance of which can not be explained until further production data are obtained. Parvin was superior to Tommy Atkins both in terms of number of fruits produced by tree and weight of fruits per tree (Table 2). The decrease in production observed during the fifth crop year was more pronounced in Tommy Atkins than in Parvin.

Table 1. Combined yearly mango production for Parvin and Tommy Atkins varieties during the first five crop years.

Year	No. fruits/tree	Weight fruits/tree(kg)
1 (1990)	75 c	36.4 c
2 (1991)	120 b	58.6 b
3 (1992)	190 a	87.7 a
4 (1993)	175 a	93.2 a
5 (1994)	146 b	66.4 b
	LSD= 3 (P=0.05)	LSD= 12.3 (P=0.05)

Julie and Cubano outperformed other rootstocks tested regarding of combined yields of both scion varieties (Table 3). Yields of Eldon were significantly lower than for the other varieties, including Colombo Kidney, which was included in the experiment as a standard non dwarfing rootstock. Previous studies have demonstrated that Eldon, Julie, and Malda are dwarfing rootstocks (Anonymous, 1994; Cedeño *et al.*, 1987).

Mayagüezano and Turpentine, both of which outperformed Eldon, were included in the experiment because of their extensive use as rootstocks in Puerto Rico and elsewhere. Cubano was included in the experiment because it is planted extensively as a dwarf variety in backyards and small orchards in southern Puerto Rico.

Table 2. Production of Parvin and Tommy Atkins during the first five crop years.

Year	Variety	Avg. no. fruits/tree	Avg. weight fruits/tree(kg)
1 (1990)	Parvin	141 d	68.2 d
1 (1990)	Tommy Atkins	8 f	4.9 f
2 (1991)	Parvin	191 c	88.2 c
2 (1991)	Tommy Atkins	48 e	27.9 e
3 (1992)	Parvin	274 a	120.0 a
3 (1992)	Tommy Atkins	101 d	55.7 d
4 (1993)	Parvin	237 ab	118.3 ab
4 (1993)	Tommy Atkins	113 d	68.2 d
5 (1994)	Parvin	230 b	101.7 bc
5 (1994)	Tommy Atkins	62 e	31.0 e
		LSD= 38 (P=0.05)	LSD= 17 (P=0.05)

Table 3. Combined performance of Parvin and Tommy Atkins on different rootstocks.

Rootstock	Avg. no. fruits/tree	Avg. weight fruits/tree (kg)
Eldon	89 d	42.5 c
Colombo Kidney	131 c	61.0 b
Mayagüezano/Turpentine	132 c	66.6 b
Cubano	167 ab	82.4 a
Malda	142 bc	67.9 b
Julie	184 a	90.0 a
	LSD= 29 (P=0.05)	LSD= 13.3 (P=0.05)

Table 4. Yield of Parvin mango on different rootstock

Rootstock	No. fruits/tree	Weight fruits/tree (kg)
Eldon	126 d	56.8 d
Colombo Kidney	207 c	91.4 c
Mayagüezano	165 d	79.5 c
Cubano	240 bc	111.0 b
Malda	262 ab	123.1 ab
Julie	288 a	134.0 a
	LSD= 42 (P=0.05)	LSD= 18.9 (P=0.05)

Table 5. Yield of Tommy Atkins mango on different rootstock

Rootstock	No. fruits/tree	Weight fruits/tree (kg)
Eldon	51 cd	28.2 bc
Colombo Kidney	55 bcd	30.6 bc
Turpentine	99 a	53.8 a
Cubano	95 ab	54.0 a
Malda	23 d	12.7 c
Julie	81 abc	46.1 ab
	LSD= 42 (P=0.05)	LSD= 18.9 (P=0.05)

Table 6. Yield of Parvin and Tommy Atkins mangoes as influenced by rootstock

Cultivar	Rootstock	No. fruits/tree	Weight fruits/tree (kg)
Parvin	Eldon	126 de	56.8 d
	Colombo Kidney	207 c	91.4 c
	Mayagüezano	165 d	79.5 c
	Turpentine		
	Cubano	240 bc	111.0 cb
	Malda	262. ab	123.1 ab
	Julie	288 a	134. 0 a
Tommy Atkins	Eldon	51 hi	28.2 ef
	Colombo Kidney	55 ghi	30.6 ef
	Mayagüezano	99 ef	53.8 d
	Turpentine		
	Cubano	95 efg	54.0 d
	Malda	23 i	12.7 f
	Julie	81 fgh	46.1 de
		LSD= 42 (P=0.05)	LSD=18.9 (P=0.05)

For Parvin, both yield and number of fruits per tree were higher on Julie and Malda as rootstocks (Table 4). Parvin yields were significantly lower on Eldon and Mayagüezano.

For Tommy Atkins, yield was significantly higher with Turpentine, Cubano, and Julie as rootstocks than on Colombo Kidney, Malda, and Eldon (Table 5). Irrespective of rootstock variety, yields were significantly higher for Parvin than for Tommy Atkins (Table 6). Best yields of Parvin were nearly three times higher than those obtained with Tommy Atkins. For both Cultivars poorest yields were obtained on Eldon.

These results indicate that Eldon is an inferior rootstock for both cultivars tested and should not be recommended for commercial orchards. This finding contrasts with earlier findings and recommendations of this rootstock (Cedeño *et al.*, 1987; Perez *et al.*, 1987). On the basis of present results, Julie and Malda are recommended rootstocks for Parvin, while Mayagüezano/Turpentine, Cubano and Julie, are recommended rootstock for Tommy Atkins.

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INTEGRATION OF PIGEON PEA ALLELOPATHY IN PEPPER AND TOMATO WEED MANAGEMENT SYSTEMS

Nelson Semidey, Agricultural Experiment Station, HC 01 BOX 11656, Lajas, Puerto Rico 00667.

ABSTRACT. Pigeon pea cultivars Kaki, 2B Bushy, PR 147 and Blanco, and Lines 12, 84, and 92 were evaluated at Juana Diaz, Puerto Rico, for their effect on weed suppression and pepper and tomato yield in the following cropping systems. Pigeon pea was grown from mid-July 1994 until 2 February 1995 when whole plant material above soil surface was mowed and disked into the soil. Pepper and tomato seedlings were transplanted after bedding 9 March 1995 and harvested during June 1995. The seven cultivars reduced weed density, which ranged from 50 to 91% in the pepper management system. Value of produce obtained from the pigeon pea-pepper harvest was estimated at US$19,945/ha, an increase of $9,865/ha over that of no pigeon pea rotation. In the tomato management system, weed suppression ranged from 69% to 89% with the same pigeon pea cultivars. Total value of produce from the pigeon pea-tomato harvest was estimated at $14,626/ha. Pigeon pea allelopathy contributed to weed suppression in both pepper and tomato management systems. Value of produce per unit area per year can be increased by the integration of pigeon pea in a rotation scheme with pepper and tomato.

INTRODUCTION

In Puerto Rico, weed management programs for tomato and pepper include hand-weeding, mechanical cultivation, and the use of herbicides in combination with plastic mulching (Liu, 1990). None of these methods alone can provide full-season control of existing weeds. Based on an economic analysis of total expenses, weed control cost could range from 44% to 77% in tomatoes and 59% to 89% in peppers (Liu, *et al.*, 1987). For this reason, new management strategies are needed to enhance weed control and reduce production cost in these crops.

The results of several studies indicate the potential benefits which pigeon pea rotation may have in crop production systems (Bosque-Fernández, 1986; Hepperly and Diaz, 1983; Talleyrand *et al.*, 1977). Pigeon pea has demonstrated allelopathic activity against grassy weeds (Hepperly *et al.*, 1992). Average reduction in weed density was 57% in a tomato crop that followed pigeon pea (Semidey *et al.*, 1994). Purple nutsedge, one of the most difficult weeds to control, was suppressed up to

93% by pigeon pea cv. 2B Bushy and Kaki and Line 84 in tomato (Semidey, 1995).

The objective of this study was to evaluate cultivars and new lines of pigeon pea for weed suppression in tomato and pepper cropping systems that followed pigeon pea.

MATERIALS AND METHODS

Cultivars and new lines of pigeon peas were field planted in July 1994 at Juana Diaz, Puerto Rico. Plots not planted with pigeon peas were included as check plots following a randomized complete block (RCB) design with eight replications. All plots (2.7 x 4.5 m) were cultivated periodically to prevent weed interference with pigeon peas. Mature pigeon pea pods were harvested from late December 1994 to January 1995. Plant material from each pigeon pea cultivar was soil incorporated by disking after green pod harvesting, and plot identity was maintained. The soil belongs to the San Anton series (fine-loamy, mixed isohypertermic). Two experiments, following a RCB design with four replications, were established with tomato cv. Heatwave and pepper cv. Key Largo six weeks later. For each experiment, three rows 0.90 m apart and 4.5 m long were transplanted for each crop. Metribuzin (0.35 kg a.i./ha) and fluazifop-P (0.28 kg a.i./ha) were applied to all plots and over the top of tomato three and four weeks after planting, respectively. A mixture of paraquat (0.37 kg a.i./ha) and fluazifop-P (0.28 kg a.i./ha) was directed between pepper rows four weeks after planting.

Plots were evaluated for weed emergence, crop stand, crop dry weight, and height three and six weeks after planting (WAP). Peppers and tomatoes were harvested in June 1995 and yield was compared to estimates for each crop. Data were analyzed by ANOVA procedures and means were separated by LSD at $P = 0.05$ level. To estimate reduction in weed density by pigeon pea cultivars, data were compared to the check plots without pigeon pea.

RESULTS AND DISCUSSION

None of the pigeon pea cultivars affected plant dry weight or height of tomato and pepper (data not included). All pigeon pea cultivars or lines reduced weed density in tomato at three and six WAP (Table 1). Weed reductions were non significant in pepper at three WAP, however, reduction was evident at six WAP. Herbicides applied to pepper and tomato at three to four WAP reduced weed density in all plots, except in the check. Line 84 was more consistent in weed suppression, with 89% and 91% weed reduction at six WAP pepper and tomato, respectively. Cultivar Blanco

was not consistent in weed suppression; however, differences among cultivars and lines were not significant in either crop.

Table 1. Average weed density and reduction three and six weeks after transplanting (WAP) tomato and pepper in plots previously planted with different pigeon pea cultivars[a].

Cultivar	Tomato		Pepper	
	No. weeds/0.5 m^2			
	3 WAP	6 WAP	3 WAP	6 WAP
Kaki	66(68)[b]*	22 (84)*	114 (40)	38 (71)*
2B Bushy	71 (65)*	22 (84)*	141 (25)	35 (73)*
PR 147	60 (71)*	28 (80)*	88 (53)	29 (78)*
Line 12	68 (67)*	27 (81)*	129 (32)	47 (64)*
Blanco	75 (63)*	32 (77)*	126 (33)	65 (50)*
Line 92	77 (62)*	44 (69)*	103 (46)	31 (76)*
Line 84	90 (56)*	16 (89)*	78 (59)	12 (91)*
Check	204	142	189	129

[a]Weed counts within a 0.5 x 1.0 m frame thrown at the middle of the plot.
[b]Numbers in parentheses means % reduction as compared to check.
*Significant reduction compared to check plots using LSD at $P < 0.05$.

At six WAP, average weed density was reduced 81% (from 142 to 27 plants/0.5 m^2) in tomato, and 71% (from 129 to 37 plants/0.5 m^2) in pepper that followed pigeon pea (Table 2). Tomato and pepper yields recovered from plots planted with individual pigeon pea cultivars and lines were similar to yields produced in plots without pigeon pea (only data of average yields are presented). Value of produce (gross income) for a single year may be increased when the value of pigeon pea produce was added to the value of tomato or pepper. Integration of pigeon pea in both cropping systems may contribute to weed suppression and also to increased gross income.

Table 2. Weed density and average gross income expected in different cropping systems.

Cropping system	Weed density[a] kg/ha	Crop yield no./0.5 m^2 $/ha	Value of produce[b] $/ha	Estimated increase
Pigeon pea-tomato	27	7,474 + 7,213	14,626	9,865
Pigeon pea-pepper	37	7,474 + 12,090	19,945	9,865
Tomato only[c]	142	7,330	4,760	0
Pepper only	129	12,920	10,080	0

[a]Weed counts within a 0.5 x 1.0 m frame at six weeks after planting.
[b]Estimated value per kg in 1994-95 was as follows: tomato, $0.66; pepper, $0.78; and green pigeon pea, $1.32.
[c]Tomato yield was lower than expected because of virus diseases.

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ALTERNATIVE METHODS FOR PRODUCING INDUSTRIAL TOMATO PLANTS BY SMALL FARMERS

J.W. Dupuy, M. Sencion, J. Fabelo, and V. Ferreiras, Barceló Industrial, P.O. Box 63. Santo Domingo, Dominican Republic.

ABSTRACT. The history and economic damage caused by the white fly, *Bemisia tabaci*, is well documented worldwide. The processing tomato industry in the Azua Valley of the Dominican Republic, represents the main source of incomes for more than 3,000 small farmers and the principal activity for 4 tomato industries established in the region. The tomato industry was almost devastated as the result of the presence of the White Fly and the geminivirus (TYLCV) infestations. To recover the productivity of the tomato crop, it was necessary to implement and validate a series of integrated pest management practices. Correct planting time, use of resistant and early varieties, and application of legal measures, are among these practices. Combined with these, the production of tomato plantlets under mosquito net tunnels, reduces the early infection of TYLCV. This reduction results in an increase of yield and greater incomes to farmers. This paper describes a viable and economic method of producing planting materials using locally available resources.

RESUMEN. Los daños ocasionados por la mosca blanca *Bemisia tabaci*, y los virus que transmite, en especial el "Tomato Yellow Leaf Curl Virus" (TYLCV), han sido de gran impacto en diversas zonas agrícolas del mundo. La documentación sobre el desarrollo de la plaga y las pérdidas que la misma ha generado entre los productores de vegetales es abundante. El tomate industrial representa la principal fuente de ingresos para más de 3,000 pequeños y medianos productores de la planicie de Azúa, República Dominicana. En esta región intervienen 4 empresas procesadoras que tienen como línea principal la producción de pasta de tomate, catchup y otros derivados. Dichas empresas, además de ofrecer financiamiento a los productores, brindan asistencia técnica y otros servicios. La industria del tomate de la República Dominicana resultó devastada a raíz de los problemas surgidos con la presencia de la mosca blanca y la incidencia de la geminivirosis del tomate. Para sus recuperación fue necesario la implementación de nuevas estrategias para el control del complejo mosca blanca-geminivirosis, para lo cual se validaron y aplicaron una serie de medidas, tanto legales como culturales. Dentro de estas medidas se destaca la producción de plántulas a través de semilleros protegidos como forma de reducir o retrasar la infestación temprana por geminivirus. Se describe a

continuación un método práctico que se viene aplicando en la planicie de Azúa para la producción en gran escala de plántulas de tomate "libres de virus", mediante la utilización de materiales simples y de fácil adquisición en el mercado local.

MATERIAL AND METHODS

A modified mosquito netting, with steel rods ¼" x 80" was used. Transplant trays containing 288 holes with Sunshine No. 3 growing mix. Trays are filled with the growing mix, pre-wetted before planting, seeded by hand and placed on a seedbed covered with the netting. Seedbeds are formed in selected areas where the soil has been previously prepared. Recommended dimensions are 0.92 m wide by 40 m long, each one accommodating 150 trays. Calculating a germination rate of 80%, each tray will produce 230 healthy plants for transplanting to the field. A seedbed of 40 m long with 150 trays will produce enough material for two acres using a population of 17,415 plants on 45" bed.

Plantlets can also be produced directly in the seedbed, sowing the seeds by hand in rows 10 cm apart. Before planting, the soil is treated with Diazinon (Diazinon) and Ridomil (Metalaxyl) (0.5 l and 437 g, per 50 gal. drum, respectively). An application of Sencor (metribuzine) (435 g/50 gal.) is used for weed control. A tunnel is formed with netting and steel rod, in arch form. Netting for covering one seedbed is 2 m wide by 45 m long. Steel rod is 2.05 m (80") long forming an arc 0.61 m (24") high. The netting is tightened by stretching and tied down. Soil is used to cover the sides of the tunnel. Varieties planted were Ferry Morse 96ON, FM 1047N, FM 1010N, Peto Gem Star and Heinz 9425N, all hybrid and nematode resistant. Since a nematode problem exists in the Valley, only nematode tolerant materials are used. This also lowers production costs. Trays are irrigated by hand three times weekly and fertilized alternately with 20-20-20 foliar and Keyplex 350. Fungicides used were Maneb, Metalaxyl + Mancozeb and Captan. No insecticides were applied.

RESULTS

Plants were ready for transplanting in 17 days, after attaining a height of 0.12 m to 0.15 m (5" to 6") with excellent vigor (normally 20-21 days). Plants were protected from insects and weather. Protecting cost of hybrid seed, reduction of insecticide and lower cost, virus free transplants, and increase of 62% yield of tomatoes harvested.

In conclusion, individual farmers can produce their own transplants free of TYLCV, using the simple method described here.

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EVALUACION DE CULTIVARES DE TOMATE *Lycopersicom esculentum Mill.* POR RENDIMIENTO Y TOLERANCIA A LA GEMINIVIROSIS TRANSMITIDA POR *Bemisia sp.* EN ZONAS PRODUCTORAS DE LA REPÚBLICA DOMINICANA

S. Alcántara, R. Arbona y R. Geraldo, Centro de Investigaciones Aplicadas a Zonas Aridas (CIAZA), Secretaria de Estado de Agricultura, Santo Domingo, D.N., República Dominicana.
J. Nuñez y C. Serra, Instituto Superior de Agricultura (ISA), Santiago, República Dominicana.
R. Pérez-Duvergé, Fundación de Desarrollo Agropecuario Inc. (FDA), José Amado Soler #50 Santo Domingo, República Dominicana.
J. Dupuy, Barceló Industrial, S.A. - Azúa, República Dominicana.

ABSTRACT. Ninety-six cultivars of tomato were evaluated for natural virus infestation of the tomato yellow leaf cut virus (TYLCV) in two regions of the Dominican Republic. These same cultivars were inoculated with TYLCV early in the growing season and field tests were conducted using plants produced under a shade-house. The cultural practices used in the field were similar to those used by the farmers. Data was collected on final yield, infestation rates, percentage of soluble sugars, and presence of the virus using hybridization of nucleic acids. The results suggest that using plants that were protected from the virus infestation can leads to yields of 43.3 t/ha. The majority of the cultivars used for commercial production (canning) are susceptible to this disease. However, some cultivars that are used mainly for salads showed a high level of resistance. The best materials were DRS-RH1, DRS-RH2, TY 8479, Gem Star, and PT 1095. The uses of early varieties with good production potential seem to be an important factor in obtaining an acceptable yield.

RESUMEN. A través de pruebas realizadas en dos regiones de la República Dominicana, se evaluó el comportamiento de 96 cultivares de tomate bajo condiciones naturales de infestación y también con inoculación temprana del virus rizado amarillo del tomate (TYLCV). Los ensayos se establecieron utilizando plántulas producidas en umbráculos. En el campo se aplicó el manejo tradicional que aplican las compañías y los productores. Se realizaron mediciones sobre el rendimiento, grado de infestación del TYLCV, porcentaje de sólidos solubles y se hizo detección de geminivirosis mediante pruebas de hibridación de ácido nucleico (NASHA). Los resultados sugieren que, un inicio temprano de la siembra y utilizando plántulas producidas bajo protección para evitar la infestación temprana, es

posible obtener rendimientos promedios de 43.3 t/ha y buena calidad de fruta, con una amplia gama de variedades e híbridos de los evaluados. En las evaluaciones para resistencia al TYLCV se pudo determinar que la mayoría de las variedades de tomate para uso industrial son susceptibles a la enfermedad. Sin embargo, algunos materiales mostraron un alto grado de resistencia, sobre todo los tipos para ensalada. Entre estos materiales se destacan el DRS-RH1 y DRS-RH2, TY 8479, el Gem Star y el PT 1095. El uso de las variedades precoces de buena productividad parece ser un factor clave para asegurar un nivel mínimo aceptable de ingreso a los productores.

INTRODUCCION

El cultivo del tomate industrial es uno de los más importantes en las regiones Sur Noroeste de la República Dominicana. Esta actividad representa una fuente importante de empleos en estas regiones, en especial en los sectores de más bajos ingresos. El tomate es la materia prima para las agroindustrias que elaboran derivados tales como pasta, salsa, sazones, jugos, etc., permitiendo ahorro de divisas a la economía nacional. Los rendimientos del cultivo de tomate en República Dominicana, son bajos en comparación con otros países de América y Europa. Una de las causas de esta baja productividad es la incidencia de plagas y enfermedades, que en ocasiones destruyen por completo o reducen de manera sustancial el rendimiento, haciendo las explotaciones poco rentables. Durante los últimos años los productores han sufrido cuantiosas pérdidas debido a infecciones causadas por la geminivirosis del tomate transmitida por la mosca blanca. Dentro del conjunto de acciones para reducir los daños ocasionados por la genimivirosis, una es la identificación de cultivares con buena adaptación, alta productividad y tolerancia a las infestaciones. Con el apoyo de la Fundación de Desarrollo Agropecuario Inc. (FDA), la Asociación de Fabricante de Conservas del Agro (AFCONAGRO), el Instituto Superior de Agricultura (ISA) y la Secretaria de Estado de Agricultura de la República Dominicana, se inició un proyecto para comparar variedades e híbridos de tomate a fin de determinar su adaptación a las zonas productoras, evaluar su tolerancia a geminivirosis y, determinar su capacidad productiva y la calidad de fruta. De manera específica, este trabajo reporta los primeros resultados del ensayo de evaluación de cultivares (variedades e híbridos) comerciales y experimentales procedentes de diferentes casas comerciales e instituciones de investigación. Las evaluaciones realizadas indican que existen materiales con excelente adaptación, alto potencial de rendimiento y precocidad para formar parte adecuadamente en los sistemas de producción utilizados en las regiones tomateras de República Dominicana.

MATERIALES Y METODOS

En la primera etapa del proyecto se realizaron dos tipos de ensayos en dos regiones del país. En Azúa, en la región sur, se establecieron dos ensayos con 93 variedades e híbridos de tomate, en dos diferentes sitios bajo condiciones naturales de infestación de TYLCV (Cuadro 1). En cada ensayo los materiales se distribuyeron al azar en dos repeticiones. Uno de los ensayos se estableció en el Centro de Investigaciones Aplicadas a Zonas Aridas (CIAZA) y el otro en el campo experimental de la Empresa Transagrícola, S.A. Por otro lado, en el Instituto Superior de Agricultura (ISA), en Santiago, se evaluó el grado de tolerancia al TYLCV así como la productividad de los materiales bajo condiciones de alta presión de infestación.

Las plántulas para los ensayos fueron producidas en umbráculos por la empresa LUOMA VITROLAB en sus instalaciones de Santiago, República Dominicana. Se utilizaron bandejas de 200 hoyos con sustrato a base de "peat-moss". La fertilización consistió en la aplicación diaria, 7 días después de la siembra, de 150 ppm de N en el agua de riego, 200 ppm de N, más 400 ppm de NPK y micronutrientes en forma foliar. En el umbráculo, se realizaron aplicaciones de los fungicidas BANROT (0.75 ml/l), BAVISTIN (1.5 ml/l), y PREVICUR (2 ml/l).

Ensayos de adaptación y productividad. En Azúa, las plántulas se trasplantaron al campo sin ser infectadas con TYLCV, a fin de someterlas a la presión natural bajo las condiciones actuales de siembra con un manejo comercial. El Transplante se realizó a los 43 días de la siembra en umbráculo, a un marco de plantación de 1.15 m entre surcos por 0.25 m entre plantas a hilera simple, para una densidad de plantación de 34,500 plantas/ha. Se dió un manejo comercial típico de la zona para este cultivo. No obstante, a pesar de que el objetivo principal de estas pruebas fue determinar el comportamiento, la productividad y la calidad de frutas de los cultivares, se realizaron dos lecturas del grado de infección con TYLCV, siguiendo la escala y procedimientos utilizados por Serra *et al.*, (1994). La escala consiste en la asignación de valores de índices de infección que oscilan entre 0 y 3, donde:

0= sin presencia de síntomas
1= sospecha de presencia de síntomas
2= síntomas típicos, rizado amarillo
3= plantas achaparradas, síntomas severos en hojas nuevas

Se tomaron muestras de la tercera hoja superior completa de cinco plantas por tratamiento, se envió una membrana de Florida a fin de detectar la presencia o no de geminivirus. Además del grado de infección

del virus, se evaluó el rendimiento en dos cosechas y el porcentaje de sólidos solubles. La segunda cosecha se vió seriamente reducida en alrededor de un 40% debido a fuertes lluvias.

Evaluación de la resistencia a TYLCV. Esta evaluación fue realizada por el ISA en Santiago (zona norte del país) y para tal fin las plántulas fueron inoculadas previamente. El procedimiento consistió en colocar dichas plántulas en jaulas de 2 m o viruliferas, provenientes del laboratorio, colocando aproximadamente un vector por planta y dispersándose varias veces al día. Esta metodología ha sido empleada exitosamente en otros ensayos de comparación y selección de líneas y cultivares (Serra *et al.*, 1994, Scott *et al.*, 1995). El transplante se realizó a los 49 días y se utilizó una distancia de 1.20 m entre hileras y 0.40 m entre plantas. Se trasplantaron 20 plántulas por cada cultivar. Se realizaron resiembras a 8 y 11 días después del trasplante y se evaluaron un total de 96 cultivares.

RESULTADOS Y DISCUSION

En la zona sur (Azúa) se observó que con baja presión de poblaciones de moscas blancas es posible obtener rendimientos de 43.3 t/ha en promedio con una amplia gama de variedades e híbridos de tomate para procesamiento evaluados en este ensayo (Cuadro 2). Bajo las condiciones de estas pruebas, una infección tardía con TYLCV (después de la mitad del ciclo) no afecto significativamente los rendimientos frescos de frutos. El uso de plantas sanas producidas en ambiente protegido contra el ataque temprano de moscas blancas puede contribuir a retardar y reducir los efectos sobre el rendimiento y calidad de frutas. Una alta proporción de cultivares de los evaluados en estas pruebas mostraron un mayor potencial de producción y de contenido de sólidos solubles en los frutos que la variedad Peto 98 que es tradicional en la zona. El porcentaje promedio de sólidos solubles de los cultivares evaluados fue de 3.9% el cual se puede considerar relativamente bueno. Al momento de la segunda lectura de infección por geminivirus, a los 75 días del trasplante, alrededor de 19 materiales tuvieron una lectura de 1.8 siendo el promedio de la prueba de 1.9. Entre estos materiales se destacan el Gem Star con 0.4, el TY 8479 con 0.7 y el PT 1065 con 1.6. Los promedios alcanzados con la variedad Peto 98 en cuanto a rendimiento, contenido de sólidos solubles y lectura de infección por TYLCV, estuvieron por debajo de los promedios alcanzados en las pruebas para cada una de estas evaluaciones. Los valores de Peto 98 fueron de 1.3 kg/planta, 2.7% y 2.0, respectivamente. Los resultados promedios de las evaluaciones aparecen en el Cuadro 4.

En Santiago (zona norte) los resultados de tolerancia a geminivirosis muestran altos índices de infección de 96 cultivares de

tomate, en cultivares susceptibles, lo que demuestra una alta eficiencia del método utilizado. Alrededor del 90% de los materiales evaluados en estas pruebas, según la escala utilizada, mostraron altos índices de infestación. En la primera evaluación los índices variaron entre 0 y 2, segunda evaluación los cultivares TY 8479, Gem Star y DRS-RH1 y DRS-RH2 que mostraron un índice medio de infección inferior a 0.5. En la tercera evaluación los tomates de mesa DRS-RH1 y RH-2 resultaron igualmente con índices muy por debajo de 0.5. El híbrido PT 1095 alcanzó un índice de 2.2, aproximadamente. La mayoría de los cultivares alcanzaron índices de infección superior a 2.5, mostrando síntomas severos. En el Cuadro 2 se muestran los resultados de la prueba de hibridación de ácido nucleico realizada en Florida con la colaboración de la Dra. Jane Polston, los cuales confirman la alta incidencia del TYLCV en los cultivares evaluados. Un 91.7% de las muestras resultaron positivas (+) y un 8.3% negativas (-). El Cuadro 4, resume los resultados de las evaluaciones de rendimiento y grado de infección realizadas en Santiago en el ensayo de evaluación de la resistencia a TYLCV.

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Cuadro 1. Variedades e híbridos de tomate en evaluación en los ensayos de Azúa, 1995-1996. Localidades CIAZA y TRANSAGRÍCOLA, S .A.

Nombre	Origen	Nombre	Origen	Nombre	Origen
FMX 1078 17244	F.M.	CXD 154 VFFN	C. S.	NS-220-F-1 HXB	O.S.
FMX 1072 17410	"	CXD 165 VFF	"	DICING MÁSTER	"
LIGNON 8.6	L-U.	CXD 170 VFF	"	PRIMO TOM	"
HEINZ 2710	H.	CXD 177 VFFNP	"	FANCY PEEL II	"
HEINZ 3044	"	FMX 1048 N	F. M.	LONG PEEL	"
HEINZ 3302	"	FMX 883	"	DUR PEEL	"
HEINZ 8773	"	FMX 1031 N	"	SUPER PEEL 143	"
HEINZ 8892	"	FMX 1047 NP	"	FANCY PEEL	"
HEINZ 8893	"	CANNERY ROW 17266	"	SPECK-N-PEEL	"
HEINZ 9036	"	FMX 1045 N	"	NAPOLI VF	P.
HEINZ 9176	"	HYBRID 924	"	PETO 98	"
HEINZ 9177	"	HEINZ 2322	H.	UC-82B	"
HEINZ 9280	"	HEINZ 9143	"	NVH4476	R.
HEINZ 9281	"	HEINZ 9035	"	RELIANT	"
HEINZ 9314	"	HEINZ 8704	"	NVH 4779	"
HEINZ 9387	"	HEINZ 9144	"	NVH 4784	"
HEINZ 9425	"	HEINZ 7155	"	N 4781	"
HEINZ 9492	"	HEINZ 3302	"	RPT 1294	"
FMX 943 NP	F.M.	HYPEEL 287	P.	RPT 1570	"
CARDENAL	W.H.	HYPEEL 153	"	PT1095	"
BOS 707	O. S.	NEMA 512	"	PT 1852	"
BOS 3155	"	TY 8479	H.I.	LA ROSA	"
BOS 3203	"	GEM STAR	P.	N 4764	"
BOS 432	"	SUN 6109-54095	S.S.	NAPOLI I	P.
SUPER 528	"	SUNRE 6190-94A223	"	RIO GRANDE	"
BOS 8033	"	SUN 6200-54278	"	PETO 86	"
BOS 8095	"	NS-224-F-1 HX	B.G.	NAPOLI III	"
BOS 8132	"	NS-220-F-1 HXB	"	NVH 4785	R.
BOS 8147	"	NS-225-F1	"	CXD 181	C.S.

		HXB			
BOS 9540	"	NS-225-F-1HXB	O. S.	UC-82B	P.
CXD 136 VFF	C. S.	NS-224-F-1HXB	"	PETO 98	"

Las siguientes abreviaciones se refieren al nombre del origen de los materiales. F.M. = Ferry Morse; I.R. = Inra-Urpv; H = Heinz; W.H. = West Hill Seeds; O.S. = Orsetti Seed; C.S. = Campbell Seeds; P. = Petoseed; H.I. = Hazera Israel; S.S. =Sund Seed; B.G. = Breeders Grower; O. = Ochoa Seeds; R. = Rogers.

Cuadro 2. Presencia de TYLCV por hibridización de ácidos nucleicos.

Material				Material			
FMX 1078N	5	0	100	Heinz 3302	5	0	100
FX 1072 N	5	0	100	Hypeel 287	4	1	80
Lignon 8.6	4	1	80	Hypeel 153	4	1	80
Heinz 2710	5	0	100	Nema 512	4	1	80
Heinz 3044	4	3	57	TY 8479	4	1	80
Heinz 3302	5	0	100	Gem Star	3	2	60
Heinz 8773	4	1	80	Sun 6109	4	1	80
Heinz 8892	5	0	100	Sun 6190	5	0	100
Heinz 8893	3	2	60	Sun 6200	5	0	100
Heinz 9036	4	1	80	NS-224-F-1 HX	5	0	100
Heinz 9176	5	0	100	NS-220-F-1-HXB	5	0	100
Heinz 9177	5	0	100	NS-225-F-1 HXB	5	0	100
Heinz 9280	5	0	100	NS-225-F-1 HXB	5	0	100
Heinz 9281	5	0	100	NS-224-F-1 HXB	5	0	100
Heinz 9314	5	0	100	NS-220-F-1 HXB	5	0	100
Heinz 9387	5	0	100	Dacing Máster	5	0	100
Heinz 9425	5	0	100	Primo Tom	3	2	60
Heinz 9492	5	0	100	Fancy Peel II	3	2	60
FMX 943 NP	4	1	80	Long Peel	5	0	100
Cardenal	5	0	100	Dur Peel	5	0	100
BOS 707	5	0	100	Super Peel	5	0	100
BOS 3155	5	0	100	Fancy Peel	5	0	100
BOS 3203	5	0	100	Speck-N-Peel	5	0	100

BOS 432	6	0	100	Napoli-VF	5	0	100
Super 528	5	0	100	Peto 98	3	2	60
BOS 8033	4	1	80	UC-82	4	2	67
BOS 8095	5	0	100	NVH 4476	5	1	83
BOS 8132	5	0	100	Reliant	5	1	83
BOS 8147	5	0	100	NVH 4779	5	0	100
BOS 9540	5	0	100	NVH 4784	2	3	40
CxD 136 VFF	5	0	100	N 4781	5	0	100
CxD 154 VFFN*	5	0	100	RPT 1294	5	0	100
CxD 165 VFF	5	0	100	RPT 1570	5	0	100
CxD 170 VFF	5	0	100	PT 1095	5	0	100
CxD 117 VFFNP	5	0	100	PT 1852	5	0	100
FMX 1048 N	5	0	100	La Rossa	5	0	100
FMX 883	5	0	100	N 4764	5	0	100
FMX 1031 N	5	0	100	Callisto F-1	5	0	100
FMX 1047 NP	5	0	100	Napoli I	5	0	100
Cannery Row	0	5	0	Rio Grande	5	0	100
FMX 1045 N	5	0	100	Peto 86	5	0	100
Hybrid 924	5	0	100	Napoli II	5	0	100
Heinz 2322	5	0	100	NVH 4785	5	0	100
Heinz 9143	5	0	100	CxD 181	5	0	100
Heinz 9035	5	0	100	Hypeel 287	5	0	100
Heinz 8704	5	0	100	Nemabrix	4	1	80
Heinz 9144	4	1	80	DRS-RH1	4	1	80
Heinz 7155	5	0	100	DRS-RH2	3	2	60

Cuadro 3. Cultivares seleccionados con base a la prueba de inoculación artificial con TYLCV.

Cultivares	Tolerancia[1]	Rendimiento[2]	Potencial[3]
Tomate Industrial: Primera opción			
1 FMX 1078N	baja	alto	alto
2 FMX 1072	baja	muy alto	muy alto
3 Lignon 8.6	baja alto	alto	alto
8 Heinz 8892	baja	alto	alto
18 Heinz 9492	baja	alto	medio
22 BOS 3155	baja	alto	alto
25 Super 528	baja	alto	medio
31 CXD 136	baja	muy alto	muy alto

32 CXD 154	baja	muy alto	alto
33 CXD 165	baja	muy alto	alto
34 CXD 170	baja	muy alto	alto
37 FMX 883	baja	alto	alto
40 Cannery Row	baja	bajo	bajo
47 Heinz 9144	baja	alto	alto
54 Gem Star	baja	alto	medio
77 NVH 4779	baja	alto	alto
82 PT 1095	media	alto	muy alto
Tomate Industrial: Segunda opción			
4 Heinz 2710	baja	medio	alto
6 Heinz 3302	baja	medio	medio
9 Heinz 8893	baja	medio	alto
13 Heinz 9280	baja	alto	medio
15 Heinz 9314	baja	medio	alto
17 Heinz 9425	baja	alto	medio
26 BOS 8033	baja	alto	medio
38 FMX 1031N	baja	alto	medio
42 Hybrid 924	baja	medio	bajo
71 Speck-N-Pecl	baja	alto	medio
74 UC-82B	baja	alto	medio
79 N 4781	baja	medio	alto
Tomate de mesa			
53 TY 8479	alta	bajo	medio
95 DRS-RH1	alta	muy alto	muy alto
96 DRS-RH2	alta	muy alto	muy alto

Categorías relativas para tomate industrial (o de mesa):

1. Según índices: baja: 0-1.0, media: 1-2.5, alta: >2.5
2. Rendimiento, t/ha : bajo: <2(<5), medio: 2-4 (5-10), alto: 4-5.5 (10-12), muy alto: >5.5 (>12)
3. Potencial, t/ha: bajo: <6 (<10), medio: 6-9 (10-15), alto: 9-11 (15-20) muy alto: >11 (>20)

Cuadro 4. Rendimiento, Grado Brix y Lectura de infección por Geminivirus de las 93 entradas evaluadas. Azúa, 1995/1996.

Nombre y tipo	Rendimiento (kg/planta) Cosecha 1(%)		Cosecha 2 (%)		Rend. Total (kg/planta), t/ha		Brix % SS	virus (0 a 3)
FMX 1078N 17244 (H)	0.905	63	0.530	37	1.435	44.7	3.8	2.0
FMX 1072 17410 (H)	1.076	66	0.547	34	1.623	50.5	3.7	1.7
LIGNON 8.6 (V)	1.105	78	0.309	22	1.414	44.0	4.1	2.0
HEINZ 2710 (H)	1.239	74	0.427	26	1.666	51.9	4.0	1.8
HEINZ 3044 (H)	0.880	76	0.281	24	1.161	36.1	3.4	2.1
HEINZ 3302 (H)	1.198	74	0.417	26	1.615	50.5	3.6	1.8
HEINZ 8773 (H)	1.152	86	0.194	14	1.346	41.8	3.7	2.0
HEINZ 8892 (H)	0.785	56	0.628	44	1.413	44.0	4.3	1.9
HEINZ 8893 (H)	0.955	57	0.714	43	1.669	51.9	4.0	2.0
HEINZ 9036 (H)	0.747	43	0.993	57	1.740	54.8	3.8	1.9
HEINZ 9176 (H)	0.634	60	0.420	40	1.053	33.7	4.0	1.9
HEINZ 9177 (H)	1.025	75	0.337	25	1.362	42.5	3.5	2.0
HEINZ 9280 (H)	1.334	84	0.257	16	1.591	49.7	3.5	1.9
HEINZ 9281 (H)	0.932	68	0.436	32	1.368	42.5	3.9	1.9
HEINZ 9314 (H)	1.012	63	0.590	37	1.602	50.5	3.8	1.9
HEINZ 9387 (H)	0.877	61	0.558	39	1.435	44.7	3.7	1.9
HEINZ 9425 (H)	0.809	54	0.687	46	1.496	46.9	3.5	1.8
HEINZ 9492 (H)	0.699	42	0.976	58	1.674	52.7	4.7	2.0
FMX 943 NP (H)	1.191	78	0.337	22	1.528	47.6	4.2	2.0
CARDENAL (V)	1.068	81	0.251	19	1.319	41.1	3.9	2.0
BOS 707 (H)	1.090	75	0.364	25	1.454	45.4	4.6	2.1
BOS 3155 (H)	0.953	69	0.424	31	1.377	43.3	4.4	1.8
BOS 32.03	0.819	62	0.503	38	1.322	41.1	4.3	2.0
BOS 432 (H)	0.985	74	0.345	26	1.330	33.9	4.5	1.9
SUPER 528 (H)	1.151	77	0.353	23	1.504	38.9	2.5	2.0
BOS 8033 (H)	0.996	75	0.327	25	1.322	39.7	4.0	2.0
BOS 8095 (H)	1.016	78	0.286	22	1.302	64.2	4.6	2.0
BOS 8132 (H)	0.854	68	0.407	32	1.261	32.4	2.8	2.0
BOS 8147 (H)	0.826	61	0.519	39	1.344	44.7	3.4	2.0
BOS 9540 (H)	1.230	81	0.289	19	1.519	36.8	3.8	1.8
CXD 136 VFF (V)	1.036	70	0.453	30	1.489	33.2	4.1	2.0
CXD 154 VFFN (V)	1.429	83	0.291	17	1.720	48.3	3.8	1.9
CXD 165 VFF (V)	1.057	63	0.616	37	1.673	49.0	4.1	1.8
NOMBRE Y TIPO	Rendimiento (kg/planta) Cosecha 1(%)		Cosecha 2 (%)		Rend. Total (kg/planta), t/ha		Brix % SS	virus (0 a 3)
CXD 170 VFF (V)	1.480	83	0.312	17	1.792	43.3	4.2	2.0
CXD 177 VFFNP (V)	1.353	86	0.218	14	1.572	40.4	3.8	.18
FMX 1048 N (H)	0.843	70	0.366	30	1.208	39.7	4.2	2.1
FMX 883 (H)	0.908	64	0.502	36	1.411	44.0	3.7	2.0
FMX 1031 N (H)	0.898	72	0.341	28	1.239	33.9	4.3	1.9
FMX 1047 NP (H)	0.916	69	0.411	31	1.326	41.1	4.5	2.0
CANNERY ROW 17266 (H)	1.110	73	0.402	27	1.512	43.2	3.9	2.1

FMX 1045 N (H)	0.792	73	0.286	27	1.079	46.1	3.8	1.9
HYBRID 924 (H)	1.054	74	0.378	26	1.431	38.2	4.0	2.0
HEINZ 2322 (H)	1.107	90	0.125	10	1.232	32.4	4.0	1.8
HEINZ 9143 (H)	0.899	67	0.434	33	1.333	39.7	4.3	1.8
HEINZ 9035 (H)	1.084	69	0.481	31	1.565	41.1	3.7	1.9
HEINZ 8704 (H)	0.915	56	0.704	44	1.619	38.2	3.5	2.0
HEINZ 9144 (H)	0.587	47	0.675	53	1.262	39.7	3.6	1.8
HEINZ 7155 (H)	0.906	64	0.500	36	1.406	48.3	3.6	1.9
HEINZ 3302 (H)	1.281	71	0.515	29	1.796	41.1	3.8	1.9
HYPEEL 287 (H)	0.669	62	0.405	38	1.074	44.0	4.3	1.8
HYPEEL 153 (H)	0.871	70	0.376	30	1.246	54.8	4.3	2.0
NEMA 512 (H)	0.795	63	0.473	37	1.268	36.8	3.9	2.0
TY 8479 (H)	1.275	62	0.766	38	2.041	36.1	3.9	0.7
GEM STAR (H)	0.758	74	0.273	26	1.030	34.6	3.7	0.4
SUN 6109-54095 (H)	1.066	74	0.373	26	1.439	44.0	4.0	1.8
SUNRE 6190-94A223 (H)	0.868	74	0.300	26	1.169	60.5	3.7	1.8
SUN 6200-54278 (H)	0.648	61	0.416	39	1.064	46.2	4.8	2.0
NS-224-F-1 HX (H)	1.396	90	0.153	10	1.549	37.5	4.2	1.8
NS-220-F-1 HXB (H)	1.115	71	0.458	29	1.572	40.3	4.2	2.0
NS-225-F-1 HXB (H)	0.981	72	0.391	28	1.373	41.1	4.2	1.8
NS-225-F-1 HXB (H)	0.911	71	0.379	29	1.290	32.5	4.2	1.9
NS-224-F-1 HXB (H)	0.938	74	0.330	26	1.268	27.4	4.7	1.9
NS-220-F-1 HXB (H)	1.096	78	0.315	22	1.412	39.7	4.6	2.0
DICING MASTER (V)	0.655	60	0.434	40	1.088	36.8	4.1	2.0
PRIMO TOM (V)	0.799	61	0.517	39	1.315	33.9	4.3	2.0
FANCY PEEL II (V)	0.784	56	0.609	44	1.393	37.5	4.7	1.9
LONG PEEL (V)	0.835	57	0.631	43	1.466	36.8	4.0	1.9
NOMBRE Y TIPO	Rendimiento (kg/planta) Cosecha 1(%)		Cosecha 2 (%)		Rend. Total (kg/planta) t/ha		Brix % SS	virus (0 a 3)
DUR PEEL (V)	0.419	34	0.796	66	1.215	43.3	4.3	1.9
SUPER PEEL 143 (V)	0.614	59	0.422	41	1.036	41.8	4.1	1.9
FANCY PEEL (V)	0.819	65	0.444	35	1.263	41.8	3.8	2.0
SPECK-N-PEEL (V)	0.972	74	0.341	26	1.312	41.1	3.9	2.0
NAPOLI VF (V)	0.813	66	0.413	34	1.227	41.1	4.2	1.9
PETO 98 (V)	0.802	63	0.462	37	1.264	39.7	2.7	2.0
UC-82B (V)	1.270	83	0.265	17	1.535	41.8	4.4	2.0
NVH 4476 (H)	0.713	54	0.607	46	1.320	47.6	3.7	1.7
RELIANT (H)	1.049	74	0.362	26	1.412	46.9	3.8	1.9
NVH 4779 (H)	0.991	57	0.761	43	1.752	54.1	4.0	1.9

NVH 4784 (H)	0.865	73	0.316	27	1.181	52.7	3.7	2.0
N 4781 (H)	0.727	64	0.414	36	1.141	56.3	4.5	2.0
RPT 1294 (H)	0.600	54	0.515	46	1.115	49.0	3.7	2.0
RPT 1570 (H)	0.835	60	0.567	40	1.402	37.5	3.2	1.9
PT 1095 (H)	1.164	60	0.768	40	1.932	44.0	4.1	1.6
PT 1852 (H)	0.899	61	0.581	39	1.480	38.9	4.0	1.7
LA ROSSA (H)	0.829	69	0.368	31	1.198	41.8	4.5	2.1
N 4764 (H)	0.972	76	0.313	24	1.285	47.6	3.6	2.0
RIO GRANDE (V)	0.755	74	0.272	26	1.028	44.7	4.0	2.1
PETO 86 (V)	0.520	59	0.357	41	0.877	48.2	4.0	2.1
NAPOLI II (V)	0.672	53	0.590	47	1.262	41.8	4.3	2.1
NHV 4785 (H)	0.792	68	0.375	32	1.167	49.0	4.0	2.1
CXD 181 (H)	0.715	66	0.364	34	1.079	50.5	4.4	2.1
UC-82B (V)	0.832	70	0.360	30	1.192	39.7	3.8	1.9
PETO 98 (V)	0.816	70	0.357	30	1.173	64.0	4.0	2.0
PROMEDIO	0.935		0.443		1.378	53.3	3.9	1.9

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LA MARTINIQUE, LA GUADELOUPE ET LE MARCHE COMMUNAUTAIRE DE LA BANANE

Guy Ovide-Etienne, Président de la Chambre d'Agriculture de la Martinique, ancien membre du Comité Economique et Social Européen.

ABSTRACT. Martinique and Guadeloupe are two islands of the Caribbean integrated into the European Community as French departments. The organization of the common market of Banana of 1993 distinguishes between bananas from the community members from those produced by ACP countries and undeveloped nations. This device is intended to safe guard the interest of producers from the community. The commercial members of the European Community should permit the continuity of this activity in the banana production in the French Antilles. This activity is crucial for maintaining an economical and social balance in these territories.

RESUMEN. La Martinique et la Guadeloupe, îles de la Caraïbe, sont en leur qualité de Département Français des Régions intégrées à la Communauté Européenne. L'Organisation Communautaire du Marché de la Banane de 1993 distingue entre les bananes d'origine communautaire, les bananes d'origine des pays ACP et les bananes des pays tiers. CE dispositif qui entend sauvegarder des intérêts des producteurs communautaires et des partenaires commerciaux de la Communauté Européenne doit permettre la poursuite de l'activité de production bananière dans les Antilles françaises. Cette activité est essentielle pour l'équilibre économique et social de ces territoires.

INTRODUCTION

Le commerce de la BANANE fait depuis le 1er Juillet 1993 l'objet d'une Organisation Commune de Marché sur le territoire de la communauté européenne. Cette organisation essentielle pour les Antilles, obtenue après de longues négociations, fait quotidiennement l'objet d'attaques de ses adversaires; parmi les plus virulents, l'Allemagne et les multinationales américaines. Pourtant, sans porter atteinte aux intérêts des multinationales, le nouveau régime communautaire du marché de la Banane contribue à l'équilibre économique et social des pays de la caraïbe et singulièrement de la Martinique et de La Guadeloupe.

I- LA BANANE DANS LE MONDE

La BANANE arrive en tête des fruits produits et consommés dans le monde. En 1990, la production atteignait 46 millions de tonnes dont 9 millions de tonnes de bananes dessert, sont exportés. La banane occupe environ un million et demi d'hectares plantés sur plusieurs continents: Asie-Amérique du Sud et Centrale, Afrique. En tête des zones de production, on trouve l'ASIE et l'Amérique latine avec pour chacun environ 40% de la production mondiale. Le Brésil et l'Inde premiers producteurs mondiaux consomment la totalité de leur récolte. Le marché à l'exportation représente plus de 10 millions de tonnes (Annexe 1).

L'Amérique Latine est aujourd'hui le premier exportateur avec plus de 70% du marché mandial (Annexe 2).

La quasi totalité du commerce mondial se fait en direction des pays industrialisés d'Europe de l'Ouest, d'Amérique du Nord et du Japon. Les 2/3 du commerce mondial sont détenus par trois sociétés multinationales, CHIQUITA, DOLE, DELMONTE.

II- LA PROBLEMATIQUE DE L'OCM

La communauté européenne premier importateur mondial devant les U.S.A. avec près de 4 millions de tonnes importés, s'approvisionne principalement auprès des pays d'Amérique Latine (Annexe 3).

Il existe une production communautaire d'environ 800 000 tonnes venant des Régions dites ultrapériphériques de la Communauté. La Martinique et la Guadeloupe produisent entre 350 et 400 000 tonnes. Les Canaries environ 350 000 tonnes. Madère, 50 000 tonnes et la Crète, 15 000 tonnes. Le Marché Unique institué au 1er Janvier 1993, a rendu indispensable l'organisation du Marché Communautaire.

1o) - Avant l'O C M, une mosaïque de situations:

Avant le 1er Juillet 1993, il n'existait pas en Europe de marché commun pour la banane. Le marché des Douze était cloisonné et caractérisé par la coexistance de trois types de situations:

* Six Etats membres appliquaient un droit de douane de 20% et des restrictions quantitatives, plus ou moins strictes selon le cas, afin d'assurer l'écoulement des bananes de l'Union Européenne et de certains pays ACP; il s'agissait de la France, du Portugal, de la Grèce, de l'Angleterre et de l'Italie.
* Cinq Etat membres n'appliquaient pas de restrictions quantitatives, mais un droit de douane de 20%; il s'agissait de Irlande, du Danemark, de la Belgique, des Pays Bas et du Luxembourg.

* Un Etat membre bénéficiait d'une exonération de droit de douane en vertu d'un protocole spécial annexé au Traité de Rome et ne pratiquait pas de restriction quantitative, il s'agissait de l'Allemagne.

Cette situation était incompatible avec le grand marché qui a fait de la libre circulation entre les Etats membres une règle incontournable à compter du 1er Janvier 1993. Cependant, la disparition de cette organisation risquait de mettre les bananes communautaires et les bananes ACP en concurrence directe avec les bananes d'Amérique Latine qui supportent des coûts de productions moins élevés; en particulier couts salariaux. Les bananes communautaires étaient donc condamnées à disparaître avec les profonds déséquilibres économiques sociaux et humains qui en auraient résultés dans les régions où les possibilités de substitution n'existait pas en nombre.

2o) - L'O C M: La recherche d'une solution équilibrée.

Il s'agissait donc de trouver une solution commune respectant l'équilibre entre les intérêts des diverses sources d'approvisionnement (communautaire - ACP - Amérique Latine) et tenant des engagements, pris par l'Union Européenne:

* Le principe de la préférence communautaire a l'égard des productions de l'Union (Martinique-Guadeloupe-Canaries-Madère-Crète).
* La convention de L'OME à l'égard des Etats ACP;
* Les règles du GATT (et de la future OMC) à l'égard des pays tiers (banane dollar).

Le règlement communautaire adopté le 13 Février 1993 traduit le souci du législateur de respecter cet équilibre:

1.- Le volet interne prévoit pour les producteurs communautaires, un régime d'aide compensatoire destiné à compenser les pertes de recettes résultant du décloisonnement du marché.

Cette aide aboutit à:

Une limitation a 854 000 tonnes des quantités commercialisables par les producteurs communautaires.

Ce quota d'aide peut par conséquent être assimilé à un contingent. Au délà de 854 000 tonnes, les producteurs communautaires ne peuvent plus bénéficier de l'aide sans laquelle la vente de bananes communautaires est impossible. En effet, les prix de vente des bananes Latino-Américaine sont beaucoup plus concurrentiels du fait de leurs coûts de productions très inférieurs.

2.- Le volet externe prévoit:

* Une limitation à 857 700 tonnes des importations à droit nul en provenance des Etats ACP traditionnels. Au delà, le régime prévu pour les bananes dollar s'applique.
* Une limitation à 2 000 000 de tonnes des importations de banane dollar, assujettis à un droit de 100 écu/tonne. Au delà, l'accès est libre et il est perçu un droit de douane de 850 écu/tonne (750 écus/tonnes pour les Etats ACP non traditionnels).

Chacune des sources d'approvisionnement (UE-ACP-Pays tiers) a donc été limitée. La limitation quantitative a été établie selon le critère commun du volume des importations traditionnelles.

Pour éviter une structure oligopolistique du marché, des certificats d'importation des bananes dollars ont été institués:
* 66,5% pour les opérateurs qui ont des références de commercialisation de banane d'Amérique Latine et ACP non traditionnels.
* 30% pour ceux qui ont des références de commercialisation de bananes communautaire et ACP traditionels.
* 3,5% pour les nouveaux opérateurs.

3.- Les adaptions de l'OCM

Le règlement a prévu une souplesse d'adaptation de l'OCM aux modifications des conditions du marché et de la production:
* Augmentations régulières du contingent pour répondre à la progression de la demande;
* Fixation annuelle du montant de l'aide compensatoire;
* Délivrance de certificats spéciaux en cas de calamités.

Des adaptations ont été effectuées:

L'accord de Marrakech conclu avec quatre pays latino-américains (Colombie - Costa-Rica - Vénézuela - Nicaragua) et intégré dans le résultat final de l'Uruguay Round, a eu notamment les conséquences suivantes:

* L'augmentation du contingent pays tiers porté à 2,1 millons de tonnes en 1994 et 2,2 millions de tonnes en 1995.
* La réduction du droit de douanes de 100 écus/tonnes à 75 écus.
* La fixation de quotas spécifiques pour les pays d'Amérique Latine et ACP non traditionnels.

L'élargissement de l'Union Européenne à 15 états membres a également entraîné des aménagements. L'OCM se présente donc comme un compromis judicieux entre les intérêts de l'ensemble des opérateurs. Pour la Martinique, l'enjeu est important, tant sur le plan économique que sur le plan social.

III- LES ENJEUX DE L'OCM BANANE POUR LA MARTINIQUE

La banane est avec la canne à sucre les productions dites traditionnelles de la Martinique. La bananeraie martiniquaise couvrait 9 200 ha en 1994, soit près du quart de la superficie agricole utilisée. La production a varié entre 217 000 tonnes en 1991 et 169 000 tonnes en 1994. Les exportations ont varié entre 187 000 tonnes en 1991 et 152 000 tonnes en 1994. Ces variations montrent la sensibilité de cette culture aux conditions météorologiques. La banane est cultivée sur un millier d'exportations essentiellement familiales et de petite dimention (80% ont moins de 5 ha).

L'aide compensatoire obtenue dans le cadre de l'OCM, calculée sur la base de la différence entre le prix moyen de l'année considérée et la moyenne des prix d'une période de référence était de 1 955,57 F/tonne en 1993 et 1 372,88 F/tonne en 1994.

Dans une région ou près de 40% de la population active est au chômage, le secteur bananier a créé à lui seul environ 1 000 emplois en 1995. Dans le revenu global des exportations, la banane figure pour 45%.

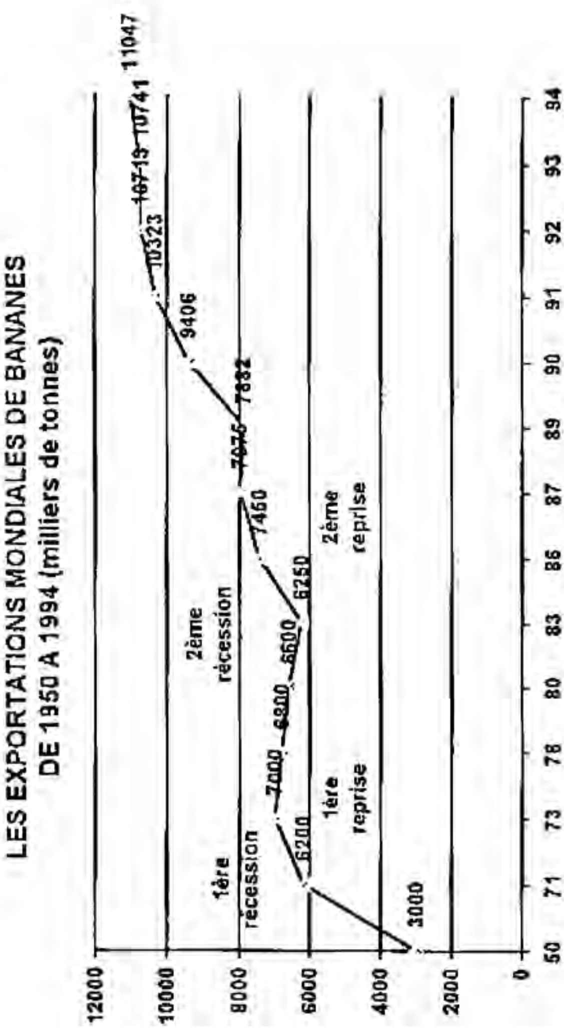
Comme on le voit, la banane est donc d'une haute importance pour l'économie de la Martinique. Les producteurs ont montré leur dynamisme. La martinique qui dispose d'un volume de 219 000 tonnes admis à la compensation dans le cadre de l'OCM atteindra ce tonnage en 1996 si aucune intempérie ne vient perturber la production.

Par ailleurs, la qualité de la banane martiniquaise est en sensible amélioration. Les producteurs font actuellement d'énormes efforts de rationalisation de leur production et d'amélioration de l'image du produit. L'OCM a donc introduit un dynamisme certain dans le secteur bananier.

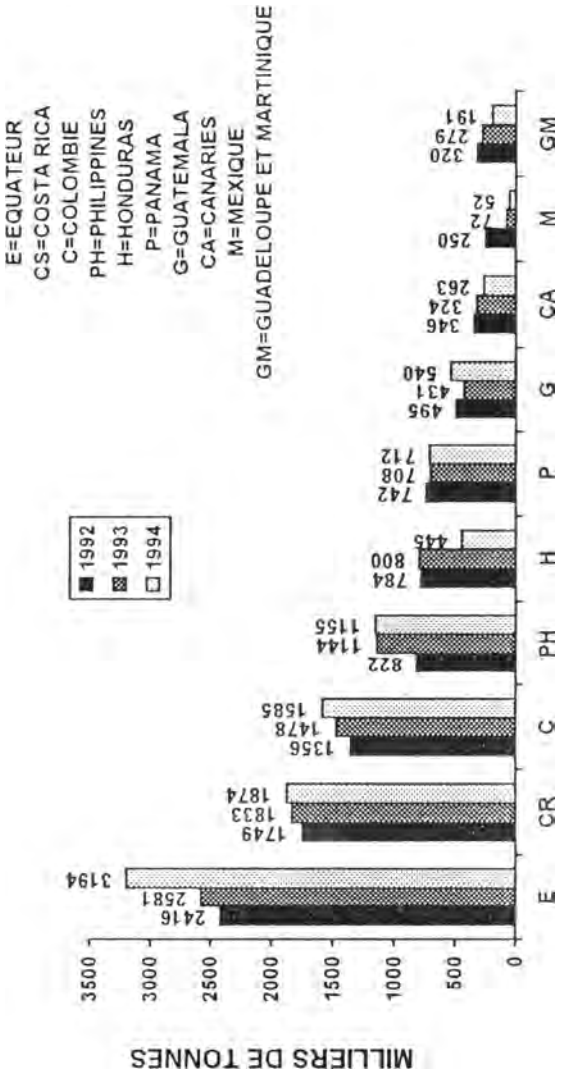
Ce résultat est détenu sans remise en cause des intérêts des autres opérateurs. En effet, la part des productions de la zone dollar sur le marché communautaire est passée de 60% en 1989 à 64% en 1994. Celle des producteurs communautaires de 23% en 1989 à 17% en 1994.

La part des pays ACP passant de 17% à 19% sur la même période (Annexe 4). L'OCM ne pénalise donc pas la production des pays de la zone dollar, ni ne remet en cause les intérêts des multinationales. Par contre, il permet aux producteurs communautaires et ACP, notamment ceux de la Caraïbe, de continuer à pratiquer une production souvent vitale pour leur économie et pour leur population.

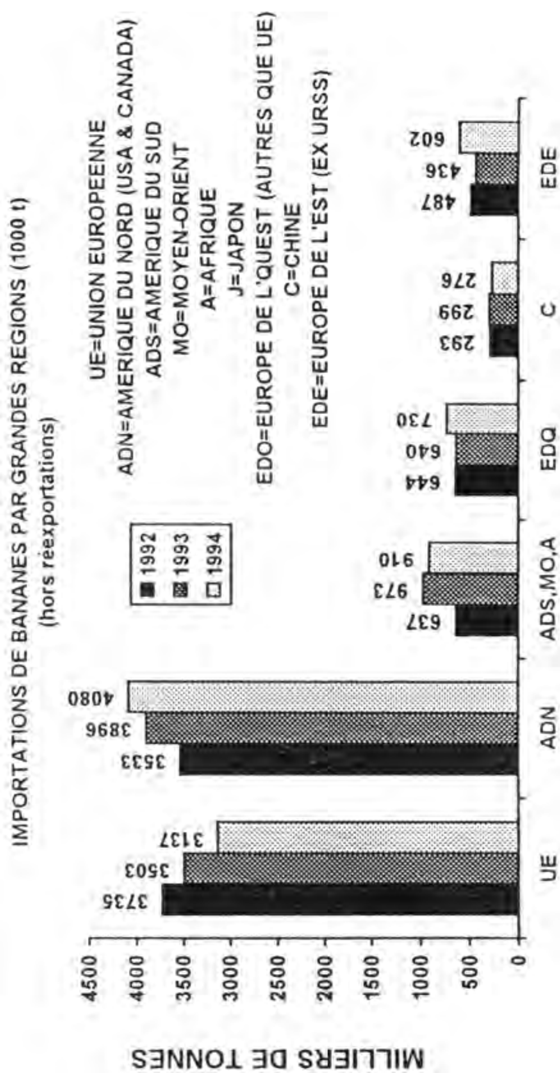
Le cas de la Martinique qui a été décrit ici peut s'appliquer en effet à nos voisins de la Caraïbe.



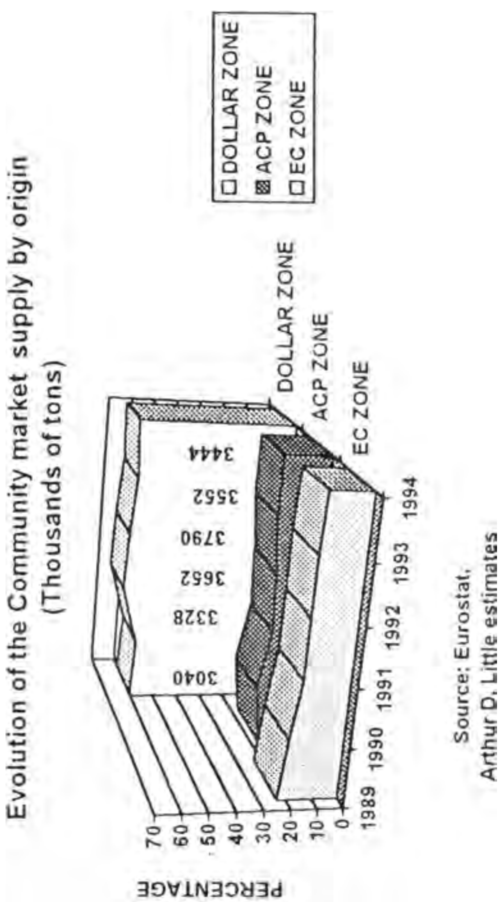
Annexe 1. LES EXPORTATIONS MONDIALES DE BANANES DE 1950 A 1994.



Annexe 2. LES EXPORTATIONS MONDIALES DE BANANES PAR PAYS.



Annexe 3. IMPORTATIONS DE BANANES PAR GRANDES REGIONS.



Annexe 4. EVOLUTION OF THE COMMUNITY MARKET SUPPLY BY ORIGIN.

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ELABORATION D'UN CAHIER DES CHARGES ENTRE LES PRODUCTEURS DE GOYAVE ET ROYAL S.A.

Odile Marcelin Francois-Haugrin and Gérard Chauvet, Royal Usine Denel Gros-Morne Martinique.

ABSTRACT. The Royal S.A. Company located in Groes-Morne (Martinique) produces and sells tropical fruit juices and jellies. Guava extract represents more or less 40% of the total volume produced. The company regrouped the guava grower's association in 1991 in order to secure self-sufficiency and quality of pulp. Fifty-one ha of guava were planted between 1991 and 1996. These should come into full production in the 1996 to 1997 season. The factory will be able to process 1000 t of fruit per year, enough to become self-sufficiency in pulp production. The work presented here shows the legal and technical aspects within the relationship of the producers and the Royal S.A. Company.

RESUMEN. L'entreprise Royal S.A. située au Gros-Morne (Martinique) fabrique et commercialise des jus et des confitures à base de fruits tropicaux. Le parfun goyave représente près de 40% des volumes produits en jus et confitures. Afin de s'assurer une autosuffisance en pulpe locale de qualité régulière, l'entreprise initié en 1991 la création d'une Assotiation qui regroupe des planteurs de goyave. 51 Ha de goyaviers sont ainsi plantées de 1991 à 1995. La pleine production prévue pour la campagne 1996-1997 permettra à l'usine de traiter environ 1000 tonnes de fruits par an ce qui lui assurera l'autosuffisance en purée de goyave pour réaliser la totalité des jus et confitures. Le cahier des charges que nous présentons formalise les aspects juridiques et techniques de la relation entre les planteurs et l'entreprise Royal S.A.

I- PRESENTATION DU PROYET

L'entreprise Royal, située au Gros-Morne fabrique et commercialise des jus et des confitures à base de fruits tropicaux. Depuis 1989, l'entreprise s'investit dans la recherche concernant la goyave dans la mesure où ce parfum représente près de 40% des volumes produits en jus et en confitures.

La transformation de ce fruit à l'usine est basée sur un approvisionnement local quantitativement insuffisant et de qualité irrégulière. De ce fait, afin d'assurer ses productions, l'entreprise est contrainte, depuis 1987, d'importer des purées dont les caractéristiques organoleptiques sont très différentes de celles des purées locales.

En 1991, Royal initie un plan de mise en culture de goyaviers dont l'objectif est d'assurer à l'entreprise un approvisionnement en fruits en quantité suffisante, normalisé et spécifique du terroir de la Martinique.

L'Association des Producteurs de Goyaves du Gros-Morne et ses Environs est créée. Elle regroupe les planteurs associés au projet, au nombre de 13 à ce jour. De 1991 à 1995, 51 hectares de goyaviers ont été ainsi plantés, l'objectif de rendement étant de 20 à 25 tonnes par hectare.

La pleine production, prévue pour la campagne 1996/1997, permettra à l'usine de traiter environ 1000 tonnes de goyaves par an, ce qui lui assurera une autosuffisance en purée de goyave pour réaliser 100% de ses jus et confitures.

Les variétés de plantes ont été sélectionnées, en collaboration avec le CIRAD FHLOR (Martinique), sur des critères agronomiques et physico-chimiques. Il s'agit de Centeno prolific, Beaumont, Red hybride et Red Suprême Ruby.

Le cahier des charges que nous présentons ici, a pour objectif de définir précisément les critères juridiques et techniques auxquels devront se conformer aussi bien Royal que les planteurs, l'Association des Producteurs de Goyaves du Gros-Morne et ses Environs jouant le rôle de coordinateur.

Un tel document est établit en concertation entre les deux parties car il ne s'agit pas d'imposer des critères irréalisables. Notamment, le présent cahier des charges, n'est pas encore validé par les deux parties, et pourra subir des modifications.

Nous présentons ici l'architecture globale du document.

II- PRESENTATION GENERALE DU CAHIER DES CHARGES

Selon l'ouvrage "Agro-alimentaire - Comment grandir la qualité" d'A. Soroste, "le cahier des charges définit aussi complètement que possible une fourniture à travers les principales caractéristiques et spécifications souhaitées par le client mais aussi à travers les moyens techniques de production et de contrôle mis en oeuvre pac le fournisseur".

C'est donc un outil méthodologique utilisé dans le cadre de la mise en oeuvre d'une politique de gestion de la qualité. Il intervient préférentiellement lorsqu'une relation client/fournisseur s'instaure entre deux entreprises.

Le cahier des charges vise à atteindre des objectifs à la fois juridiques et techniques.

Pour l'aspect juridiques, l'existence d'un cahier des charges est un élément de sécurité tant pour l'entreprise client que pour le fournisseur, dans la mesure où il constituera une référence essentielle en cas de litige.

C'est en effet, un document contractuel qui résulte d'un accord entre un fournisseur et un client.

Au niveau technique le cahier des charges vise à définir un produit le plus complètement que possible, ce qui comprend:

* la traduction en termes techniques des objectifs à atteindre.
* la précision des moyens d'évaluation du niveau réel de qualité obtenu et donc la conformité avec les objectifs initialement fixés.

III- LE CAHIER DES CHARGES ENTRE ROYAL ET LES PLANTEURS

A/ PARTIE CONTRACTUELLE

1.- CONVENTION

Cahier des charges: GOYAVES FRUITS
Date/AVRIL 1996
Entre: **L'ASSOCIATION DES PRODUCTEURS DE GOYAVES DU GROS-MORNE ET SES ENVIRONS**
Coordinateur
Représenté par NOM DU PRESIDENT
Adresse:
Téléphone:
Télécopie:

Signature
(précédée de la mention "lu et approuvé")

LE PLANTEUR
Fournisseur
Représenté par NOM DU PLANTEUR
Adresse:
Téléphone:
Télécopie:

Signature
(précédée de la mention "lu et approuvé")

ROYAL S.A.
Acheteur
Représenté par NOM DU DIRECTEUR DE PRODUCTION
Usine Dénel- 97213 Gros-Morne
Téléphone: 6751 23
Télécopie: 6767 56

Signature
(précédée de la mention "lu et approuvé")

2.- OBJECT ET DOMAINE D'APPLICATION

Le présent Cahier des Charges établi en concertation, a pour objet de décrire, de façon aussi exhausive et objective que possible, les moyens et méthodes nécessaires et suffisants à mettre en oeuvre par les deux parties pour que leur collaboration se déroule dans des conditions optimales.

Il est constitué de spécifications relatives au produit visé, les deux parties s'engagent à les respecter pour ce qui les concerne. Il décrit également les méthodes, procédures et documents que les deux parties s'engagent à utiliser pour ce qui les concerne. L'objectif des cosignataires étant de garantir au mieux l'aptitude du produit visé à remplir ses fonctions.

Afin de garantir l'adhésion des parties à ces objectifs, le présent Cahier des Charges et ses mises à jour seront visés par les responsables <Qualité> et <Commerciaux> des entreprises concernées.

Le premiers garantissant la compatibilité entre le présent Cahier des Charges et les capacités et contraintes de leur entreprise respective. Les seconds garantissant la compatibilité entre le présent Cahier des Charges et les capacités et contraintes commerciales de leur entreprise respective.

Par le présent Cahier des Charges, le PLANTEUR s'engage à fournir à ROYAL la totalité de sa production de goyaves.

En contrepartie, ROYAL s'engage à acheter la totalité de la production du PLANTEUR aux prix définis au & A/4/c.

3/ DUREE D'APPLICATION

Le présent Cahier des Charges est conclu pour une durée de un an. Il peu être révisé à la demande de l'une des deux parties en cas de besoin.

Il peut être dénoncé à tout moment, sans indemnités, par l'une ou l'autre des parties, avec un préavis de deux mois, et prendra fin à l'expiration dudit préavis.

La partie désirant mettre fin au cahier en avise l'autre par lettre recommandée avec accusé de reception.

4/ RESPONSABILITES

a) FRUITS

Le PLANTEUR s'engage à fournir des goyaves qui auront les caractéristiques générales suivantes:

a) Qualité conforme aux critères définis dans le présent cahier des charges (& B/3).
b) Variétés: Centeno prolific, Beumont, Red hybridge, Red Supréme Ruby.

c) Les fruits n'auront pas subi avant cueillette de traitements susceptibles de les rendre impropres à la consommation.

b) LIVRAISON

Le PLANTEUR s'engage à effectuer les livraisons de goyaves à l'usine DENEL, au Gros-Morne, du Lundi au Jeudi, de 8 à 15 heures.

En pleine saison (d'Août à Octobre), les fruit seront également réceptionnés le Vendredi, de 8 à 12 heures.

A son arrivée, il prendra contact avec la personne chargée de la réception des fruits à ROYAL.

A chaque livraison, seront effectuées différentes opérations, décrites au & B/3.

Ces opérations sont effectuées en présence du PLANTEUR et visent à définir la catégorie qualitative du lot de fruits.

A chaque livraison, la personne chargée de la réception des fruits à ROYAL remet au PLANTEUR l'original du bon de livraison.

c) PRIX

Les prix d'achat de lots de fruits sont fixés en fonction de 2 critères:

* La saison

Pleine saison: d'Août à Octobre

Basse saison: de Novembre á Julliet

* La qualité

Lot conforme tel que définis au & B/3

Lot déclassé tel que définis au & B/3

CRITERES	PRIX
Basse saison/ lot conforme	maximum
Pleine saison/lot conforme	75% du maximum
Basse saison/ lot déclassé	62.5% maximun
Pleine saison/lot déclassé	47.5% maximum

5/ ECHANGE

ROYAL s'engage à tenir à la disposition du PLANTEUR les résultats d'analyse de chaque lot de fruits et tient à sa disposition tous les documents de contrôle raltifs aux produits.

Les types et modalités de contrôle effectués sur les produits sont spécifiés par ROYAL dans le présent cahier des charges.

Tout anomalie qualitative détectée, et non prise en compte dans le présent cahier des charges, doit être identifiée et étudiée en commun afin d'être résolue.

Une modification du cahier des charges doit ensuite être effectée.

6/ CONFIDENTIALITE

Les conditions d'achat et de facturation doivent être conservées comme confidentielles envers tout tiers, hormis les Services officiels habilités.

ROYAL s'engage à considérer les informations et documents qui lui ont été, lui sont ou lui seront communiqués dans le cadre du présent cahier des charges, comme strictement confidentiels. ROYAL s'engage à ne pas reproduire les documents, ni les divulguer, tant pendant la durée du contrat qu'après, sauf autorisation écrite et préalable du PLANTEUR.

Réciproquement, le PLANTEUR s'engage à ne diffuser aucune information ou document que ROYAL et lui-même auront pu, ou pourront échanger dans le cadre du présent cahier des charges.

7/ ELECTION DE DOMICILE

Toute contestation ou différent qui pourraient surgir entre les parties dans le cadre du présent cahier des charges devront obligatoirement faire l'objet d'une tentative de règlement amiable entre elles et, si besoin est, par l'intermediaire d/un arbitre désigné d'un commun accord, qui statuerait alors comme amiable compositeur.

En cas de désaccord sur la nomination de cet arbitre, ou d'impossibilité d'un règlement amiable entre elles, les parties conviennent dès à présent de saisir alors le Tribunal de Commerce de Fort-de-France qui sera seul compétent, même en cas d'appel en garantie et de pluralité de défendeurs. Elles renoncent dès à présent et expressément à toutes dispositions contraires.

Pour l'exécution du présent cahier des charges et de ses suites, chaque partie fait élection de domicile en son siège social mentionné ci-dessus.

8/ CONDITIONS DE PAIEMENT

Le paiement s'effectuera selon des modalités définies en concertation par le PLANTEUR et ROYAL.

9/ DROIT DE VISITE DES PLANTATIONS DE GOYAVES

ROYAL se réserve le droit de visiter et d'auditeur les plantations de goyaves du PLANTEUR afin de vérifier leur adéquation aux critères définis au & B/1 du présent cahier des charges.

B/ PARTIE TECHNIQUE

I/ AGRONOMIE

Cette partie comprend toutes les spécifications validant la conformité des plantations des goyaves.

a) AMENAGEMENTS GENERAUX

* Si nécessaire, défrichage du terrain et viabilisation par aménagement de chemins.
* Préparation du sol: sous solage profond et une ou deux façons superficielles.
* Si nécessaire, installation d'une brise-vent (ERYTHRINA FUSCA), nom courant ERYTRINE, autour du verger.
* Plantation du brise-vent: sillonage localisé, apport de fumure (50 kg/400 m linéaire), mise en place des boutures (80 cm entre les arbres).

b) PLANTATION

* Distance de plantation entre les arbres: 6 m x 6 m.
* Trouaison manuelle: trou de 80 x 80 x 80 cm, rebouchage et fumure de fond. Par trou de plantation, mettre: 3 kg de chaux magnésienne, 1 kg de sulfate de potasse, 1 kg de super phosphate.
* Plantation.
* Tuteurage.

c) ORIGINE DES PLANTS

Les producteurs devront se procurer les plants auprès du CIRAD FHLOR. Ils doivent être en mesure de fournir la preuve de l'origine des arbres constituant le verger par la facture d'achat.

d) ITINERAIRE TECHNIQUE

* Entretien

Le controle de l'ensemble se fait:
- pour les interlignes, manuellement ou par utilisation d'un girobroyeur (6 passages par an).
- sur la ligne des plants, par des sarclages manuels pendant un an et demi, puis par des traitements herbicides au GLYPHOSPHATE (round up).

* Fertilisation

Année	Urée	Engrais complet	Nombre d'apports
1	75	150	12
2	150	300	8
2	175	350	6
3	300	600	4
4 et plus	375	750	3-4

* Taille

Les arbres seront taillés chaque année à partir de la deuxieme année.
Ils devront être maintenus en forme de gobelet libres pour faciliter la récolte.

* Traitements

Il n'y a pas de traitements systématiques. Des interventions auront lieu si les maladies ou les ravageurs font des dégâts importants.

* Récolte

La récolte se fera sur l'arbre. Les fruits seront cueillis au stade tournant qui correspond au virage du vert au jaune de l'épiderme. Les fruits seront stokés à l'abris du soleil jusqu'à leur transport vers l'unité de transformation.

Le délai entre la récolte et la réception des goyaves à ROYAL ne devra pas excéder 24 heures. La récolte se fera par variété et en aucun cas, le PLANTEUR ne devra effectuer des mélanges de variétés par contenant unitaire.

* Suivi technique

Le technicen désigné par le Groupement des Producteurs de Goyaves et ses Environs, assurera une visite mensuelle sur les plantations du PLANTEUR. A cette occasion, il vérifiera la conformité des plantations au présent cahier des charges. Le technicien pourra effectuer des visites ponctuelles à la demande du PLANTEUR ou de ROYAL, en cas de problème technique exceptionnel.

A l'issue de ses visites, le technicien rédigera un rapport sur l'état des plantations du PLANTEUR, qui sera remis au Président du Groupement des Producteurs de Goyaves et ses Environs. Ce document sera tenu à la disposition du PLANTEUR.

e) CULTURES INTERCALAIRE

Elles sont recommandées car elles permettent d'amortir en partie les frais d'installation du verger et d'améliorer la trésorerie de l'exploitation en attendant les premières récoltes. Cependant, elles ne sont pas obligatoires.

Les producteurs intéressés par ces cultures intermédiaires (chou, caraïbe, igname, patate douce, dachine, concombre, giraumon, ananas bouteille, gingembre...) peuvent contacter la Chambre d'Agriculture.

2/ TRANSPORT DES FRUITS A ROYAL

a) CONTENANTS

* Au moment de la cueillette, les fruits sont disposés dans des bacs gerbables et emboîtables.
* les bacs ne devront pas être remplis au dessus de l'encoche de gerbage.

b) TRANSPORT

* Le transport des fruits est à la charge du PLANTEUR
* Les bacs devront être gerbés et arrimés convenablement afin d'éviter les blessures de fruits, liés à des chocs.

3/ CONTROLE DE RECEPTION DES FRUITS A ROYAL

a) DECHARGEMENT

* Le PLANTEUR remet à la personne chargée du contrôle de réception des fruits à ROYAL, une note qui mentionne le nombre de bacs de fruits par variété. La personne chargée du contrôle de réception des fruits à ROYAL compte le nombre de bacs de fruits par variété, en présence du PLANTEUR.
* Le PLANTEUR effectue le déchargement des bacs de fruits directement sur la balance.
* La pesée des bacs, par variété, est alors effectuée simultanément par la personne chargée du contrôle de réception des fruits à ROYAL. Le PLANTEUR vérifie également la valeur de la pesée
* Après pesée, le PLANTEUR dispose au fur et à mesure les bacs de fruits sur des palettes fournis par ROYAL.

A ce moment, la personne chargée du contrôle de réception des fruits à ROYAL, choisit, au hasard, les bacs de fruits destinés au contrôle de réception. Les modalités d'échantillonnage sont explicitées au & B/3/b.
* Le PLANTEUR récupère, à ROYAL, un nombre de bacs également imprimés a son nom, équivalent à celui qu'il laisse.

b) ECHANTILLONNAGE

* Une unité du lot est présentée par un bac de fruit.
* L'échantillon correspond à 10% du lot, par variété.

c) TRI SUR ECHANTILLON

* En présence du PLANTEUR, la personne chargée du contrôle de réception des fruits à ROYAL, vide et trie les bacs de fruits, constituant l'échantillon, l'un après l'autre, sur la table d'inspection.
* Les fruits conformes et non conformes sont regroupés séparément.
* La conformité des fruits est définie en fonction de 3 critères.

-degré de maturité
-blessures telles les fendillements, morsures d'oiseaux ou d'insectes.
-propreté de l'épiderme.

* Le tri en fonction du degré de maturité prend en compte 4 stades, basés sur la colaboration de l'épiderme des fruits:

- vert
- vert/jaune (stade tournant)
- jaune
- jaune/marron (surmaturité)

Les fruits à l'épiderme vert/jaune à jaune sont conformes. Les fruits à l'épiderme vert et jaune/marron sont non conformes.

Les fruits conformes répondent aux 3 caractéristique suivantes, simultanément:

- Epiderme non blessé
- Epiderme vert/jaune à jaune
- Epiderme propre

Les fruits non conformes répondent au moins à une des caractéristique suivantes:

- Epiderme blessé
- Epiderme vert ou jaune/marron
- Epiderme présentant des moisissures
- Epiderme sale

d) CONDITIONS STATISTIQUES D'ACCEPTABILITE DU LOT A LA RECEPTION

* Les fruits non conformes sont regroupés dans des bacs qui sont pesés.
* Pour une variété donnée:

Un lot est accepté si l'échantillon prélevé sur ce lot presente un pourcentage de non conformité inférieur ou égal à 1%. Un lot de fruits est déclassé mais accepté si l'échantillon prélevé sur ce lot présente un pourcentage de non conformité supérieur à 1% et inférieur à 5%. Un lot de fruits est refusé si l'échantillon prélevé sur ce lot présente un pourcentage de non conformité supérieur à 5%.

* Si le lot de fruits est accepté, la personne chargée du contrôle de réception des fruits à ROYAL, remplit le bon de livraison.
* Le document est rédigé en double exemplaire, le PLANTEUR reçoit l'original et le double est conservé par la personne chargée du controle de réception des fruits à ROYAL.
* Si le lot de fruits est accepté, la personne chargée du contrôle de réception des fruits à ROYAL, identifie le lot par une étiquette.

4/ VERIFICATION PHYSICO-CHIMIQUE DU STADE DE MATURITE DES FRUITS

Les échantillons, provenant des lots acceptés à la réception, seront soumis à des contrôles physico-chimiques complémentaires, au niveau du laboratoire de ROYAL.

a) ECHANTILLONAGE

Sur l'échantillon, le laboratoire prélève le 10% des fruits répondant à tous les critères de conformité définis au &B/3.

b) PARAMETRES MESURES

* Sur chaque fruit: - Poids net (g) - Fermeté (g)

Pour chaque paramètre, on considere la moyenne des résultats obtenus.

* Sur la purée brute, obtenue après broyage et tamisage sur maille 2 mm, de la totalité des fruits:

- Degré brix - pH - Acidité
- Viscosité - Couleur (L*.a*,b*)

c) PROTOCOLE EXPERIMENTAUX

* Mesure du poids

Chaque fruit est pesé sur une balance (SARTORIUS, BA110S) avec une précision au 10ème de mg.

* Mesure de la coloration de l'épicarpe

Effectuée avec un chromamètre (MINOLTA, CR300: mesure par réflexion de la lumière).

La couleur du fruit est décomposée en 3 paramètres:

- La teinte: a*
- La luminosité (b*), aspect vif/terne de la couleur

- La clarté (L*), aspect clair/sombre de la couleur

Les valeurs des paramètres L*,a*,b* sont la moyenne de 3 impulsions lumineuses prises en 3 points différents, pour chaque fruit. La corrélation entre les grandeurs physiques et la couleur sensorielle est effectuée grâce au diagramme des couleurs représenté sur un poster.

* Mesure de la fermeté

Cette mesure est effectuée avec un analyseur de texture (RHEO,TAXT2):

- Module: 4 mm
- Vitesse: 0.5 mm/s
- Déplacement à partir du contact avec le fruit: 5 mm

Pour chaque fruit, 3 mesure sont effectuées en 3 points différents et moyennées. La valeur du pic positif caractérise la fermeté: c'est la plus grande valeur force/déplacement que le capteur a enregistré lors de l'essai.

La fermeté est exprimée en grammes.

* Mesure du pH

Matériel:

- pH mV metre à compensation automatique de température.
- Béchers de 100 ml
- Agitateur magnétique
- Barreaux aimantés
- Electrode gélifiée de pénétration, pointe 6 mm.
- Electrode argenthal haute température.

Sur purée brute (milieu compact), la mesure du pH est effectuée avec une l'électrode de pénétration, sans agitation.

* Mesure du degré brix

La mesure du degré brix permet d'estimer le pourcentage de sucres solubles (exprimé en saccharose) présents dans le milieu.

Matériel: - Réfractomètre d'ABBE

* Mesure de l'acidité titrable

Materiel:

- Burette de titration de 50 ml
- Béchers de 100 ml
- Agitateur magnétique
- Barreaux aimantés
- Balance de précision

10 g de purée brute ou de sérum pesés dans un bécher de 100 ml et additionnés de 3 gouttes de solution alcoolique de phénolphtaléine à 1%. Le milieu est agité avec un barreau aimanté, sur agitateur magnétique, jusqu'à parfaite homogénéisation puis titré avec un volume (V_{NaOH}) de solude 0,1 N jusqu'à apparition d'une coloration rouge permanente. L'acidité titrade (Néch) est exprimée en milliéquivalents/litre: Néch = 10 * V_{NaOH}

* Mesure de la viscosité

Matériel:

- Viscosimètre rotatif HAAKE, système de mesure RS (dispositif à peigne composé de 6 barreaux de 1.9 cm chacun, disposés alternativement sur un corps tournant), gradient de vitesse =30 s^{-1} atteint en 0.5 mn.
- Bain-marie thermostaté
- Bécher de 100 ml

Remplir à ras bord le bécher de 100 ml, avec de la purée brute.

Placer le bécher dans le bain-marie régulé à 40°C durant 30 mn sous agitation avec le module du viscosimètre. Cette préincubation est nécessaire pour que la température de la purée s'équilibre à 40°C. Relever la valeur de viscosité après 10 mn d'incubation. Cette valeur est calculée directement par l'intégrateur du viscosimètre en Pa.s.

La viscosité est exprimée ensuite en centipoises (cP=mPa.s)

d) NORMES D'ACCEPTABILITE

Ces normes définissent les intervalles dans lesquels doivent se trouver les valeurs des paramètres mesurés, pour chacune des quatres variétés.

	Cent. Prol.	Beaumont	Red. Hyb.	Red Sup. Ruby
Poids (g):	95-175	85-124	253-379	145-212
Fermeté (g):	451-1480	131-628	331-802	397-680
Degré brix:	8.2-10	7.1-7.9	9.7-10.5	9.8-10.6
pH:	3-3.2	3.3-3.5	3.5-3.7	4.1-4.3
Acidité:	192-266	126-152	61-73	55-63
Visosité (cpoises):	2700-3100	2100-2500	3200-3600	4200-4600
Couleur:				
L*	51.1-51.7	39.7-42.1		46.9-48.1
a*	16.7-18.9	12-13		15.3-16.9
b*	10.4-13.0	7.8-8.6		8.9-9.7

e) CONFORMITE DU LOT DE FRUITS

Le laboratoire décrète le lot de fruits conforme si tous les paramètres mesurés sur l'échantillon prélevé sont inclus dans les intervalles définis ci-dessus. Le laboratoire décrète le lot de fruits non conforme si au moins un des paramètres mesurés sur l'échantillon prélevé n'est pas inclus dans les intevalles définis ci-dessus.

Un exemplaire du bulletin d'analyse du lot de fruits peut être transmis au PLANTEUR, s'il en formule la demande. Si un lot de fruit présente une non conformité physico-chimique, la PLANTEUR ainsi que le technicien désigné par le Groupement des Producteurs de Goyave du Gros-Morne et ses Environs en sont immédiatement informés.

Une étude exceptionnelle est alors menée au niveau du verger, avec toutes les personnes concernées, afin rechercher et d'expliquer les causes de cette non conformité.

Des mesures correstives et préventives seront alors mises en place.

IV/ CONCLUSION

Le cahier des charges présenté ici constitue la traduction écrite et technique de la relation entre ROYAL, le Groupement de Producteurs de Goyave du Gros-Morne et ses Environs et le PLANTEUR.

Sa mise en oeuvre impose de respecter certaines règles de présentation afin de mieux définir les responsabilités de chacun.

Un tel document est nécessairement évolutif et pourra être révisé à tout moment, sur la demande, fondée, de l'une et de l'autre des parties.

Enfin, ce document doit être le résultat de l'esprit de concertation et de confiance instauré entre les deux parties.

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CULTURES MARAICHERES SOUS ABRI DONNEES TECHNICO-ECONOMIQUES MARTINIQUE

Roselyne Joachim, Chambre d'Agriculture de la Martinique.

ABSTRACT. Intensive horticultural crop production is limited in Martinique due to rain distribution and inconveniences tied to low soil fertility. In order to overcome these limitations, since 1984, growers have relied on two types of greenhouse production systems, first the Hors-Sol and then the Pleine-Terre. Through financial support provided by the Chamber of Agricultural and research conducted by CIRAD some limitations have been overcome to the point that in 1996 there are 13 ha of greenhouses installed. This communication will attempt to answer what are the cost and profitability associated with these production methods.

RESUMEN. La production maraichère à la Martinique est limitée par un certain nombre de contraintes qui réduisent les possibilités d'intensification. Afin d'y pallier les agriculteurs se sont lancés dés 1984 dans les systèmes de production sous serre à savoir le Hors-sol au début et ensuite la Pleine-terre. Les difficultés liées au manque de la technicité et au financement ayant été levées grâce aux programmes de recherche du CIRAD et à l'action de développement de la Chambre d'Agriculture, on atteint en 1996 environs 13ha d'abris. Dans le but de répondre aux préoccupation de ceux qui se demandent combien cela coûte et si cela est rentable, cette communication aborde les points suivants: 1) Le choix et le coût des investissements; 2) La rentabilité: des exemples nous permettent d'apprécier le niveau de rentabilité des serres en fonction du système de culture choisi; 3) Un panel des espèces produites sous abri nous donne enfin une idée de la diversification possible dans ce domaine.

I) HISTORIQUE ET JUSTIFICATIONS DE LA CULTURE SOUS ABRI

En pays tempéré,

* Les cultures sous serres ont été développées dans le but de pallier les contraintes climatiques (froid de la période hivernale), et de produire toute l'année en conditions maîtrisées.

En Martinique,

* Une pression démographique élevée (300 hab./km^2) générant une demande importante en produits maraîchers;

* Un relief accidenté limitant les disponibilités en surface cultivable;

* Un climate de type tropical avec une saison pluvieuse largement excédentaire;

* Des contraintes d'utilisation du sol liées à de nombreux agents pathogènes telluriques;

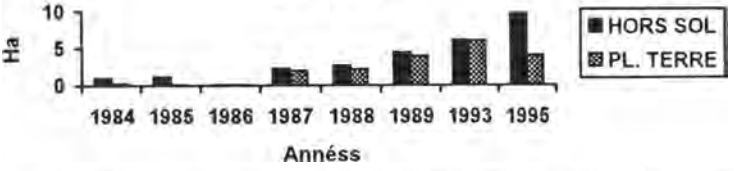
sont les principales raisons qui ont amené les producteurs à se lancer dès 1984 dans la production sous abri.

La Figure 1 montre l'évolution depuis 1984 des surfaces sous abri à la Martinique. Les surfaces en Hors-sol ont augmenté régulièrement jusqu'à maintenant. Celles en Pleine terre ont elles aussi augmenté mais une régression est apparue depuis 1995. Elle est à mettre en relation avec les contraintes de fertilité de sol évoquées.

La situation de 1986 s'explique par une insuffisance de maîtrise des techniques. La ténacité des producteurs, l'action de recherche du CIRAD et celle de vulgarisation de la Chambre d'Agriculture, ont permis de corriger ce phénomène et on atteint aujourd'hui: 9 ha en Hors-Sol et 4 ha en Pleine terre.

EVOLUTION DES SURFACES SOUS ABRI

1984-1995



La Figure 2 montre, en dépit de la période critique de 1986, une évolution constante du nombre d'exploitations en Hors-Sol (27 exploitations en 1996), alors que la diminution du système de production en Pleine terre est assez nette (35 exploitations en 1996 contre 50 en 1993).

En Hors-Sol ce sont les plus grosses exploitations qui s'agrandissent en améliorant leur technicité.

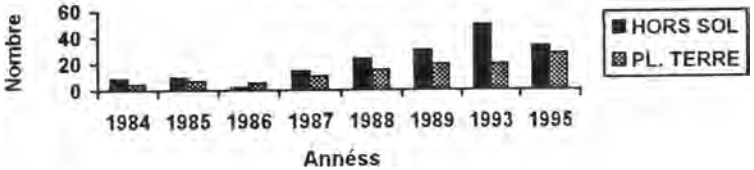
Les surfaces moyennes par exploitation en témoignent:

Hors-Sol: 2500 m^2

Pleine terre: 960 m^2

EVOLUTION DU NOMBRE D'EXPLOITATIONS

1984-1995



II) CHOIX ET COUT DES INVESTISSEMENTS

II.1) LA STRUCTURE:

L'effet principal recherché dans l'abri tropical est un effet de parapluie. Pour cela les structures les plus utilisées sont les tunnels simples métalliques (arceaux en demi-lune). Les chapelles (arceaux à base droite) récemment fournies en Martinique, pourraient aussi se faire une place.

* Les Tunnels simples sont d'un coût plus modéré, faciles à monter et semblent être mieux conçus pour résister aux vents violents. Les Chapelles à bord droits, qui ne présentent pas les avantages précités, permettent cependant, grâce à une augmentation de la hauteur sous faîtage, une amélioration de l'aération, indispensable au bon développement des plantes.

* Le chox du type de couverture, à cause de l'effet de serre (augmentation de la température), reste encore problématique. En Martinique, on utilise le Film Polyéthylène simple induisant l'effet de serre minimum par rapport aux autres matériaux. Le peu d'expérience dans ce domaine ne permet pas encore de préférer les nouvelles bâches conçues pour diminuer d'avantage ces effets au film polyéthylène simple. De plus, ce dernier est 50% moins cher.

A ce niveau, il est intéressant de constater, qu'en pays tropical, le serriste peut se contenter de structures simples qui n'atteignent pas les coûts élevés des serres verres permettant l'effet serre le plus élevé et la maîtrise du climat recherchés en zone tempérée. Ces outils sont abordables pour un jeune agriculteur qui bénéficie en outre d'une aide publique à l'investissement.

II.2) COUT MOYEN D'UNE SERRE (au m^2, en 1993)

Martinique

	TUNNEL		CHAPELLE	
NATURE	PL. TERRE	HORS SOL	PL. TERRE	HORS SOL
Structure montée, couverte	122.5 F	122.5 F	169.5 F	169.5 F
Arrivée d'eau + Aspersion	18 F		18 F	
Filtration + Injection + Goutteur + Automat.	22 F	54.5 F	22 F	54.5 F
Autres aménagements	17 F	64.6 F	17 F	64.6 F
COUT TOTAL	179.5 F	241.6 F	226.5 F	288.6 F

France

NATURE	TUNNEL		CHAPELLE		SERRE VERRE	
	PL. TERRE	HORS SOL	PL. TERRE	HORS SOL	PL. TERRE	HORS SOL
Structure montée, couverte	51 F	51 F	147 F	147 F	260 F	260 F
Arrivée d'eau + Aspersion	9 F		9 F		9 F	
Filtration + Injection + Goutteur + Automat.	21 F	36 F	21 F	36 F	21 F	36 F
Autres aménagements	7 F	45 F	7 F	45 F	7 F	45 F
Chauffage	20 F	40 F	20 F	40 F	45 F	115 F
COUT TOTAL	108 F	172 F	204 F	268 F	342 F	456 F

II.3) LES EQUIPEMENTS SOUS SERRE

Ils assurent la maîtrise des conditions favorables au développement des plantes en même temps que la diminution des dépenses en main d'oeuvre et en instrants.

Ce sont en général:

* L'alimentation générale en eau et en électricité, variable d'une exploitation à l'autre;

Et en particulier, - Pour la Pleine-terre:

* La filtration en cas de distribution au goutte à goutte;
* L'irrigation par aspersion nécessaire au moment de la préparation du sol;
* Un poste d'injection pour l'irrigation fertilisante.

-Pour le Hors-sol:

* La station de tête obligatoire comprenant: la filtration, 2 postes d'injection des engrais, la commande automatique et le systeme de distribution au goutte à goutte;
* L'équipement pour le Hors-sol: conteneurs et substrat;
* Le matériel de mesure: ph mètre et conductivimètre.

Le système Hors-sol est évidement plus complexe et plus coûteux l'est d'autant plus que les prix pratiqués en Martinique atteignent souvent le double des prix de la France, pays d'origine du matériel. Les autres aménagements comme les systèmes de brumisation, les tapis Hors-sol et les gouttières de culture ou pluviales, sont proposés à des prix réellement prohibitifs. Des systèmes d'aménagement simple en Hors-sol constitués de parpaings et de substrat à base de gravier concassé présentent alors un réel intérêt.

NATURE	Prix F.(H.T.)/m²	NATURE	Prix F.(H.T.)/m²
Tapis Hors sol	32 F	Film PE 180 mic.	5.95 F
Gouttières de culture	22 F	Parpaings (7 rangs)	10.6 F
Substrat Sable et ponce	22 F	Substrat Gravier de carrière	9.31 F
TOTAL	76 F	TOTAL	25.86 F

En conclusion:

De part la nécessité en pays tempéré d'utiliser surtout des serres verres équipées d'un système de chauffage et parfois d'antigel et d'enrihissement en CO_2, on atteint des coûts en Hors-sol en France comparables à ceux obtenus en Martinique.

Selon les informations chiffrées que nous possédons et si l'on reste dans les systèmes les plus simples, le coût des investissements pour la production en Hors-sol ne semble pas plus élevé dans nos conditions qu'en pays tempéré.

III) LA RENTABILITE

Les chiffres présentés donnent des ordres de grandeur pour une serre de 500 m². Dans la pratique, on peut rencontrer des écarts, dus à des choix d'équipements ou des conditions de marchés différents. Les charges de structure considérées sont seulement les amortissements.

III.1) LES RENDEMENT ANNUELS (en kg/m2)

		LAITUE	TOMATE	CONCOM-BRE	MELON
Densité moyenne (m²)	Plein champ	12	1.5	1.3	1.1
	Sous-abri Pl. terre	12	2.5	2.5	2.5
	Sous-abri Hors-sol	14	2.5	2.5	2.5
Nombre de cycles par an	Plein champ	5.5	2	3	3
	Sous-abri Pl. terre	8	3	3.8	3.8
	Sous-abri Hors-sol	10	3.5	4	4
Rendement moyen/cycle/m²	Plein champ	1.5	2	3.3	2
	Sous-abri Pl. terre	3	5.5	6	2.5
	Sous-abri Hors-sol	4	7	10	3.5
Rendement annuel (kg/m²)	Plein champ	8	4	9.9	6
	Sous-abri Pl. terre	24	16.5	22.8	9.5
	Sous-abri Hors-sol	40	24.5	40	14

Les rendements augmentent sensiblement en passant du plein champ à la Pleine-terre sous abri puis au Hors-sol. Cela s'explique par:

- une plus grande densité de plantation;
- un nombre de cycles par an plus important;
- des rendements par pied et par cycle plus élevés.

III.2) LES COUTS DE PRODUCTION (Par cycle en F/m^2)

		LAITUE	TOMATE	MELON CONCOMBRE
Semences	Pleine terre	4.2 F	1 F	1 F
	Hors-sol	4.9 F	1 F	1 F
Palissage	Pleine terre		0.3 F	0.3 F
	Hors-sol		0.3 F	0.3 F
Eau	Pleine terre	0.76 F	1.4 F	1.4 F
	Hors-sol			
Amendmt. + Eng Solut° nutritive	Pleine terre	1.2 F	1.8 F	1.8 F
	Hors-sol	1.7 F	3.6 F	3.6 F
Produits phytosanitaires	Pleine terre	0.5 F	0.75 F	0.75 F
	Hors-sol	0.45 F	0.6 F	0.60 F
Fournitures	Pleine terre	4 F		
	Hors-sol	4 F		
Main-d'oeuvre	Pleine terre	8 F	18 F	18 F
	Hors-sol	6.8 F	16 F	16 F
SOUS-TOTAL	Pleine terre	18.66 F	23.25 F	23.25 F
	Hors-sol	17.85 F	21.50 F	21.50 F
Amortissement	Pleine terre	4.6 F	12.2 F	9.24 F
	Hors-sol	5.66 F	16.17 F	14.15 F
COUT TOTAL	Pleine terre	23.26 F	35.45 F	32.49 F
	Hors-sol	23.51 F	37.67 F	35.65 F

Globalement, les coûts de production augmentent dans de faibles proportions lorsque l'on passe de la Pleine-terre au Hors-sol. Cependant, le gain de rendement en Hors-sol fait diminuer le coût de production au kilo.

Les graphiques de répartition des charges nous montrent que les plus élevées sont:

- Le coût de la main d'oeuvre qui représente entre 35 et 50% du coût en Pleine-terre contre 28 à 42% du coût total en Hors-sol, laissant supposer une meilleure organisation de la main d'oeuvre.

- Le coût de l'amortissement, de 24 à 42% du coût total en Hors-sol contre 20 à 34% du coût total en Pleine-terre montrant l'importance du choix des équipements, qui doit être le plus judicieux possible.

-Les coûts comparés de la solution nutritive et de l'ensemble: amendement + eau + engrais, respectivement de 9.6 et 9 % (cas de la tomate) du coût total montrent que bien conduite, l'irrigation fertilisante n'entraîne pas des coûts tellement plus élevés qu'une fertilisation courante.

REPARTITION DES CHARGES, exemple de la tomate (Annexe 1).

III.3.) LES MARGES BRUTES (/an/m^2)

	MELON		TOMATE		LAITUE		CONCOMBRE	
	Pl. Terre	Hors-Sol	Pl. Terre	Hors-Sol	Pl. Terre	Hors-Sol	Pl. Terre	Hors-Sol
Chif. d'Affaires Théor./an/m^2	96.6	143	129	191	V:204 T:283	V:350 T:413	84.4	148
Coût Partiel/an/m^2	88.35	86	69.7	72.2	V:117.3 T:149.3	V:138.5 T:178.5	88.3	86
Coût Total/an/m^2	123.4	142.6	106.3	131.8	V:154 T:186	V:195.1 T:235.1	123.5	142.6
Marge brute/an/m^2	8.5	57	59.2	115.7	V:86.7 T:133.7	V:212.5 T:234.9	-3.99	62
Marge directe/an/m^2	-26.6	0.4	22.8	59.1	V:50 T:97	V:154.9 T:178.5	-39.1	5.40

- Dans les conditions citées de rendements et de commercialisation, le melon et le concombre sont à exclure en Pleine-terre sous abri. Ils deviennent économiquement rentables es Hors-sol (surtout si le matériel est amorti). Cependant, si pour le concombre on obtient des rendements élevés et des fruits de bonne qualité, il n'est pas de même pour le melon en Hors-sol qui garde des qualités gustatives très médiocres;

- Les prix de vente minimum à appliquer pour couvrir ses charges sont:

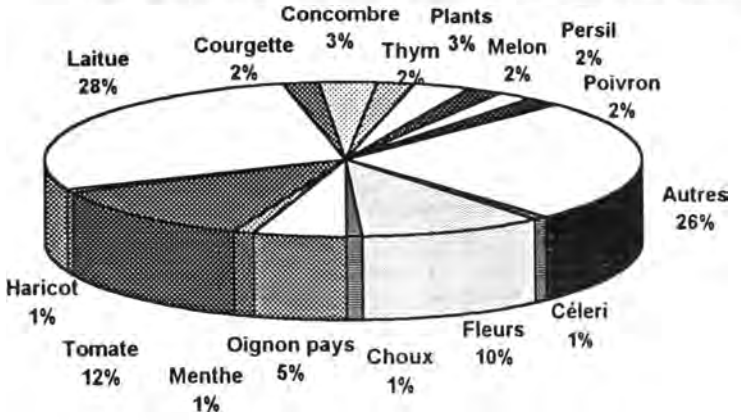
	MELON		TOMATE		LAITUE		CONCOMBRE	
	Pl. Terre	Hors-Sol	Pl. Terre	Hors-Sol	Pl Terre	Hors-Sol	Pl. Terre	Hors-Sol
Prix de vente minimum (F)	13	10.18	6.45	5.38	V:6.42 T:1.99	V:4.87 T:1.68	5.41	3.56
Prix de vente moyen 95 (F)	10.21		8.20		V:10.2 T:3.10		3.70	

- La tomate et encore plus la laitue sont les cultures présentant les rapports les plus élevés.

Ceci a justifié l'engouement de nos producteurs pour elles mais compte tenu des difficultés croissantes liées à la commercialisation, il serait souhaitable de penser à la diversification, à partir de références produites par la recherche.

C'est dans cette optique que nous présentons un panel de toutes les espèces produites sous abri. La répartition des cultures montre que certaines espèces sont peu représentées. Il conviendrait peut-être de les développer, comme par exemple le poivron et les épices.

REPARTITION DES SPECULATIONS SURFACE RELATIVE

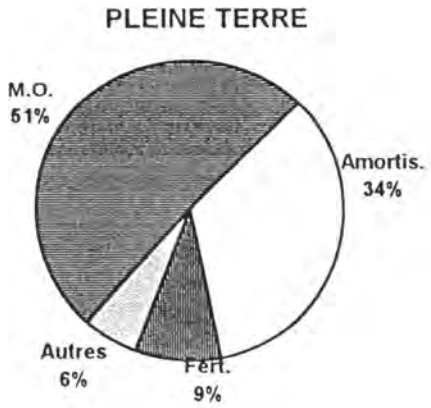


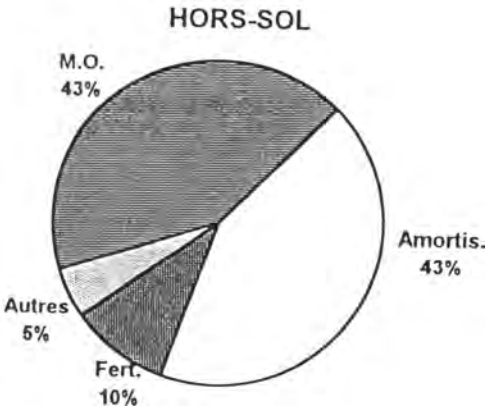
EN CONCLUSION

Les condition de réussite des cultures sous abri en Hors-sol sur lesquelles nous avons voulu attirer l'attention résident dans:

- L'augmentation des rendement liée à une très bonne technicité
- Une très bonne organisation du travail
- Une meilleure organisation de la commercialisation permettant de valoriser au mieux le produit de qualité issu de la serre. En effet malgré une qualité reconnue, le produit de serre ne bénéficie pas de conditions avantageuses de marché.

En outre l'augmentation rapide du coût des fournitures (plus de 20% de 1993 à 1996) ne cesse de mettre en périfil la production sous abri à la Martinique.





Annexe I. REPARTITION DES CHARGES, EXEMPLE DE LA TOMATE.

Proceedings of the Caribbean Food Crops Society. 32:150-158. 1996

DEVELOPPEMENT DES PETITS PLANTEURS D'ANANAS EN MARTINIQUE

Gilles Moutoussamy, Chambre d'Agriculture-SUAD Martinique
Paul Marie-Alphonsine and Frank Marie, CIRAD-FLHOR Martinique

ABSTRACT. A specific project for the training and technical assistance of small pineapple farmers has been completed by CIRAD-FHLOR since 1981. This effort catalyzed significant improvements regarding intensification and organization (creation of an association: ASPA) and resulted in a regular increase in productivity. About 50 growers, who together manage more than 100 hectares of land, produce about 20% of the total volume of pineapple on the island. Since 1991, SUAD (a government agricultural development service) and CIRAD-FHLOR/ASPA have collaborated to continue assisting those farmers. Regular farm visits and meetings on predefined subjects provide efficient technical assistance. Moreover, an economic survey of those farms was done, especially by studying a panel of reference plots. Besides the collection of numerous data, this situation helps farmers create effective personal development programs.

RESUMEN. A partir de 1981, une opération spécifique de formation et d'assistance tecnique auprès de petits planteurs d'ananas de Martinique a été réalisé par le CIRAD-FLHOR cette action a induit une dynamique de progrés significatifs, tant au niveau technique (haut niveau d'intensification), qu'au niveau organisationnel (création d'une association: ASPA), ce qui s'est traduit par une productivité globale en constance augmentation. Une cinquantaine de planteurs exploitant plus d'une centaine d'hectares, assurent environs 20% de la production totale de l'île. Depuis 1991, une action concertée SUAD /CIRAD/ ASPA poursuit l'encadrement de ces planteurs. Des visites individuelles régulières et dess réunions autour de thèmes préalablement définis permettent d'assurer un appui technique adapté et efficace. De plus ces expltoitations sont étudiées sous l'angle économique, notamment au travers d'un réseau de parcelles de références. Outre la collecte de nombreuses informations, ce dispositif permet de fournir une aide à la décision du planteur, et d'élaborer des schémes de développement personnalisés et cohérents.

INTRODUCTION

Vers la fin des années 70, des petits planteurs se sont lancés dans la culture de l'ananas qui apparaît alors comme une production sûre, notamment

en raison de la présence de conserveries qui garantissent l'écoulement des fruits à un prix fixé.

Devant cet engouement, et pour pallier à un manque de technicité, une opération spécifique de formation et d'assistance technique auprès des petits planteurs d'ananas de Martinique, a été initiée en 1981 par le CIRAD/FLHOR.

Cette action a induit une dynamique de progrès significatifs, tant au niveau technique (haut niveau d'intensification) qu'au niveau organisationnel (création d'une association: ASPA), ce qui se traduit par une productivité globale en constante augmentation. En 1995, Une cinquantaine de planteurs, exploitant plus centaine d'hectares dans le nord de l'île, assurent environ 20% (i.e.3500 tonnes) de la production totale de l'île.

Depuis 1991, une action concertée CIRAD-FLHOR/ Chambre d'Agriculture-SUAD/ASPA poursuit l'encadrement de ces planteurs. Des visites régulières et des réunions autour de thèmes préalablement définis permettent d'assurer un appui technique adapté et efficace. De plus ces exploitation sont étudiée sous l'angle économique, notament au travers d'un réseau de parcelles de références. Outre la collecte de nombreuses informations, ce dispositif permet de fournir une à la décision au planteur, et d'élaborer des schémas de développement personnalisés et cohérents.

Culture traditionnelle aux Antilles, l'ananas est le plus souvent cultivé au sein de jardins créoles, dans le principal but d'alimenter le marché du frais local. Seule île dotée d'une industrie de transformation significative, la Martinique a vu l'installation de la première conserverie dès le début du siècle. A l'instar de l'évolution de la situation des îles Hawaii, la production s'est progressivement organisée au sein de grandes et moyennes exploitations vers une intensification et une mécanisation très poussées pour réduire les coûts essentiellement liées à la main d'oeuvre.

Au début des années 80, un groupe de petits planteurs se tourne vers cette production, notamment en raison de la sécurité qu'elle procure: faible sensibilité de la culture aux aléas climatiques (cyclones) et garantie de l'écoulement de la production à un prix fixé, grâce à l'aide accordé aux conserveries par le Fond Européen d'Orientation et de Garantie Agricole (FEOGA).

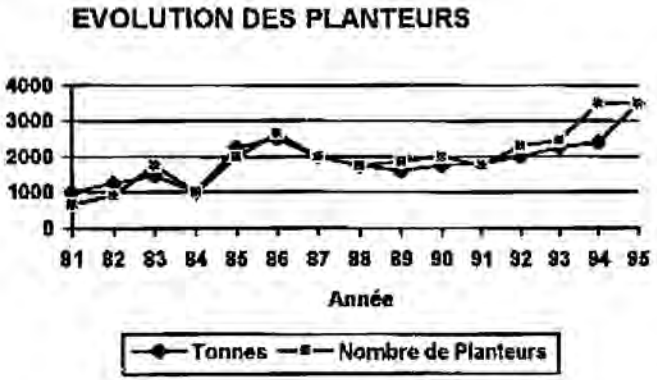
Ces nouveaux planteurs ne disposant d'aucune expérience dans le domaine de la production d'ananas, une opération d'encadrement et d'assistance technique a été initiée par l'IRFA (actuellement CIRAD-FLHOR) EN 1981. Cette intervention a été complétée en 1991 par l'intervention du SUAD (service de développement de la Chambre d'Agriculture).

Après une identification des besoins, la méthodologie a combiné l'approche collective et les contacts individuels. Des présentations théoriques en salle, ciblées sur des thèmes précis et illustrées par une visite sur le terrain, ont constitué des sessions de formation de groupe. Un suivi individuel régulier a permis d'apporter des solutions au cas par cas. Une relation de confiance

mutuelle entre le technicien et l'agriculteur est indispensable pour la réussite d'une telle opération.

Chronologiquement, les premiers efforts ont principalement portés sur les aspects techniques (optimisation des pratiques culturales) alors que dans un second temps, l'accent a été mis sur la gestion économique de l'exploitation et l'établissement d'un référenciel technico-économique pour la culture de l'ananas en Martinique.

2- L'EVOLUTION DE LA PRODUCTION



En 1995, le tonnage livré à l'usine a atteint 3500 tonnes, soit près de 20% des livraison totales. De plus, ces planteurs participent largement à l'approvisionnement du marché du frais local, estimé à 2500 tonnes.

L'augmentation constante de la production est la manifestation la plus évidente des progrès techniques réalisés en 15 ans.

3- LES PROGRES TECHNIQUES

Depuis la préparation du terrain jusqu'au Traitement d'Induction Floral (TIF) et à la gestion d'une seconde récolte, les petits planteurs maîtrisent désormais les principales techniques de production. Sensibilisés à l'importance du travail du sol, ils utilisent du matériel adapté. Le regroupement des petits planteurs dans une zone réduite a permis à certain d'entre eux de rentabiliser l'achat d'équipement spécifique (charrue, rotavator, billonneuse) en louant leur service.

Grâce aux connaissances acquises, l'emploi de pesticides est rationnel et efficace. De même, les apports de fertilisants sont raisonnés et planifiés en fonction de l'âge de la plante, de l'état sanitaire, et de besoins réels de la culture. Le T.I.F., dont la date est établie en concertation avec l'usine, est généralement réalisé à l'ethrel.

Le niveau de mécanisation s'est considérablement élevé au cours de ces dernières années. Des nombreux planteurs se sont équipés d'appareils de pluvérisation (traînés ou portés, avec rampe ou avec lance). La conjoncture d'appareils de pulvérisation mieux adaptés et de systèmes de plantation pensés en fonction du mode d'épanage, a permis de renforcer l'efficacité des traitement du fait d'une meilleure homogénéité des applications. Pour la récolte, les planteurs se sont fréquemment tournés vers l'acquisition d'un véhicule tout terrain.

Actuellement, la maîtrise des pratiques culturales et la mécanisation plus poussée de certaines opérations se traduisent par une productivité remarquable: le rendement moyen en première récolte, situe entre 65 et 75 tonnes/hectare, alors que la conduite d'une deuxième récolte (la plus rentable) se généralise.

4- LES ASPECTS ECONOMIQUES

L'analyse diagnostic réaliasé au départ ayant mis en évidence une carence au niveau de la gestion économique et financière; il s'est avéré nécessaire de mettre en place un dispositif permettant de palier à ce problème.

4-1 Méthode

Trois étapes ont été retenus: La formation, le suivi, la restitution.

4-1-1 La formation

La formation a été principalement axée sur la maîtrise des outils de base de la gestion et de la compatibilité:

- Notion de coût
- Charges (opérationnelles,structure)
- Marges (brute,directe,nette)
- Revenu agricole
- Bénéfice

4-1-2 Le suivi

- Choix d'un réseau de parcelles servant d'échantillons en vue de collecter des données.
- Une fiche de gestion de culture par parcelle, est remise à chaque planteur, sur laquelle il notera toute les opérations conduites (depuis la préparation du terrain jusqu'à la récolte)

- Remise d'un tableau de bord technico-économique, lui permettant de prévoir la trésoreric nécessaire pour chaque opération et par la suite de comparer les prévisions aux réalisations.
- Des visites régulières afin de contrôler les notations.

4-1-3 La restitution

Après chaque récolte, les éléments notés tout au long du cycle sont analysés et les différents coûts calculés.

Les résultats sont présentés individuellement sous forme de tableaux, et de graphiques, ce qui permet au planteur d'apprécier plus facilement son travail. D'autre part, l'analyse en cammun dc ces résultats permet de déterminer les points forts et les points faibles et de fixer les prochains objectifs.

4-2 Résultats et Commentaires

Cette opération a permit de constituer un référentiel technico-économique départemental sur la culture de l'ananas (annexe 1). Les résultats individuels sont par la suite comparés à ce référentiel, ce qui permet à l'agriculteur de bien situer.

Trois groupes ont été constitués à partir dc ces résultats:

- Groupe dc tête (A)
- Groupe du milieu (B)
- Groupe de queue (C)

Cette classification permet de créer une certaine dynamique et motive les planteurs.

5- CONCLUSION ET PERSPECTIVES

Cette opération a permit aux planteurs d'optimiser leur exploitation. Les résultats en terme dc marges sont globalement meilleurs à chaque cycle de culture. De plus en plus de parcelles sont suivis et pour certains il s'agit d'une approche globale de l'ensemble de l'exploitation qui tient compte de toutes des spéculations.

D'autre part, le groupe dc queue a tendance à s'amenuiser au profit du groupe du milieu.

L'obectif est dc poursuivre la recherche d'une meilleure rentabilité, compte tenu du fait que depuis quelques années le prix payés pas l'usine de transformation n'a pas évolué, et qu'il risque de ne pas évoluer, sinon de très

peu, dans les années à venir. Pour cela, à terme l'ensemble des exploitations devront être suivi dans leur globalité.

Annexe 1:

REFERENTIEL TECHNICO-ECONOMIQUE ANANAS

Paramètres		Densité plt/ha	Prix plt (F)		Prix vente (F/T)
		55000	0,5		2480
	Rend. t/ha	Produit (F)	M.O. SMIC	M.O. Tracteur	Transport
1° Cycle	75	186000	50 F/H	250 F/H	100 F/T
2° Cycle	40	99200			

CALCULS DES CHARGES 1° Cycle

Opération	Produits	Quantité (kg/l)	Prix unitaire (F/kg.l)	M.O. Smic (H)	M.O. tracteur (H)	Total
Herse					16	
Labour					8	
Rotavator					4	
Billons					6	
Traces					16	
Nématicide	Mocap	200	25	12		
Herbicide	Karmex	2	95	16		
Achat plants		55000	0,5			
Tri				80		
Plantation				150		
Fongicide	Aliette	6	280		16	
Herbicide	Karmex	2	95			
Total Charges de Structures Spécifiques						63960
Insecticide	Dyniston	165	25	68		
Engrais	12,04,24+4	3300	3	100		
Nématicide	Mocap	220	25	24		
Nématicide	Dyfonate	110	50	12		
Pulvérisation	Urée	650	2,5			
	Potasse	900	3			
	Méthyl	60	100			
	Gésapax	30	65		36	
Désh. Traces				12		
Désh. manuel				120		
T.I.F.	Ethrel	2	320			
	Urée	100	2,5		4	
Récolte				230		
Transport		70	100			
Total Charges Opérationnelles du 1° Cycle						82590

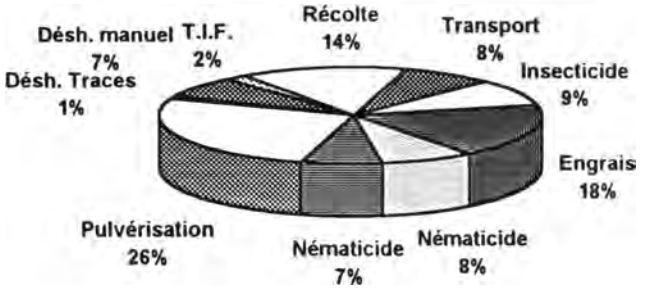
CALCULS DES CHARGES 2° Cycle (F)

Opération	Produits	Quantité (kg/l)	Prix unitaire (kg/l)	M.O. Smic (H)	M.O. Tracteur (H)	Total 18780
T.I.F.	Ethrel	2	320			
	Urée	100	2,5		4	
Désherbage	Gésapax	6	65		4	
Récolte				230		
Transport		40	100			
Amortissement/Cycle= Charges de Structure/2=			63960/2=	31980		
Charges locatives = 1/3 de la Marge Brute						

CALCULS DES MARGES (F)

	Rend. t/ha	Produit (F)	CH. OP.	Marge Brute
1° Cycle	75	186000	82590	103410
2° Cycle	40	99200	18780	80420
Total	115	285200	101370	183830

POURCENTAGE CH.OP. SUR CYCLE 1

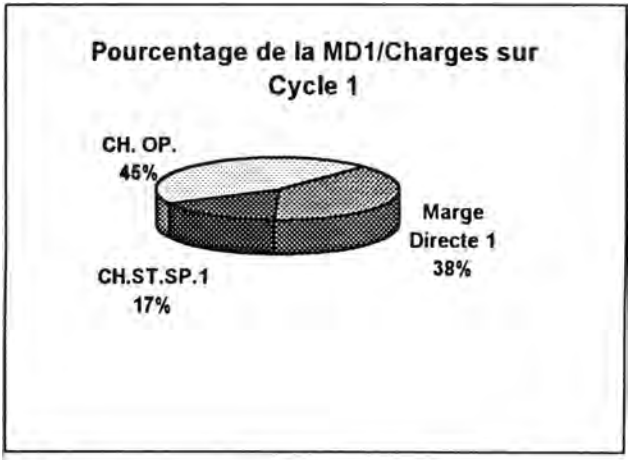


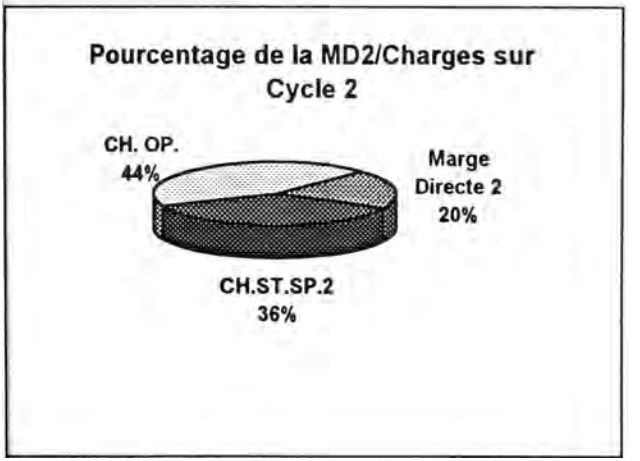
Classification des Agriculteurs

Marge Brute	Groupe A (Tête)	Groupe B (milieu)	Groupe C (Queue)
Cycle 1	>60 %	50-60 %	<50 %
Cycle 2	> 85 %	75-85 %	<75 %
Les 2 Cycles	>70 %	60-70 %	<60 %

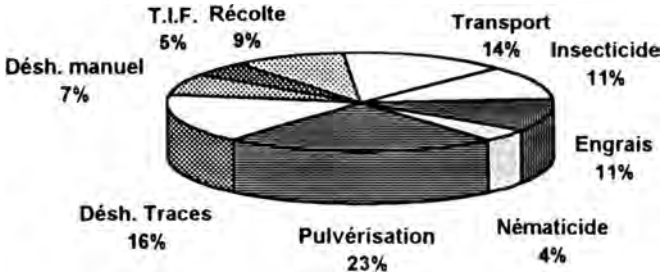
MARGES DIRECTES

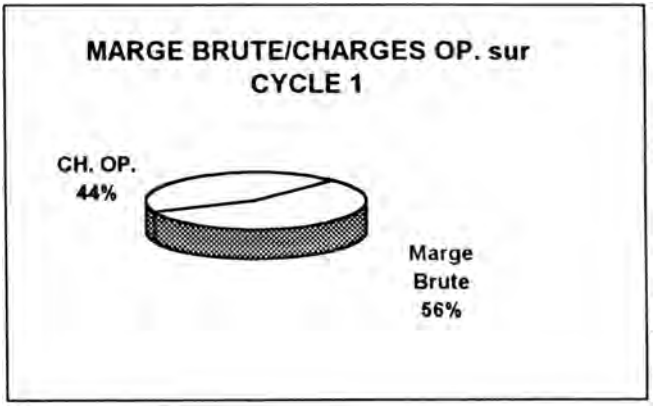
MARGE DIRECTE SANS CHARGES LOCATIVES					
	Rend. t/ha	Prod. Brut.	CH. OP.	CH.ST.SP.1	Marge Directe 1
1° Cycle	75	186000	82590	31980	71430
2° Cycle	40	99200	18780	31980	48440
Total	115	285200	101370	63960	119870
MARGE DIRECTE AVEC CHARGES LOCATIVES					
1° Cycle	75	186000	82590	66450	36960
2° Cycle	40	99200	18780	58786	21634
Total	115	285200	101370	125236	58594

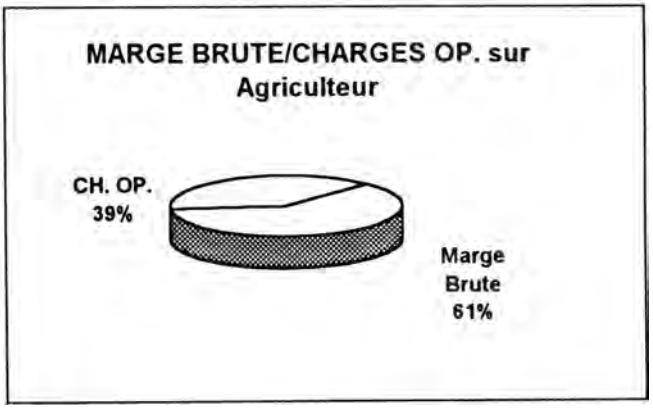




POURCENTAGE CHARGES/AGRICULTEUR







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WILL SMALL YAM FARMERS IN JAMAICA ADOPT THE MINI-SETT TECHNOLOGY?

Veronica Williamson and Armando Reyes-Pacheco, IICA, Jamaica.

ABSTRACT. To alter the production and productivity structure at the farm level entails technological innovations for achieving a more efficient use of natural, human, and economic resources. Beyond the complexity of devising technology in itself, it impels recasting the farming systems to emphasize a more commercially-oriented system than subsistence traditional production. This transformation demands that agricultural technology adoption and sustainability among small farmers be examined within the context of their perception. It must surpass the generation and exposure processes of technological alterations to farmers if it is to be cost-effective and provide elements of sustainability. If agricultural research and technology transfer is to promote suitable agricultural technology, generate sustainable farming techniques and methods, foster technology flows, and generally strengthen income levels, it merits to incorporate the social and economic milieu and often overlooked; farmers' attitudes.

INTRODUCTION

This research paper is a renewal attempt to clarify the importance of farmers' social context and opinions related to embracing a technological production package. It overviews and incorporates attitudinal questions centered on farmers discernment of The Mini-Sett Technology for yam production. The objective is to conceptualize and ascertain the social and attitudinal traits of those farmers who are more likely to espouse said technology.

There is no single set of socio-economic variables that will ensure the adoption and sustainability of a given technological package. However, the existence of a profile of a Jamaican farmer who are disposed to adopt The Mini-Sett Technology in the production of yams goes a far way towards facilitating the implementation of technology transfer, which is likely to become more cost-effective as it is target-oriented and focused on those yam farmers who seem most likely to become adopters.

An interview of 100 farmers selected randomly from the seven (7) major producing Parishes of Jamaica revealed that the knowledge of the Mini-Sett Technology related to yam production is fairly widespread. Most farmers have currently undertaken in their yam production systems some of technology

components and practices. However, many are unaware of, and unable to highlight, formally, the specific practice or component they have incorporated to address their individual constraints to a more productive yam enterprise. It seems that the small farmers intuitively derived their technical rationale that validates the adoption of a partial element or complete technological package.

Based on the study's results, there is a positive attitudinal predisposition among small yam farmers towards adopting technological change even if it involves risks. The transformation of traditional yam production is up-and-coming. Any attempt to identify those farmers who are more likely to accept and adopt The Mini-Sett Technology requires a clean understanding of the technology, its objectives and the problem-solving capability of applying the techniques-partially or totally. Indeed, there is evidence to support the thesis that yam production and productivity can be enhanced due to the application of this technology. A sense of optimism prevails that it might well constitute a major break-through in the transformation of the traditional system of yam production among the small farmers of Jamaica.

Small farmers' participation in the generation and transfer of technology was not always considered essential for incorporating technological innovations in their production processes. Technology was considered overall neutral. The situation is different today. Technology is rapidly changing the way we live and produce. Production units are compelled to increase production and productivity at a relatively faster rate than before to be able to remain competitive. This requires more knowledge and skills to be procured, devised and delivered to the farming community expeditiously to accelerate adoption. To hasten this process, the technology generation and transfer processes must take into consideration small farmers' participation and perception as well as knowledge of their environment.

Increases in agricultural productivity entail either a design of a technological innovation to alter a prior production system, or a modification of the production process. While this is feasible, as it encourages efficiency in maximizing production, it does not ensure increases in production by itself, for it requires to be adopted by producers. Thus, the transfer and adoption of agricultural technology is crucial for enhancing production especially among small farmers. Indeed, this process recognizes the need to assess farmers' opinions, preferences, criticisms and suggestions as they refer to a specific technology. Once this perception is known and evaluated it can be communicated more readily to technology designers who need to understand the farmers' point of view about the usefulness of a new technology to enhance its adoption (Crowder *et al.*, 1993).

The Mini-Sett Technology was developed to improve the efficiency of yam production especially for export and was tested on farmers' fields through the IICA/MINAG Cropping Systems Project in 1987 (Chin, 1993). This technological package was introduced to increase yam production by changing

the traditional system thereby reducing labour costs, achieving more efficient use of stakes, and of the amount of planting material required per production unit. Additionally the mini-sett method simplifies packaging and grading for export, diminishes harmful effects due to post-harvest chemical treatments, and contributes to the control of soil erosion (Chin Sue, 1991). Its dissemination was through the National Yam Export Development Project.

OBJECTIVE:

The core of this paper is to discern the profile of those farmers likely to adopt The Mini-Sett Technology. The objective of this study is to feature the underlying rationale for the adoption or non-adoption of this technology by giving an insight concerning small farmers priorities and decision making processes. Thus, a Jamaica's farmers' profile that seems more prone to adopt this technology can be suggested, identified, from which in turn a clientele can be portrayed and targeted. Indeed one could muse that the viability of this technology to be transferred, adopted and be more cost effective is high once ensemble to farmer's needs.

JUSTIFICATION:

Traditionally the process of agricultural technology generation and transfer in Jamaica has been "Top-to-Bottom" as limited consideration has been given to the views of farmers who are the "end-users". Efforts developed and disseminated following this approach are often frustrated, mirrored on the adoption levels. The cost-effectiveness of this methodological procedure to increase production and productivity remains a subject of debate. A weakness lies within the research procedures used to develop new technological packages, as they lack evaluations or assessments of farmers' perspectives and perceptions of the problems to be addressed, and more importantly, how the innovations will affect them. An alternative is the On-Farm Research and Extension Systems Approach.

Like many other technological packages, the Mini-Sett Technology for yam production was introduced among the farming community in Jamaica without enough consideration as to its acceptability in satisfying the farmer's needs. Ashby, (1990) refers to some of the objectives that circumscribe farmers' evaluation of the technological innovations, where include; inter alia.

(I) Supporting farmers' needs for year-round timely food supply; and

(ii) Compatibility with their farm plans, which incorporate an insurance strategy reflected in their high crop mix to buffer price variability, crop failures, etc.

Indeed, their production function seems to reflect an income flow stabilization rather than a profit maximizing objective. The complexity of small farming systems in Jamaica is a function of multiple objectives. These systems are compelled to be self sufficient, and this is reflected in their need to produce a continuous and reliable supply of food based on a constant and balanced cash flow to cover farm or household expenditures. These considerations set apart the importance for designers of new technologies to measure and evaluate farmers' perceptions and motives for their specific problems and solutions if one is to expect increased and sustained levels of adoption. This is especially the case when dealing with small farmers having very low resource endowments, a fragile natural resource base from which they operate and limited and unreliable supply of institutional services and infrastructure.

METHODOLOGY

Study Design and Sample:

A survey was conducted in the seven (7) major yam growing parishes in Jamaica (St. Andrew, St. Catherine, Clarendon, Manchester, St. Ann, Trelawny, and Hanover). Data was collected from one hundred (100) farmers randomly selected throughout the parishes. The questionnaire was designed to gather information on farmers' background, their criteria for choosing a new technology and their reaction to novel technological practices.

Method of data analysis: Apart from the descriptive statistics used to summarize the responses of the questions (frequencies and cumulative frequencies), factor analysis was used to identify the factors behind the interrelationship among the various attitudinal and opinionated questions. The purpose of using factor analysis is to represent a variable Zj in terms of several underlying factors.

The specification of the factor analysis model used is as follows:

$$Z_j = a_{j1}F_1 + a_jF_2 + \ldots\ldots\ldots a_{jm}F_m + d_j u_j \; (j = 1,2,\ldots,n)$$

where each n observed variables are described linearly in terms of m common factors and a unique factor. The common factors account for the correlations among the variables, while each unique factor accounts for the remaining variance of that variable. The coefficients of the factors are frequently called "loadings".

The model may be further written explicitly for the value of variable j for individual I as follows:

$$Z_{ji} = \sum_{p=1}^{m} a_{jp}.F_{pi}...+d_j u_{ji} \ (I = 1,2,....,n_{ji} = 1,2,...,n)$$

In this expression F_{pi} is the value of a common factor P for an individual I, and each m terms $a_{jp}.F_{pi}$ represents composite, while $d_j u_{ji}$ is the "residual error" in the theoretical representation of the observed measurement Z_{ji}.

The commonality of a variable Z_j is given by the sum of squares of the common-factor coefficients, i.e.,

$$h^2_j = a^2_{j1} + a^2_{j2} + ... a^2_{jm} \ (j=1,2,....,n)$$

The factor analysis model may be expanded and expressed as follows:

$$Z = a_{11}F_1 + a^2_{j1} + a^2_{j2} + ...a^2_{jm} \ (j = 1,2,....n)$$

$$Z = a_{21}F_1 + a_{22}F_2 + ... + a_{2m}F_m .....d_2u_2$$

$$Z = a_{n1}F_1 + a_{n2}F_2 + ... a_{nm}F_m..... + d_nu_n$$

This set of equations is called the factor pattern.

Explanation of model:

The basic factor analysis model used is described as the Analysis of Variance (ANOVA), which seeks to explain the following:

(i) Overall significance of the regression.

(ii) Significance of the improvement of fit obtained by the introduction of additional explanatory variables in the model.

(iii) Quality of coefficients obtained from the different samples.

(iv) Extra sample performance of the regression, and the stability of the coefficients.

(v) Restriction imposed on the coefficient of the function. In other words, to examine the correlation between and among the explanatory variables ($F1...F_m$) to determine how they influence the model (if all other variables are held constant, i.e., if specific explanatory variables are removed from the model).

ANOVA was used to identify the extent, and the impact of the error term variations (between and among the explanatory variables) on the model, thus the relative impact on the coefficients of the variable used. Hence, the explanation of loadings can be done by testing the quality of coefficients, and the restriction imposed on the coefficients of the function.

For the model $Z_j=a_{ji}F_i+a_jF_2+.....a_{jm}F_m+d_ju_j(j=1,2..n)$ is explaining Z_j=Total of sum of squares of the model $a_jF_1+a_jF_2.....a_{jm}F_m$ = total sum of squares variations among and between the explanatory variables; $d_j\ u_j$ = the residual error (or the unexplained error) which is equivalent to the correction factor a_j = the coefficient of correlation of the explanatory variables of the model.

The individual observation, Z_{ji} is a subset of the composite model Z_j, with its components a_{ji}, F_{pi} - a subset of a_j F_j and a_{jp}, being the coefficient of and among the m explanatory variables $F_1...F_m$. The model built from the individual observations upwards using jm common factors namely:

(i) The correlation among the explanatory variables,

(ii) The summation of the regression lines of system of equations expressed in a matrix form, and

(iii) Along with the residual error $d_j\ u_j$, seeks to explain the impact of each individual variable on the model. It also seeks to determine the level of correlation between the other explanatory variables ($F_1...F_m$) and how it relates to the variation (the spread of the data among the points on the regression line) which is due to the unexplained (residual error). Hence, the model $Z_j=a_{ji}F_1+a_jF_2.....a_{jm}F_m+d_j\ u_j$ (j=1, 2..n) is applied.

RESULTS

Social Aspects of Farmers:

This section focuses on the farmers' socio-economic aspects and related information solicited in the survey. The parameters relate to: sex, age, income, educational level, farm size, land tenure, experience in and exposure to farming, and also the farm family's contribution to farm labour requirements. The rationale is that if generation and transfer of technology is to be effective and sustained, an understanding of the socio-economic setting on which small farmers' operate is essential.

Comparative analysis of results to the social aspects of the respondents in the "Minisett Adoption Technology Survey, 1995" carried out by IICA, and the "Modified Baseline, 1992" carried out by the Ministry of Agriculture, shows similar characteristics. Table I of the Annex shows that the gender of farmers is predominantly male with about 50% of them being over 50 years of age. Sixty-seven percent (67%) of the respondents had less than or equivalent of primary

education, 73% being full time farmers with 56% having more than twenty five (25) years of farming experience. In short, farmers have been engaged in agriculture for very long period and are dedicated to farming activities, but have achieved only limited formal educational levels. This provides an information base for on-farm technology generation and transfer systems.

Tables 2 and 3 display the acreage of land use and tenure of the respondents. Most (56%) farmers used land within the range of 1-5 acres, and 18% with less than 1 acre, with 55% on slightly more than half of them being titled owners. The structural implications regarding size of these farming units bias the technological feasibility of these innovations. Similarly, the land tenure situation conveys a high correlation about the type of crops (annual vis-à-vis perennial) to be introduced on those farming systems as a function of the land tenure status.

While approximately 73% of the farmers derived their income from farming it is important to note that 62% of them were utilizing labour from the farm family. Tables 4 and 5 correspondingly underline the high level of economic dependence on the management, production and productivity of their farms, within their low level of endowment.

General Information:

If the primary objective of a given technological practice or package, (i.e., The Mini-Sett Technology), for small farmers is to increase productivity, in order to be effective and meaningful, it must be envisioned in a way that incorporates and reflects the farmer's needs and their absorptive and adoption capacities more effectively. The absence of a researcher-farmer relationship is a major limitation to the traditional existing research procedures, that must be changed to one in which farmers' participation is basal.

In order to facilitate the analyses of yam-farmers production practices and appraise their systems and perspectives will be necessary to provide additional information to avoid blindly prescribing blanket recommendations, unrelated to causal factors that will limit their application, adoption and ultimate success. For instance (66%) of farmers appeared dissatisfied with the income generated from present yam production, low prices being the frequently uttered opinion. Tables 6 and 7 advances the various problems that are likely to be encountered in the production of yam. As expected, the high cost of labour accounted for 50% of the problems, followed by erosion, 26%. While only 1% had difficulty acquiring stakes, responses to the other problems were almost equally distributed. This serves as a preamble to try new production packages or technological innovations that specifically save on labour costs.

When questioned on the awareness of The Mini-Sett Technology, 93% responded positively. Similarly a high percentage reported that they had either practiced the technique or seen it done (Table 8). Thus the coverage of this technology among the farming community is not only well-known but practiced, at least with some of the technological components as presented in Table 9. Indeed, 24% are currently planting on mounds, with almost equal amounts (23%) using mulch. Close planting is practiced by 18% and while 23% are planting smaller setts, 4% are using smaller stakes. Eight percent (8%) of the respondents are not currently using any of the practices. This confirms previous findings that some components of The Mini-Sett Technology are being adopted by small yam farmers (Chin-Sue *et al.*, 1995).

Given that Extension by far was the most reliable source of agricultural information (Table 10), it supports the high levels of awareness and adoption. Also it is a reflection of the effectiveness of the means used to transfer technological information. Farmers seem to prefer the on-spot extension system to uphold one-to-one discussions and demonstrations. Small farmers consider very highly and reliable the inter-personal relationship with the extension officer, on this case, through the implementation of the National Yam Development Project by The Rural Agricultural Development Authority (RADA) in disseminating this technology.

Attitudinal Variables:

For a technology generation and transfer system to be demand-driven, it is critical to understand and analyze measurements pertaining to the farmer's view on technological changes, specifically to The Mini-Sett Technology. Several attitudinal questions, Table 11 of the Annex displays the results of the responses measured on a "yes, "no", "don't know" questions.

While common belief prevails that farmers are reluctant to change, it does not reflect how "easy and/or comfortable" they feel about accepting changes. Sixty five percent (65%) of the farmers indicated that they did not feel uncomfortable accepting technological changes. Similarly the general perception about small farmers not being risk-prone, does not account for their attitude towards their readiness to make changes even if they involve risks as 81% agreed to this. It seems that for small farmers, risk is a matter of degree (a calculated risk). Approximately 88% strongly agreed that farmers should participate in research experiments. It calls for small farmers' participatory approach to a sense of belonging or involvement in innovations.

Responses to the statements "new technologies are expensive, new technologies are labor intensive" show contrasting agreements. Most (55%) of those interviewed reported that new technologies were expensive while 53% felt that new technologies were not labour intensive. Interestingly, equal responses

(47%) were given for agreeing and disagreeing with the availability of inputs for new technologies.

As displayed, approximately 53% of the farmers admit experiencing erosion problems, compared with the 54% that indicated a preference for using mounds instead of hills. An overwhelming 91% agreed that it was good to treat planting material. This was confirmed as the question "I grow yams without chemicals" reported a 65 % disagreement with the statement.

An overwhelming 90% of those interviewed indicated that they have interest in growing yams using production systems other than the traditional, which validates the small farmers' attitudes towards change and risk. Approximately, 86% of the farmers denoted that they had some preference for using mulch. Forty-two percent (42%) indicated preference for plastic mulch while (44%) would prefer to use grass. Getting adequate water for growing yams did not seem much of a problem as the majority (55%) of the farmers indicated good water supply. Unexpectedly, responses show that more than half, approximately 58%, did not like to produce big yams. Most of the farmers, 71% reported that market outlet, for yams were available, but approximately 60% felt that the present price was unreasonable.

Factor Analysis of Attitudinal Variables:

Factor analysis was used to estimate the attitudes of one hundred (100) yam farmers in the seven (7) major yam growing parishes of Jamaica. Thus, one has to identify the factors'–underlying dimensions, behind the inter-relationships among the various attitudinal questions (Q12-Q27 as in Table 11).

A correlation matrix was used to show inter-correlation among the attitudinal variables. There is substantial correlation between questions #'s 16 & 22 (r=.83) and between questions #'s 17 & 22 (r=.69). Yet, there are also very low and negative correlations between some of these variables. Questions #'s 13 & 20 have a very low positive correlation (r=.19) whereas, questions #'s 12 and 13 have a very low negative correlation (r=-0.082). Several factors can be extracted from the matrix by inspection, but as the matrix' size increases it becomes difficult to ascertain factor patterns using this technique. Instead a mathematical technique was used for making factor analysis easier than visual inspection.

The factor analysis procedure encompasses two steps. The first is to extract the "unrotated' factors, otherwise called factor "loadings". A factor loading is essentially the same as a correlation. It expresses the relationship between a variable and a factor (allowing to interpret the meaning of the factor with respect to the particular variable's meaning). Table 12 presents the factor loadings for the unrotated matrix. Only those loadings with absolute values of

0.4 and above are included in the matrix, since factors with those values sensibly delimit their attributes.

The second step in the analysis is the rotation of the factor loadings to obtain a better interpretation of the correlation, Table 13. The loadings from the unrotated matrix are different from those of the rotated matrix. For instance in the unrotated matrix, the variables load heavily on factors 1 & 3. This presents a clustered picture that makes interpretation difficult. In the rotated matrix, however, the variables are more dispersed, allowing better interpretation. The equamax method of rotation was used. The number of factors chosen to be rotated was determined by the Eigenvalue. The Eigenvalue measures the portion of total variation accredited to the common factor, which is the sum of the squares of the factor loadings. Eigenvalues less than 1.0 are usually not interpreted since they account for no more than the variance of a single variable. As a result, only seven (7) factors were chosen in the rotation matrix.

Table 14 in the Annex presents the final commonality estimates of the variables and eigenvalues. A commonality symbolizes the sum of squares of the loadings for each variable. The range in value is from 0 to 1.0. The higher the value, the higher the contribution to the total variation. For instance, question # 14 has a communality of 0.64, implying a high correlation between other variables comprising the factor, thus this variable contributes 64% of the total variation.

Discussion of key factors:

Factor 1 Three variables were significant in forming the factor –Q's # 12, 17 & 26. The farmers expressed that they were comfortable accepting changes. They implied that there was not much difficulty getting inputs for new technologies nor finding market for yams.

Factor 2 The two variables significance in this factor suggest that farmers felt new technologies were expensive with plastic mulch (which is more expensive) being preferred to grass mulch which is also labour intensive –Q's # 16 & 19.

Factor 3 Only one variable was found significant in this factor –Q # 13. It suggests that farmers are willing to undertake new technologies even if involves certain degrees of risks.

Factor 4 The single variable found significant in this factor implies that most farmers were experiencing erosion – Q # 18.

Factor 5 The variables making important contribution to this factor denote that most farmers believe that they should be involved in research

experiments, with interest of growing yams of medium to small sizes in other ways than traditional –Q's # 14, 25 & 21.

Factor 6 The two variables forming this factor centered around the use of chemical in yam production. Farmers imply that it was good to treat planting materials i.e., growing yams with the use of chemicals –Q's # 20 & 24.

Factor 7 The two variables forming this factor suggest that farmers had interest growing yams on mounds than hills and other than the traditional way– Q's # 22 & 21.

DISCUSSION

There are curbed arguments to the proposition that the technology generation and extension process for small farmers ought to be an integrated and phased approach. Phased concerning the need to focus on technology generation, before heavily investing in extension services as a vehicle for delivering information. Indeed, extension services are unlikely to be cost-effective without a strong inflow of technology that is valuable to farmers. And it should be integrated in that the research and extension processes must be demand-driven by an active and participatory role of the farmers themselves. This is an approach to make a research/extension agenda more effective and accountable to clients' needs.

Through a phased system –established on linkages of research, extension, and farmers, the delayed and uncoordinated technology generation and extension process can be accelerated. From the survey results it is evident that there is a potential for tremendous increases in yam production by means of The Mini-Sett Technology. But for this to be achieved there is a need to identify and disburden farmers' priority problems. Indeed, this facilitates building and expanding on achievements derived from pilot efforts, –the National Yam Export Development Project, to decide the best models for strengthening the research and extension work at the farm levels on a phased approach.

A look at the social variables shows that the majority (73%) of the respondent farmers, were full-time farmers, 67% with primary or no education and more than half (56%) having more than twenty-five (25) years experience in farming, whose main source of income is from farming. This identifies a social group of farmers highly dependent on their farming systems for their livelihood, but whose capacity to comprehend adequately the application stages and benefits to stem from new ideas of farming is hampered. Parallel to their land structure and tenure characteristics –74 % with less than five (5) acres, it

limits the technology generation and challenges its relevance to their limited resource base. If one is to concur farmers' years of experience --over twenty-five (25) years, they require sufficient time and constant feedback to be convinced that the practices they have used can be improved to their benefit. This suggests that the technology generation and extension system has to be constant and monitored over long periods before successful long-term use and benefits to be derived from a new technology can be realized.

This calls for technology generation and transfer to be tuned to farmers' socio-economic characteristics to enhance its effectiveness and adoption. Farmers' participation in technology generation itself is important, but also the transfer of information, where a personal relationship seems vital. Farmers rendered their appreciation for this type of relationship as 87.5% endorsed that farmers should participate in research experimentation, and 67% choose the extension officer as the most reliable means of obtaining agricultural information.

The two most severe problems reportedly encountered in the present yam production system are the high cost of labour, and the low income generated due to low market prices. If given enough technical supervision, farmers can realize that both constraints (high labour costs and low yields, since higher yields generate higher incomes) can be addressed by The Mini-Sett Technology. This realization is promising when results show that 93% of the farmers interviewed were aware of The Mini-Sett Technology with the majority, 88%, practicing some techniques involved. This implies that farmers are willing and somewhat capable of applying practices of this technology beyond the initial stages of introduction, but many are unable to identify which practices are most suitable for addressing their specific constraints, maximizing profits and minimizing the cost of producing yams.

From the attitudinal questions, the attitudes extracted from factor analysis query general perceptions, beliefs and arguments surrounding small farmers behavior towards technological innovations. The findings highlight the fact that farmers were willing to modify old practices or adjust to new methods even if they involve risks. This presents a positive environment for the adoption of The Mini-Set Technology in yam production. It denotes their willingness to use chemical treatments and a preference for plastic mulch, although farmers expressed the view that the high cost of plastic helps to contribute to their assessment that new technologies are more expensive.

This analysis feature some reactions that yam farmers display towards the viability of The Mini-Sett Technology. It accents some attitudes that seem favorable or critical constraints towards the sustainable adoption of any of the components of this technological package, recently introduced to the farming community in Jamaica. From the factor analysis it seems that the prospects for the sustainability of at least some of the components are promising. Granted it comprises a long term support for yam development programmes. This will

allow small farmers, exporters and other economic sectors to realize the economic prospects of increasing yam production and productivity on a sustainable basis through the application of The Mini-Sett Technology.

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Table 1. Social Aspects.

Social Aspects	Current Survey	Adopt. of Mini-Sett Tech. in Jamaica[1]	Ministry of Agriculture[2]
		Percent of Farmers	
Female	15	7	10
With primary or no education	67	65	67
With tertiary education	5	10	8
Over 50 years old	52	51	52
Over 25 years farming experience	56	60	46
Full time farmers	73	43	74

[1] Adoption of Minisett Technology in Jamaica, Chin-Sue, *et al.*, IICA, 1995
[2] Modified Baseline Survey NYEDP Data Bank, Ministry of Agriculture, 1992

Table 2. Acreage of Land Utilisation

Acreage	Percentage of farmers
0-1	18
1-5	56
5-10	11
10-20	9
>20	6
TOTAL	100

Table 3. Land Tenure

Tenure	Percentage of farmers
Owned	55
Rental	17
Leased	18
Other	10
TOTAL	100

Table 4. Farming as a Major Source of Income

Farming	% of farmers
Yes	73
No	27
TOTAL	100

Table 5. Land Tenure

Labour	% of farmers
Yes	62
No	38
TOTAL	100

Table 6. Income from Yam in Production.

Satisfaction	% of farmers
Yes	34
No	66
TOTAL	100

Table 7. Problems encountered in Yam Production.

Problems	% of farmers
High cost of labour	50
Lack of water	9
Shortage of sticks	1
Low yield	8
Erosion	26
Other	6
TOTAL	100

Table 8. Awareness of the Mini-Sett the Mini-Sett Technology.

Awareness	% of farmers
Yes	93
No	7
TOTAL	100

Table 9. Current Practices of the Mini-Sett Technology.

Practices	% of farmers
Mounds	24
Mulch	23
Closer planting	18
Smaller setts	23
Shorter stakes	4
No practice	8
TOTAL	100

Table 10. Most Reliable Means of Agricultural Information

Means of Information	% of farmers
Extension	67.0
Radio	9.3
Television	3.0
Newspaper	5.2
Other	15.5
TOTAL	100

Table 11. Percentage Rankings for Attitudinal Questions

	Attitudinal Questions	Yes	No	Don't Know
Q12	I feel uncomfortable accepting changes	33	65	2
Q13	I am prepared to make changes which may involve risk	80.8	18.2	1
Q14	Farmers should participate in research experiments	87.5	12.5	-
Q15	New technologies are expensive	55.1	40.8	4.1
Q16	New technologies are labour intensive	43.7	53.1	3.1
Q17	Inputs are always readily available for new technologies	43.7	43.7	12.5
Q 18	I experience erosion problems from time to time	52.6	43.3	4.1
Q 19	Plastic mulch is preferred to grass mulch	41.8	43.9	14.3
Q 20	It is good to treat planting material	90.7	9.3	-
Q 21	I am interested in growing yams in other ways than traditional	89.8	8.2	2
Q 22	I prefer hills to continuous mounds	38.8	54.1	7.1
Q 23	There is problem of getting enough water for growing yams	43.9	55.1	1
Q 24	I grow yams without the use of chemicals	29.9	64.9	5.2
Q 25	I like to grow big yams	42.3	57.57	-
Q 26	There is a problem finding market for yams	25.5	71.4	3.1
Q 27	The present price for yam is reasonable	39.6	59.5	1

Table 12. Unrotated Factor Pattern: Principal Component

Variable notation		Factor						
Q		1	2	3	4	5	6	10
12	Feel uncomfortable accepting changes			.4943				
13	Prepared to make changes involving risk			.4105				
14	Farmers should participate in research experiments	.4354						
15	New technologies are expensive							.4901
16	New technologies are labour intensive	.4099						
17	Inputs are readily available			.4879				
18	I experience erosion problem						.4611	
19	Plastic is preferred to grass mulch	.4588						
20	It is good to treat planting materials	.4298						
21	I have interest in growing yams other than traditional	.4343						
22	Prefer hills to continuos mounds			.4431				

23	Inadequate water supply for yams							
24	Grow yams without chemicals					.4877		
25	Like to grow big yams				.4740			
26	Problem finding yam market	.4747		.4993				
27	The present yam price is reasonable	.4562						

Note: Factors 7,8, and 9 were not present in the above table since there were no values represented.

Table 13. Rotated Factor Pattern: Equamax Rotation.

Variable notation		Factor						
Q		1	2	3	4	5	6	7
12	Feel uncomfortable accepting changes	.6373						
13	Prepared to make changes involving risk			.7215				
14	Farmers should participate in research experiments	.4354						
16	New technologies are labour intensive		.6794					
17	Inputs are readily available	.6466						
18	I experience erosion problem				.7677			
	Plastic is		.7133					

19	preferred to grass mulch							
20	It is good to treat planting materials						.6725	
21	I have interest in growing yams other than traditional					.5115		.6399
22	Prefer hills to continuos mounds							.7316
24	Grow yams without chemicals						.4522	
25	Like to grow big yams					.6906		
26	Problem finding yam market	.5979						

Table 14: Final Estimate of Communalities For The First Seven Variables and Eigenvalues: Unrotated Matrix.

Variable	Factor	Estimated Communality	Eigenvalue	Percent of Variation	Cumulated Percentage
Q 12	1	.4791	3.2292	0.20	0.20
Q 13	2	.4908	2.0091	0.14	0.34
Q 14	3	.6356	1.8819	0.13	0.47
Q 15	4	.4216	1.4807	0.12	0.59
Q 16	5	.4727	1.2683	010	0.69
Q 17	6	.3800	1.2070	0.09	0.78
Q 18	7	.5120	1.1051	0.07	0.85

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USING THE FREEZE-DRY TECHNIQUE TO ENHANCE PRESERVATION OF INSECT LARVAE

M. E. Headings, The Ohio State University, Agricultural Technical Institute, 1328 Dover Road, Wooster, Ohio 44691.

ABSTRACT. Some important reasons for collecting and preserving insect larvae are: (1) for teaching and research purposes, (2) for use as reference collections (of economically important species) in insect control work, (3) for museum collections, which document insect fauna of specific regions, and (4) for aesthetic purposes, including their sale by business enterprises. Insect larvae are generally preserved in vials using one of several different liquid chemical preparations. Consequently, they often lose much of their natural appearance after being in a liquid preservative for some time. The freeze-dry technique dries and preserves insect larvae through the sublimation of body water at -20° to -30°C while in a vacuum. The freeze-dryer unit used was a new benchtop 115v Yamato DC41 model. The 115v vacuum pump (model B-2) was built by Marva Scientific Manufacturing Company. This investigation illustrates specific examples of insect larvae that have been successfully preserved using the freeze-dry technique and the specific procedures used. The advantage of this technique is that there is very little body color loss or structural distortion as a result of preservation. It also provides for ease of handling and inspection of specimens.

INTRODUCTION

Insects comprise more species than that of all other plants and animals combined. Approximately three to four percent of insect species are considered pests of economic importance, while approximately seven percent are considered beneficial. Consequently, approximately 90 percent are neither pests nor beneficial and provide an interesting array of diversity in our environment. The collecting of insect specimens is important for a number of reasons. These include their use: (1) for teaching and research purposes, (2) for insect control work (as reference collections of economically important species), (3) for museum collections which document insect fauna of specific regions and habitats, and (4) for aesthetic purposes, including their sale by business enterprises.

Several different methods are employed to preserve insect larvae and other soft-bodied, fragile or minute insect specimens. Perhaps the most common is placing specimens in 70 percent alcohol or in some other

fixative such as Kahle's solution. These chemical methods are quick and easy; however, specimen colors will often change and specimens may become shriveled or distorted with time. Hot water treatment prior to placing specimens in preservatives improves retention of original colors to some extent. Other more laborious techniques of preservation include blowing or inflating larvae, and plastic embedding. Still another technique reported (but not commonly used on insect specimens) is freeze-drying (Woodring & Blum, 1963). This is a more time-consuming process than chemical methods and requires an initial investment in equipment. The end results, however, are superior in terms of color retention and reduced distortion of specimens (Roe & Clifford, 1976).

METHODS AND MATERIALS

The freeze-dry technique dries and preserves insect larvae through the sublimation of body water at -20° to -30°C while in a vacuum. "Sublimation" refers to drying specimens or products while in the frozen state (Flosdorf, 1949). Typically the freeze-dried specimen or product appears similar in color, shape, and volume to that of when it was in the frozen state.

The freeze-dryer unit used was a new benchtop 115v Yamato DC41 model. The 115v vacuum pump (model B-2) was built by Marva Scientific Manufacturing Company. Insect specimens were frozen in small beakers, which were then attached to the freeze-dry unit. The unit was operated for nine hours or more. After specimens were dried, the freeze-drier unit was then recharged periodically by drying the sieve pellets (which had absorbed moisture from the specimens) in a vacuum oven.

A new SZ 4045 Olympus trinocular zoom stereo microscope with photo tube and ringlight was used to photograph small insect larvae and other specimens.

RESULTS AND DISCUSSION

This investigation illustrates specific examples of insect larvae that have been successfully preserved using the freeze-dry technique. Specimens properly frozen retained their original characteristics; whereas, those not properly frozen turned black in color. The freeze-dry technique of preserving insects is an excellent option to permanently preserve large numbers of insect larvae simultaneously while maximizing retention of original phenotypic characteristics of the specimens. Preserving insects with this technique facilitates mounting them on insect pins rather than in

vials and thereby enhances their presentation for viewing and study. Body color loss and distortion are minimized. This investigation will continue on many other species of insect larvae. Woodring and Blum (1963) reported successfully freeze-drying larvae of twelve families of Lepidoptera, three families of Coleoptera, two families of Hymenoptera, and one family of Diptera.

CONCLUSIONS

The freeze-dry technique is an excellent option to preserve insect larvae if proper procedures are followed. There is an initial investment in equipment; however, the advantages of this technique are rewarding. Body color is preserved and structural distortion minimized. Handling, storage, and inspection of specimens are facilitated.

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DIFFICULTES RENCONTREES DANS LA LUTTE INTEGREE EN MARAICHAGE

P. Rychewaert, CIRAD-FLHOR Martinique.

RESUMEN. La lutte intégrée connait un développement réel ces dernières années, mais des problèmes persistent ou apparaissent sur certaines cultures maraichères, mettant parfois en cause son efficacité. Tout d'abord, il existe une complexié de l'entomofaune en maraichage: interactions entre les nombreuses espèces d'insectes et acariens, difficultés d'observation et de détermination. Nous notons régulièrement l'apparition de nouveaux ravageurs ou virus necessitant une remise à jou des programmes prés-établis. La lutte chimique raisonnée est limitée par l'absence de produits à la fois efficaces sus certains ravageurs et inoffensifs pour les auxiliaires, tandis que d'autres ne sont pas homologués sur cultures maraichères ou sont retirés du marché. Enfin nous notons l'apparition de population résistantes à certains insecticides. D'autre part, la définition et l'application des seuils d'intervention pour les traitement sont difficiles à mettre en place, et sont fonction des seuils de degats économiques. La lutte biologique naturelle montre aussi des insufisances: populations d'auxiliaires trop faibles, absence d'ennemis naturels pour quelques ravegeurs, hiperparasitisme et pas de possibilités de lacher inondatifs. Enfin, des difficultés sont recontrées au niveau du développement: formation des agriculteurs, motivations suivi des cultures par les techniciens, transfert de technologie entre recherche et producteurs.

INTRODUCTION

Le concept de lutte intégrée s'est développé à la Martinique suite aux recherches menées sur le *Thrips palmi* sur lequel la lutte chimique avait montré ses limites et ses inconvénients.

Ainsi l'action des insectes utiles (les prédacteurs) pouvait limiter les populations de thrips et d'autres ravageurs à condition que les traitements phytosanitaires ne les éliminent pas. Cette lutte biologique naturelle, combinée à une lutte chimique raisonnée (choix des produits, choix du moment d'application) et au respect d'un certain nombre de mesures préventives, s'inscrit dans le principe de la lutte intégrée.

Depuis plusieurs années, les principes et les techniques de la lutte intégrée sont progressivement diffusés chez les agriculteurs grâce aux suivis et formations effectués par divers organismes, en relation avec le CIRAD.

Beaucoup de producteurs ont bien accueilli ces principes respectant mieux l'environnement et la santé humaine d'autant plus qu'ils notaient une diminution des coûts des traitements phytosanitaire. Toutefois, les résultats sont parfois insuffisants et dégâts sont observés sur certaines cultures montrant ainsi la complexité des problèmes à résoudre.

L'expérience acquice sur le terrain nous a permis d'énumérer un certain nombre de difficultés dans l'application de la lutte intégrée.

COMPLEXITE DU MILIEU

Malgré sa petite taille, la Martinique possède des zones agricoles situées dans des conditions d'environnement très diverses liées aux nombreux microclimats, au relief et aux différentes natures de sols. De ce fait on pourra observer des problèmes phytosanitaires dans un secteur alors qu'ils peuvent être absents à quelques kilomètres sur la même culture.

L'environnement agricole d'une parcelle peut être un facteur défavorisant si des cultures infestées existent dans le voisinage, auquel cas un vide sanitairre sur l'exploitation aurait peu d'effet et la lutte intégrée compromise.

Le monde des insectes et des acariens est lui- même très complexe: un grand nombre d'espèces gravitent autour des cultures maraîchères; certaines ne sont présentes que sur une culture ou dans une région seulment. On a déjà dénombré plus d'une certaine d'espèces dont une partie sont utiles (les prédateurs et les parasitoïdes). Un certain nombre d'entre elles ne sont pas encore déterminées et on ne connaît pas le rôle de quelques-unes.

Quant aux interactions entre ces insectes, peu de choses sont connues. Dans ces conditions, l'évolution des populations d'insectes est souvent imprévisible et le maintien d'un équilibre satisfaisant sur la culture n'est pas évident. Enfin la petite taille et les ressemblances de beaucoup de ces insectes ne facilitent pas leur reconnaissance par les agricultures et les techniciens.

Il ne fait pas oublier qu'il apparaît régulièrement des nouveaux ravageurs: soit parce qu'ils sont introduits accidentellement sur l'île (par exemple le *Thrips palmi*), soit qu'ils existaient en très petit nombre et qu'ils se développent brutalement pour des raisons inconnues (cas de la cécidomyie de la tomate). De même la présence ou l'apparition nouvelle de certaines maladies (virus, bactéries, champignons) peuvent remettre en cause les programmes de lutte intégrée déjà établis.

LIMITES DE LA LUTTE CHIMIQUE RAISONNEE

En lutte intégrée, il fait autant que possible utiliser des produits spécifiques de certains ravageurs, qui n'atteignent pas les insectes bénéfiques appelés auxiliaires. Malheureusement, ces produits sont peu nombreux et leur

efficacité est parfois insuffisante. Pour certains groupes d'insectes (les punaises par exemple), il n'existe pas de produits de ce type.

Autre difficulté: plusieur de ces pesticides sont homologués en Martinique sur aucune ou seulement quelques cultures maraîchères, et ce avant tout pour des raisons d'étroitesse du marché. Quant à d'autres produits, ils peuvent être retirés du marché.

Il existe des cas d'apparition de résistance chez un ravageur suite à des traitement abusifs avec un même insecticide: celui-ci devient alors sans intérêt.

Le déclenchement des applications de pesticides suivant un seuil d'observation est très difficile à définir tout comme à le mettre en pratique par l'agriculteur. Dans beaucoup de cas, c'est en fait à ce dernier de ressentir le moment où il faut traiter, et cet aspect subjectif ne peut s'acquérir que par l'expérience. Ces seuils sont eux-même fonction de la culture, des périodes de l'année ou des zones géographiques, ainsi que des exigences du marché (pour la consommation locale ou l'exportation).

Notons enfin un faux problème: celui du coût de ces produits "modernes", compatibles avec la lutte intégrée. Si leur prix au litre ou au kilo est effectivement élevé, ils s'utilisent à des doses faibles et le prix de revient par unité de surface n'est pas plus important que celui d'un produit classique. En fait c'est souvent le conditionnement de ces nouveaux produits et leurs dosages prévus pour des grandes parcelles qui gênent les agriculteurs.

Enfin, un certain nombre de règles doivent être respectées concernant l'application des produits: calcul de la dose, calcul du mouillage, alternance des produits et respect du délai avant récolte.

INSUFFISANCE DE LA LUTTE BIOLOGIQUE

La lutte biologique utilisée localement est naturelle, avec des organismes indigènes (prédacteurs, parasitoïdes, entomophothogènes). Aucun lâcher en quantités (lâchers inondatifs) n'est effectué dans les cultures car d'une part, il n'existe pas localement de production en masse de ces organismes et ceux qui sont produits dans les pays de Nord ne sont pas adaptés aux ravageurs locaux, et d'autre part, les cultures étant ouvertes, y compris les serres, les individus lâchés partirait en majorité dans les alentours.

Dans un certain nombre de situations, les populations d'auxiliaires sont trop faibles sur certains ravageurs et ce phénomène peut être dû à la saison ou à l'environnement. On sait aussi que certains de ces auxiliaires ne viennent pas sur certaines cultures. Enfin des ravageurs ne possèdent peu ou pas d'ennemis dans notre contrée. Dans ce cas, il serait intéressant d'introduire de nouvelles espèces utiles (lâchers introductifs).

Autre problème: l'existance de parasites d'auxiliaires appelés hyperparasites, qui diminuent l'efficacité de la lutte biologique.

DEVELOPPEMENT DE LA LUTTE INTEGRE

La mise en place de al lutte intégrée chez les agriculteurs comporte un certain nombre de contraintes:

- convaincre le producteur à une nouvelle méthodologie plus astreignante voire contradictoire (on ne doit pas forcément traiter);
- nécessité pour l'agriculteur d'avoir un certain niveau d'études;
- obligation d'être suivi pendant au moins un an par un technicien formé à cette pratique.

Ainsi l'importance de la formation à la lutte intégré est fondamentale pour son développement.

CONCLUSIONS

La lutte intégré est sans une méthode d'avenir. Il faudra cependant ajuster continuellement les techniques en fonction de l'évolution des problèmes. La recherche et le développement doivent être en mesure de répondre aux attentes des agriculteurs dans une perspective de durabilité de la production agricole.

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ACKEE POISONING AND THE EVOLUTIONARY BIOLOGY OF JAMAICA'S ACKEE MOTIF

John Rashford, Department of Anthropology, College of Charleston, 66 George Street, Charleston, South Carolina.

ABSTRACT. There is a Jamaican riddle that asks: "Me fader send me to pick out a wife; tell me to tek only those that smile, fe those that do not smile wi' kill me" (Beckwith 1969). The answer to this riddle is the ackee (*Blighia sapida* Konig) -- the fruit of one of Jamaica's best loved food trees which is generally considered poisonous if improperly harvested, processed or prepared. According to Jamaican tradition, the fruit must open on the tree naturally -- it must "smile" or "laugh" -- before harvesting. This clear association between open ackees, smiling and well being is the most important recurring ackee theme in Jamaican culture, and its expression in oral traditions (such as riddles and folk beliefs) reveal in an essential way what Jamaicans need to know in order to eat ackees safely. The purpose of this paper is to explain within the framework of evolutionary biology why Jamaica's ackee motif has developed, and to show from this perspective that the most important of the early accounts of ackee poisoning must be reconsidered.

SCOTT AND "VOMITING SICKNESS"

The ackee is a beautiful tropical West African evergreen tree in the Sapindaceae family that was introduced to Jamaica in the eighteenth century and is now found island-wide from sea level to about 900 m (Adams 1972). Its fruit is one of the two main ingredients in "ackee and saltfish," popularly regarded as the national dish, and it is probably this fact that accounts for its selection as Jamaica's official national fruit. As a national icon, the image of the fruit, tree or dish appears on a wide variety of objects such as postcards, key rings and place mats which are often seen in homes, hotel giftshops, craft markets and stores.

The island chemist, J. Bowrey, published the earliest account of ackee poisoning in the Jamaica Gazette in 1887 and 1892, and in 1904, Turnton offered the first medical report in the Journal of Tropical Medicine. In 1913 Seidelin published the results of his investigation and Grabham did the same in 1917. It was Harold Scott, however, then government bacteriologist and pathologist, who argued most persuasively

that ackee poisoning was the cause of what had come to be known as "vomiting sickness". In his address to the Society of Tropical Medicine in December, 1916, Scott said "the Vomiting Sickness of Jamaica must be looked upon as a new disease" (1917), one he described as being prevalent in rural areas in the winter, particularly among malnourished African Jamaican children and their families. The illness began suddenly with vomiting, followed by weakness, prostration and a period of apparent improvement; then came another bout of vomiting followed by convulsions, coma and death. In the discussion that followed Scott's presentation, a Dr. G. C. Low said there were several points which he thought Dr. Scott should "follow out" further including the following:

> It certainly seems very strange why the fruit from a bruised branch, or fruit which has been opened prematurely or unnaturally, should be poisonous, while the ripe fruit which has burst open of itself is not poisonous. It seems difficult to say exactly why this should be so, though, of course, it might be that the poison is a volatile substance – a substance which has escaped in the open ripe fruit, but not in the case of the immature fruit (cited in Scott 1917).

Scott (1917) made the following comment in response to the points raised by Dr. Low:

> I cannot answer Dr. Low's question as to why the unopened fruit is toxic: that is the direction the further investigation will take. The natives know the fact themselves [my emphasis]. I shewed them several fruits, and asked, "Would you eat this?" [answer] "No." "Why?" [answer] "I don't know." I think it may sometimes be due to it not being quite ripe. It is usually those with a small seed, the fruit itself not having properly developed.

The question raised by Dr. Low and the "native" knowledge that Scott mentions can be explained within the framework of evolutionary biology.

PLANT DISPERSAL AND ANIMALS

In an effort to increase the likelihood of reproductive success, and as a consequence, ensure the continuation of the species, plants have evolved a wide variety of extraordinary techniques to facilitate the dispersal of their offspring in the form of seeds or vegetative structures. These techniques includes mechanical means of self-dispersal like spring mechanisms or explosive fruits, as well as adaptations for dispersal by gravity, wind, water, and animals (Ridley, 1930; Pijl, 1969).

Many seeds that are incidentally dispersed by animals are associated with "food offerings" from plants in the form of fleshy fruits, or fruits with fleshy appendages i.e., arils.[1] The seeds from such fruits are either rejected when the fruit is being eaten (especially when they are large), or they are regurgitated intact as occurs with some birds, or they are consumed with the fruit and spread by defecation. Usually camouflaged in green, these fleshy fruits, are often distasteful, even harmful, when their seeds are developing, but they become attractive to animals (i.e., conspicuously colored, scented, soft, juicy, sweet, and without harmful or distasteful properties) when their seeds mature and are ready for dispersal. With arilate fruits (such as many legumes), the attractive fleshy food offering is exposed when the seeds are mature.

The ackee is an arilate fruit that fits this profile. The tree produces small, fragrant, white flowers on pendulous racemes two or more times a year on which develop clusters of large, leathery, pear-shaped capsules about 8 cm long. They are green at first, but then they become a bright red or yellow, or red with flushes of yellow, or yellow with flushes of red. What sets the ackee apart from many other fruiting plants is that its fruit becomes brightly colored long before it ripens, and is traditionally considered deadly poisonous if eaten at this immature stage. But why should the fruit manifest display colors before the seeds are ready for dispersal?

A possible explanation is that this occurs to encourage dispersers to begin visiting the tree and to keep visiting the tree since the fruits open over several weeks rather than all at once. If all the fruits ripened at once the chances for dispersal would be minimal. The short-lived seeds would fall to the ground, germinate, and attempt to grow under adverse conditions -- competition with parent and siblings for space, light, water, and nutriments and exposure to the concentration of predators and diseases associated with the parent. The pre-ripened display colors and staggered ripening (i.e., the ripening of the fruits over several weeks) means that each fruit stands a better chance of being dispersed away from the parent.

Jamaica's ackee motif reveals the significance of the relationship between humans and ackees from the cultural side of the interaction. The purpose of the ackee motif – i.e., the association of open fruits with smiling and safety (as evidenced in the riddle with which this paper began) - - is to make it clear that even though the fruit is bright red or yellow (generally a sign of ripeness for many animal-dispersed fruits and their mimetic counterparts), it is not truly ripe until it opens to reveal its large, round, glossy black seeds attached to a fleshy, oblong, yellow or cream-colored aril that is oily to the touch and like marrow when cooked. The fruit must "smile" or "laugh" on the tree before harvesting.

Jamaica's ackee motif is also evident in a widely known traditional belief that points to the cultural impact of the staggered ripening of the ackee's fruits. The most commonly expressed form of this belief was related by a Jamaican informant who learned as a child that "If you laugh or smile under an ackee tree just when the crop begins to open, they will open faster." Because the ackee's fruits are borne in clusters and the fruits in a cluster do not open simultaneously, the ripe fruits must be harvested individually before they spoil or are eaten.[2] This means people must "search" to find ackees with fresh "smiles". The impatience for these highly prized fruits, coupled with this search requirement (resulting from staggered ripening), is probably the basis for the belief that ackees can be encouraged to open by smiling or laughing with them, or by "clapping" or "counting" as stated in some accounts.[3]

THE NATURE OF ACKEE POISONING

Because ackee consumption is associated with poisoning, an extensive scientific literature has developed over the past one hundred years that has focused largely on the toxicity of the fruit.[4] Jamaica's ackee motif, when accounted for within an evolutionary biology framework, is consistent with the results of these studies showing that ackee is indeed poisonous if eaten before it is fully ripe (Bressler 1976, Chase 1990, Brown 1992). This being so, Scott's influential account of ackee poisoning in Jamaica must be rejected because of its serious inconsistencies.

Scott (1917) summarized his view of "vomiting sickness" with the following profile:

1. The peculiar seasonal prevalence.
2. Limitation to Jamaica.
3. Sudden onset of symptoms.
4. The rapid and complete recovery of non-fatal cases.
5. Affection of several persons practically simultaneously in one house or close neighbors in a settlement.
6. The vastly greater preponderance in children.
7. Attacking the West Indian native in much greater numbers than the East Indian or the white man.

For Scott (1917), there was no doubt that these seven characteristics of "vomiting sickness" all found "explanation in the view that the condition is an acute intoxication by the unwholesome ackees [my emphasis]."

If, as Scott himself reports, Jamaicans know that unopened or forced-open ackees are poisonous, and that "unwholesome ackees" are

unsafe (whether because they are over-ripe, rotting, discolored, or come from broken branches, or because they have soft spots, aborted seeds or other disfigurements), then why would they eat them? And why would they eat them mostly in the countryside rather than in urban areas, and in the winter rather than at other times of the year when the ackee is also in season? These and other inconsistencies, and the questions they raise, have been recognized in the scientific literature (e.g., Williams 1954), but they are yet to be adequately explained by those who continue to accept, often uncritically, the formulation presented by Scott.

CONCLUSION

The ackee is a major food tree only in Jamaica (Adams 1971; 1972), despite claims that in the "Caribbean" it is "commonly used as a prized food" (Kingsbury 1988) or "is a popular dish" (Encyclopedia Britannica 1993); or claims that in the "West Indies" it is "a great delicacy" (Irvine 1930), "in great demand" (Sturrock 1940), or is "much esteemed" (Hedrick 1972). In fact, the ackee could well be regarded in the neotropics as a marker species for Jamaicans, and for those with Jamaican connections, since its spread in the region has been greatly influenced by economic migration and by travel in association with education and tourism (Standley 1968). It is possible that the absence of an ackee motif similar to the one in Jamaica is the reason why the ackee is not widely eaten in other Caribbean territories where the fruit is simply regarded as poisonous without further qualification.

ACKNOWLEDGMENTS

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1. Other important categories of animal-dispersed fruits are seed-predator dispersal associated with temperate nut trees, and fruits bearing prickles, spines, hooks, barbs, hairs, or sticky coverings that adhere to the fur or skin of passing animals (including human clothing and equipment) and are thereby incidentally dispersed.

2. Some Jamaicans do make an effort to protect their ackee crop, especially from birds. My father said when he was a boy some people built bird snares in ackee trees. Williams (1954) reports that some of her informants had

"observed crows and bats attacking the fruit." Jeffrey-Smith (1972) says parrots "enjoy ackees" and that when "ackees are in season [red-bellied] woodpeckers (*Centurus radiolatus*) may be seen devouring the ripe fruit, of which they are very fond and eat appreciable quantities." And in "Countryman's Diary," a well know column in the Daily Gleaner (September 18, 1976), the author describes his wife's effort to protect their ackee crop from birds in an article titled "My Wife and the Birds."

3. There are also different interpretations of this belief as is evident in a conversation between a retired physician and a young woman. The physician interpreted it to mean that during harvesting, "if you keep looking you will see more. The laughing," he said, "was not important." The woman interpreted it to mean -- as did many informants -- that "the more you go and laugh, the more the ackees open. Go everyday, everyday you see more and more." With this traditional view, "smiling" or "laughing" with ackees is an example of what Frazer (1911-1915) identified as "sympathetic magic," which is the principle that like produces like -- a smiling face produces a smiling i.e., open ackee.

4. For a review of this literature see Hill (1952), Chambers (1953), Arnold (1954), Williams (1954), Hassall and Reyle (1955) and Plimmer (1963). Examples of more recent works are Kean (1975), Thomas and Krieger (1976),Tanaka (1979), Chase *et al.*, (1990), and Brown *et al.*, (1992).

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AGROECOSYSTEMS SUSTAINABILITY IN THE CARIBBEAN AND PACIFIC ISLANDS FINDINGS AND IMPLICATIONS OF A CBAG/PBAG WORKSHOP

Friedrich H. Beinroth, *Department of Agronomy and Soils, University of Puerto Rico, Mayagüez, Puerto Rico 00680-5000.*

ABSTRACT. The workshop addressed the sustainability of island agroecosystems in general and explored how information science and technology can enhance the biophysical, economic, and societal integrity of small island states. There was unanimous agreement that the ecosystems of many islands are in jeopardy and that this dilemma can be traced to three underlying causes: misguided value systems, flawed modes of thought, and dysfunctional institutions. New paradigms, strategies, and tactics need to be developed. The workshop participants therefore recommended, *inter alia*, the establishment of information exchange networks; the generation and harmonization of an improved data and knowledge base for applying systems technology; participatory approaches; human resource development and people empowerment; and new institutional and policy frameworks. A task force was constituted and charged with implementing the recommendations and donor agencies are currently being approached for funding of a workshop to draft a comprehensive project proposal. Detailed information is provided in the published workshop proceedings.

RESUMEN. El taller trató en términos generales de la sostenibilidad de los agroecosistemas isleños y exploró como la informática y la tecnología de computadora pueden acrecentar la integridad biofísica, económica y social de las pequeñas islas. Hubo acuerdo unánime en cuanto a que los ecosistemas de muchas de las pequeñas islas están en peligro y en que el origen de este dilema obedece a tres causas subayacentes: Sistemas de valores erróneos, modos defectuosos de pensar e instituciones que no funcionan. Es necesario desarrollar nuevos paradigmas, estrategias y tácticas. Se recomendó establecer redes de intercambio de información; generar y armonizar una base mejorada de datos y conocimientos para aplicar tecnología de sistemas; enfoques participatorios; desarrollo de recursos humanos; y nuevas estructuras institucionales y políticas. Se constituyó un grupo de trabajo con la encomienda de implantar las recomendaciones y se están haciendo acercamientos a agencias donantes a los fines de que provean fondos para un taller en el que se prepare una

propuesta abarcadora a tales efectos. En las memorias del taller, ya publicadas, se provee información detallada.

INTRODUCTION

Sustainable development is an issue of global concern, but tropical islands have special and urgent needs for greater attention to economic and environmental health. Stagnant economies, growing populations, and fragile ecosystems constrain development of many of the Caribbean and Pacific islands. Yet, most of the small island nations lack the human and capital resources to generate the information needed by decision makers to formulate and implement sustainable practices and policies.

The Agroecosystems Sustainability in the Caribbean and Pacific Islands workshop, held in Orlando, Florida, from 16 to 19 October 1994, addressed these issues. Participants from both the Caribbean and Pacific Basins explored how information science and technology can enhance the performance of the agroecosystems of tropical islands and evaluated the new tools of information science to solve real-world problems related to sustainable development.

The Caribbean and Pacific Basin Administrative Groups (CBAG and PBAG) of the Tropical/Subtropical Agricultural Research (T-STAR) program jointly funded the workshop. T-STAR is composed of special grants administered by the Cooperative State Research, Extension and Education Service (CREES) of the United States Department of Agriculture. Cooperating land-grant institutions include the Universities of Florida, Puerto Rico, and the Virgin Islands in the Caribbean Basin and the Universities of Hawaii and Guam in the Pacific. The proceedings of the workshop have been published and may be requested from the author.

WORKSHOP OBJECTIVES

The workshop had two major objectives:

1. To identify priority issues that affect the sustainability of the agroecosystems of tropical islands; and
2. To explore how information science and technology can be employed to help preserve the integrity of these agroecosystems and enhance their biological, economic, and societal performance.

WORKSHOP STRUCTURE

Two keynote addresses focused on general aspects of agroecosystems sustainability in the Caribbean and Pacific islands. Five

position papers dealt with information tools, including agricultural and environmental decision support systems, rule-based systems, geographic information systems, and electronic networks and communication services. These tools were subsequently demonstrated.

Five working groups addressed particular problem areas associated with agroecosystems sustainability in the context of the Caribbean and Pacific islands: *Economics and Public Policy, Agriculture and Food Security, Environmental Issues, Societal Aspects, and Biodiversity,* and *Genetic Resources.*

WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

The discussion sessions yielded a wealth of ideas, notions, concerns, and proposals for action. The following synopsis summarizes the salient points that transpired during the discussions. It draws heavily on the report by Working Group IV, chaired by Dr. Vasantha Chase of the Organization of Eastern Caribbean States in St. Lucia, as this group examined the fundamental issues that govern agroecosystems sustainability. Notwithstanding the diversity of the topics on which the different groups focused, there emerged common concerns which precipitated a series of recommendations that are consolidated in the set of recommendations that are presented below.

The participants agreed that the integrity of the agroecosystems in the Caribbean and Pacific islands is in jeopardy. The underlying causes for this dilemma can be traced to a hierarchy of higher-order processes and interactions that affect sustainability. These are (1) value systems based on misguided incentives and underevaluation of natural resources; (2) modes of thought that evidence an inability to cope with complexities and a dominance of reductionist thinking; and (3) aspects of human organization, including sectoral orientation and disciplinary foci, lack of dynamic perspectives and participatory planning, externally driven research agendas, and lack of primary data in appropriate formats. These predicaments result in five principal constraints to agroecosystems sustainabilty in the Caribbean and Pacific islands:

- lack of stewardship ethic,
- lack of systems thinking,
- dysfunctional institutional frameworks,
- inadequate policies, and
- inappropriate research and development strategies.

The participants recognized the pivotal role that systems technology can play in addressing some, but not all, issues of agro-ecosystems sustainability. They also realized, however, that there exist impediments to their application. Most critical is the scarcity of reliable environmental and socio-economic data and the lack of maps suitable for geographic analysis. The rapid obsolescence of hardware and software, and the shortage of technical expertise are further deterrents.

In an attempt to develop an approach conducive to achieving agroecosystems sustainablity, the workshop participants recommended that:

- a functional network be established that links institutions within and between the two regions and employs state-of-the-art communication technology to facilitate the flow of information;
- the data and knowledge base required for applying systems technology be improved, expanded, harmonized, and made accessible across the two regions;
- sustainable island agroecosytems be defined and quantifiable indices of sustainability be identified;
- participatory approaches to problem solving be devised by goal-driven teams that involve a critical number of stakeholders in the problem identification, planning, implementation, and evaluation process of research and development projects;
- human resource development and people empowerment be promoted through public awareness initiatives, systems-oriented curricula at all educational levels, and training of scientists in the use of systems technology;
- institutional and policy frameworks be established for resource monitoring, marketing, trade, governance, and environmental regulations and their enforcement; and
- a system of incentives and disincentives be devised that incorporates social and environmental costs in costs of goods and services.

The recommendations adopted at the workshop are clearly conceptual rather than operational. The task ahead now is to translate them into actions that precipitate policies and practices that promote sustainability. An **Implementation Task Force** was therefore constituted at the workshop and charged with developing a long-range plan to foster systems thinking and the use of decision support tools in the context of the workshop recommendations. The task force will further identify two areas for case studies to demonstrate the application of information tools in

realistic agroenvironmental decision scenarios in the Caribbean and Pacific islands.

The challenge confronting the Implementation Task Force is to develop a problem statement and outline approaches and strategies that capture the attention of decision makers, rally support in the political arena, and convince funding agencies. Ultimately, the success of the workshop will have to be judged by the degree to which the task force accomplishes its objectives. If these efforts succeed, the workshop will turn out to be a milestone on the road to sustainable development in the Caribbean and Pacific islands.

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INFORMATION FLOW-METHODS AND SYSTEMS USED IN THE DEVELOPMENT OF JULIE MANGO PRODUCTION AND MARKETING SYSTEMS IN DOMINICA

G.C. Robin, L. Rhodes, and D. Crucefix, Caribbean Agricultural Research and Development Institute (CARDI).

ABSTRACT. The development of Julie mango production and marketing system in Dominica has been the focus of the Caribbean Agricultural Research and Development Institute (CARDI), through the British Development Division (B.D.D.) funded Exportable Fruit Crops Project (E.F.C.P.) between 1989 and 1996. The two-phase project, aimed at improving the productivity and marketability of Julie mango in Dominica and the O.E.C.S., was a multidisciplinary in nature and included components of technology generation, validation, transfer, adoption, and commercialization. During the project implementation, several methods were used to effect efficient information flows. This paper reviews the existing traditional systems, the different approaches used for effective implementation of information flows from technology generation through to adoption and commercialization.

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POTENTIAL FOR PROCESSING OF FRUITS AND VEGETABLES IN THE U.S.V.I.

Arthur C. Petersen, Jr., Francois Dominique, Lawrence W. Lewis, and Louis C. Petersen, Jr., Department of Agriculture of the United States Virgin Islands, Estate Lower Love, St. Croix, U.S.V.I. 00850.

ABSTRACT. The U.S.V.I. is interested in creating opportunities for the importation of fruits and vegetables into the Virgin Islands from neighboring islands. The department is further interested in doing this to initiate a processing industry to improve the produce imported and create a product with longer shelf life which could be marketed locally or in the USA mainland. The vehicles for enabling this process are two: The Department of Agriculture and the Industrial Development Cooperation. This forum will provide an opportunity for discussing these possibilities with potential participants.

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THE BENEFITS OF MYCORRHIZAL ASSOCIATIONS TO TROPICAL ORNAMENTALS, FRUITS AND VEGETABLES

U.K. Yadav, Horticultural Consulting Services, Lake Mary, FL 32746, USA.

ABSTRACT. Mycorrhizae are symbiotic associations between certain fungi and roots of higher plants. Vesicular-arbuscular mycorrhizae (VAM) are involved in mineral absorption, primarily phosphorus and may improve shoots and root ratio, water uptake, yield and transplantability. A strategy is proposed for successful inoculation. Research results are presented to illustrate the benefits of mycorrhizal associations to tropical plants.

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POTTING MIXES AND CHEMICAL FERTILIZATION TO IMPROVE QUALITY OF NURSERY GROWN COFFEE PLANTS (*Coffea arabica* L.) GROWING IN PLASTIC BAGS, UNDER 50% SHADE

Odilo Duarte, Leonel Contreras, and Dania Chávez, Department of Horticulture, Escuela Agrícola Panamericana, Zamorano, Honduras.

ABSTRACT. In 1991, mixtures of soil rich in organic matter plus one of the following materials were used to fill up the plastic bags: decomposed barn manure, decomposed coffee pulp, decomposed sawdust, burned or raw rice hulls, decomposed pine needles. The proportions were 2 to 1, except some treatments that included river sand replacing one of the parts of soil, making a 1:1:1 mixture. A Randomized Block design was used. The best combinations were soil plus decomposed coffee pulp or manure, with or without sand, resulting in 30%, 40%, 20% and 30% more leaf area, plant height, stem thickness and dry weight respectively, than the control plants (in plain soil) 5 months after transplanting. The other sources of organic matter produced mixes that gave results inferior to the control. In 1992, soil rich in organic matter plus decomposed manure or coffee pulp were used in a ratio of 2:1, with or without additions of 1, 2, or 3 g N (Urea) and 2, 4, or 6 g P_2O_5 (Triple superphosphate) per plant (3 kg of mix), in a factorial design. Fertilizations were made 15 and 45 days after

transplanting. The mixture of soil and decomposed coffee pulp plus 2 g of N and 2 g of P_2O_5 per plant resulted in significant higher leaf area, plant height, stem thickness, and dry weight than all other treatments, although 1 g N produced almost equal results as 2 g. As a group all mixes containing decomposed coffee pulp gave better results than the ones containing decomposed barn manure. Chemical fertilizers although helpful, did not seem essential. These mixtures could be useful for small farmers, with low technology levels and no access to chemical fertilizers.

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A CONSORTIUM APPROACH TO HELP THE SUSTAINABLE DEVELOPMENT OF HILLSIDE AREAS IN CENTRAL AMERICA

Roduel Rodriguez, National Coordinator, IICA-IFPRI Project, Tegucigalpa, Honduras.

ABSTRACT. Hillsides are important for the development of sustainable agriculture in Central America. They encompass the majority of the territory of every country, accounting for figures that vary from 32 to 82 percent of the total area. Most hillside areas are overpopulated and the peasants practice all sorts of activities ranging from subsistence agriculture and extensive livestock production systems to somewhat sustainable forms of production such as coffee and other cash crops. In addition, hillsides are also important for the following contributions to society: source of low cost labor; source of food and other goods for the large growing cities; source of water for the whole population; and potential areas for future development. However, population pressure for food production and other goods have led to overexploitation of the resource base resulting in high levels of degradation and increase of poverty. This situation will be aggravated by continuos population growth and other factors associated with global relationships among countries and groups of countries. In order to meet the challenge for the development of widespread sustainable production systems on Central American Hillsides, a coordinated effort has to be made for the various institutions and local organizations. A consortium approach, integrated by IFPRI, CIAT, and the IICA-HOLLAND Project is currently being implemented in Central America. The objectives of the projects directed by the three institutions are: to characterize the Central American hillsides; to carry out strategic research; to asses the effects of current and alternate policies on the management of natural resources; and to strengthen the national and local organizations capability to help sustainable development. Besides other advantages of such an approach,

research sites, methodologies and data are shared by the participant institutions and training activities are jointly undertaken.

POSTER PRESENTATIONS:

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YIELD POTENTIAL OF LOCAL AND POPULAR CULINARY HERBS IN THE VIRGIN ISLANDS

J.A. Kowalski, M.C. Palada, and S.M.A. Crossman, Agricultural Experiment Station, University of the Virgin Islands, RR 02, Box 10,000, Kingshill St. Croix, U.S.V.I. 00850.

ABSTRACT. Production of local and popular cultivars of culinary herbs contributes to improved income of herb growers and economy of the Virgin Islands. Field evaluation trial was conducted to determine productivity and yield potential of selected herbs. Nine herb species were grown in 2-row plots from January to September, 1995. Lemon grass and sweet basil produced the highest fresh yield of 64.6 and 68.8 t/ha^{-1} from 4 and 3 harvests, respectively. Fresh yield of other herbs in t/ha^{-1} were thyme 40.3 (2 hvt); chives, 38.0 (2 plantings); purple basil, 30.6 (2 hvt); seasoning peppers, 25.0 (6 hvt), sage 24.6 (2 hvt); wormgrass 12.9 (2 hvt); and summer savory, 11.0 (1 hvt). Perennial herbs like lemon grass was the only species that survived the hurricane. Lemon grass offers higher yield potential, productivity and stability compared to other species.

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FHIA-03: A NEW DUAL PURPOSE BANANA FOR THE U.S. VIRGIN ISLANDS

Christopher Ramcharan, A Bulbulla, and J.J. O'Donnell, University of the Virgin Islands, Agricultural Experiment Station, RR 02 Box 10,000, Kingshill, St. Croix, U.S.V.I. 00850.

ABSTRACT. The FHIA-01 and FHIA-03 tetraploid cvs were introduced into the U.S. Virgin Islands (USVI) for evaluation in 1993 through the generosity of the Fundación Hondureña de Investigación Agrícola (FHIA).

The FHIA-03 cv has been field-tested from plant crop (PC) through the third ratoon crop (RC). The second RC was destroyed by hurricane Marilyn in September 1995. Though developed as a cooking banana with potential tolerance to Fusarium and Sigatoka leaf diseases, the FHIA-03 cv has also been accepted as a fresh eating banana in the USVI, when carefully ripened. Plant and first RC data for bunch yields and growth parameters were 20.4 and 34.4 kg average bunch weight, with 6.8 and 8.7 hands and 82 and 134 fingers respectively for the PC and first RC. Height at flowering was 2.0 and 3.0 m with stem diameters of 17.4 and 24.5 cm; number of green leaves was 14 and 14 and number of suckers 2.0 and 3.9 respectively. Days to flowering were 264 and 499 and days to harvest were 361 and 618, respectively for the PC a first RC. Preliminary data for the third RC indicate number of hands and fingers per bunch at 7 and 111, respectively, and stem diameter at 24.9 cm. These plants were completely broken off by hurricane winds only seven months ago. Few plants were uprooted and most broken pseudostems recovered quickly. The strong and healthy root system indicates good tolerance to wilt and nematode infections. The thick-leafed nature of FHIA-03 plants, originally selected for tolerance to leaf spot, is probably a highly desirable trait for tolerance to drought conditions that occur in the USVI.

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SOMATIC EMBRYOGENESIS IN 20 *Carica papaya* CULTIVARS

T.W. Zimmerman, J.A. Richards, and C. Ramcharan, *University of the Virgin Islands Agricultural Experiment Station, RR2 Box 10,000, Kingshill, U.S.V.I. 00850.*

ABSTRACT. Cell culture medium parameters were evaluated to develop a system for somatic embryogenesis in 20 papaya varieties from the Caribbean and Asia and to overcome the problems with germination of the somatic embryos. The culture medium for embryogenesis consisted of half-strength Murashige and Skoog (1/2 MS) salts and the following parameters evaluated in a factorial matrix that included: 2, 4-D at 20 and 40 mM; sucrose at 3, 6 and 9%; glutamine at 2.7 and 6.8 mM. Consistently, a greater amount of embryogenesis occurred within 4-6 weeks on 1/2 MS containing 40 mM 2, 4-D, 2.7 mM glutamine, 6% sucrose and gelled with 0.3% Phytagel from 90-100 day old zygotic embryos from immature green fruits. The bottle neck involving maturation and germination of papaya embryos was overcome. After 8 weeks on the 2, 4-D induction medium, torpedo-shaped somatic embryos were transferred onto 1/2 MS, 3%

sucrose, 2.5% activated charcoal and gelled with 0.7 g Phytagel and 8 g agar. During a 4 week period on the charcoal containing medium, the translucent embryos became white. The embryos were transferred to the later medium but without charcoal. The embryos became green and germinated within a few weeks.

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MEDICINAL PLANTS: AN ALTERNATIVE CROP FOR CARIBBEAN AGRICULTURE

O.K. Davis, University of the Virgin Islands, Cooperative Extension Service, RR02, Box 10,000, Kingshill, St. Croix, U.S.V.I. 00850.

ABSTRACT. The use of medicinal plants in the Caribbean originated with the natives who inhabited the islands and with the slaves brought from West Africa. Historically, medicinal plants have been a major part of Caribbean agriculture. In the Virgin Islands, there are over 600 species of medicinal plants, but only 200 are recorded for medicinal use for different illnesses. Women known historically as "the West Indian Weed Women" of the U.S. Virgin Islands used to collect, prepare, sell and prescribe the use of plants to their customers. With interest in alternative medicine, medicinal plants have become big business in the pharmaceutical industry. Today, Caribbean farmers have the opportunity to grow herbs on a large scale for market consumption.

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EFFECT OF BENZYLAMINOPURINE ON FRUIT SET AND SEED DEVELOPMENT IN PIGEONPEA

G.F. Barclay and C.R. McDavid, Plant Science Department, University of the West Indies, St. Augustine, Trinidad.

ABSTRACT. Terminal racemes of pigeonpea (*Cajanus cajan* L.; dwarf determinate cv. ICPL 85015) were sprayed during early fruit-set with 0.01, 0.1, or 1.0 mM 6-benzylaminopurine (BAP). At harvest (50% dry pods), treated racemes were longer, with thicker stems and more auxiliary branches, and had more, larger fruits and leaves than did control racemes.

The rate of 0.1 mM BAP increased total raceme mass (TRM) the most, but neither stem nor leaf mass reached apparent maximum levels with 1mM BAP. More fruits $\leq$ 2 cm long, with unfilled, aborted seeds, occurred as BAP level increased. Maximum fruit mass occurred with 0.1 mM BAP. Pericarp mass and seed number/raceme increased with increasing BAP level. Total seed mass (TSM) peaked with 0.1 mM BAP at twice that of untreated racemes, but decreased with 1 mM BAP to the control level. Pericarp mass/TSM increased significantly with 0.1 and 1 mM BAP treatments. TSM fruits, mean individual seed mass, seed number/fruit, and TSM/TRM decreased as BAP level increased, with no apparent minimal attained with 1 mM BAP. BAP treatments appeared to promote competition for photosynthates between developing seeds and other parts of the raceme, notably the pericarp (which grew at the expense of the seeds within).

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GENETIC IMPROVEMENT OF ALPINIA

D. Petro and G. Anais, INRA-URPV-AP BP 515 97165 - CEDEX Guadeloupe, FWI.

ABSTRACT. *Alpinia purpurata* is an ornamental Monocotyledon cultivated in the tropics for its flower. It belongs to the Zingiberales order and the Zingiberaceae family. There are only two colours of bracts (red and pink), that limit the commercial exploitation of this flower. The aim of our breeding program is to create new varieties with varied colours. There is no report on such program worldwide. We have adopted two strategies: 1) the utilization of sexual hybridization to exploit the existing variability within the species *purpurata* and the genus *Alpinia*. Various crosses were realised and the progenies are now growing under shelter to be observed for their phenotypic characters. At this stage of development (30 cm of height) morphological variations are observed. 2) the utilization of biotechnologies to create variability, for example, callogenesis which is crumbly and whitish callus obtained and the regeneration of callus is under way with good prospects of success. Also mutagenesis in which vitroplants had been treated by gamma rays at different doses. The first plants are under shelter and we are waiting for the flowering to evaluate the degree of somaclonal variation.

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APPLICATION OF GIS TO ASSES LAND RESOURCE STRESS

Hari Eswaran and Paul Reich, *International Conservation Division, USDA, National Resources Conservation Service, Washington DC.*

ABSTRACT. Most land resource information systems do not carry information on the condition of the state of the land. Soil survey information only provides information on properties which can be used to infer the potential of the land to human induced degradation. Climatic overlays, or if information is incorporated in the soil classification systems, enable the assessment of climatic stresses. The poster illustrates a global assessment of mayor land resource stresses. Using the same base information, similar assessment is made for the Caribbean region. With GIS and soil resource information at a suitable scale and sufficient detail, reliable assessments and their geographic distribution of stresses can be determined. Tension zones are signaled for more detailed evaluation. Periodic monitoring provides the over-lays for progress assessment.

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ASSESSMENT OF LAND RESOURCE STRESSES

Hari Eswaran and Paul Reich, *International Conservation Division, USDA, National Resources Conservation Service, Washington DC, USA.*

ABSTRACT. Land degradation has become an important concern affecting the wealth of nations, food security, and it is impacting the livelihood of almost every person on the earth. A new agenda requires a strong science-based approach, a good understanding of land conditions and the consequences of management, and a program that reaches out to all stakeholders. Assessment and monitoring with the use of modern technology are prerequisites. To realize this new agenda, it is necessary to:

- develop appropriate models that enhance our capabilities in land management and land use planning;
- collaborate in developing information systems that link agriculture to environment;
- help develop policies that encourage sustainable land management;

- develop economic instruments to asses impacts of land degradation; and rally the international community to collaborate in working towards reducing land degradation.

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GEOGRAPHIC INFORMATION SYSTEMS IN AGRICULTURE AND NATURAL RESOURCE INSTRUCTION AT AN 1890 INSTITUTION

L. Marsh, F. Hassien, R. Savage, E. Cook, R. Reidinger Jr, and F. Young, *Department of Agriculture Natural Resources and Home Economics, Lincoln University, Jefferson City, MO 65102, USA.*

ABSTRACT. The Department of Agriculture, Natural Resources, and Home Economics at Lincoln University of Missouri (LU) offers a bachelors degree in agriculture with programs in animal science, agri-business, natural resources, plant science, and soil science. Recent curriculum revisions have introduced undergraduate-level, elective courses in geographic information systems (GIS) and remote sensing for the Department's degree candidates as well as all students attending LU. Experience with these technologies used for inventory and analysis of spatial (map) data are highly-valued job skills by future employers. The six courses currently being taught, including fundamentals and applications of GIS, photo interpretation and map reading and digital image processing, use hands-on laboratory exercises to reinforce classroom theory. Employment opportunities in the laboratory to assist with contractual GIS projects give students the additional experience necessary to compete for entry-level GIS positions or masters programs upon graduation from LU. Support for the initial development of these classes began with a U.S. Department of Agriculture (USDA) Capacity Building Grant. These early efforts became the foundation for establishment of the Center of Excellence Initiative for GIS and Wildlife Management at LU, a program cooperatively funded by four USDA agencies.

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CHARACTERIZATION OF CITRUS CHITINASES INDUCED BY INSECT HERBIVORY

Richard T Mayer, T Greg McCollum, Roy E. McDonald, and Hamed Doostdar, U.S. Department of Agriculture, Agriculture Research Service, U.S. Horticultural Research Laboratory, 2120 Camden Road, Orlando, FL 32803-1419, USA.

ABSTRACT. The West Indies sugarcane rootstock borer weevil (*Diaprepes abbreviatus* L.) is a significant pest of *Citrus* spp. Weevil larvae feed on citrus roots can often kill the tree by girdling it at the crown. Larval feeding can also reduce yields and predispose the trees to infection by *Phytophtora* sp. Swingle citrumelo (*Citrus paradisi* Macf. X *Poncirus trifoliata*) is a cultivar that is moderately resistant to root weevil infestation. Weevil larvae feeding on the roots induce a number of acidic chitinases that may contribute to resistance by degrading the insect's peritrophic membrane and making the insect more susceptible to pathogens or other dangerous materials that may be ingested. We purified six of the weevil-induced chitinases from Swingle roots and characterized them according to physical and enzymatic characteristics. The M_r's and pI's of the enzymes range from 32,000 to 41,000 and 3.9 to 4.3 respectively. Specific activities for ^{3}H-chitin and chitosan ranged from 54 to 136 nmol GlcNAc/min/mg protein and 27 to 156 nmol GlcN/min/mg protein, respectively. The *N*-terminal sequences were determined and indicate that all of the enzymes are class II endochitinases.

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GENETIC AND PATHOLOGICAL DIVERSITY OF THE MANGO ANTHRACNOSE PATHOGEN IN FLORIDA

M.J. Davis, University of Florida, Tropical Research and Education Center, 18905 SW 280 Street, Homestead, FL 33031, USA.

ABSTRACT. The mango (*Mangifera indica* L.) is a major fruit crop grown in the tropics around the world including the Caribbean region. Anthracnose, caused by *Collectotrichum gloeosporioides* Penz., is considered the most important disease of mango in the humid tropics.

Pectic zymogram analysis, randomly amplified polymorphic DNA (RAPD), and pathogenicity tests on inflorescence and detached leaves, and fruits were used to examine diversity among isolates of the pathogen from naturally infected leaves, panicles, flowers, and immature and mature fruits. Although considerable genetic diversity was found, cluster analysis of the pathogenicity and RAPD data indicated two major groups of isolates. Based on spore shape, one group might be classified as *C. acutatum* and not *C. gloeosporioides*. Isolates of the *"C. acutatum"* group tended to be more virulent on inflorescence and immature fruit; whereas, isolates of the *C. gloeosporioides* group tended to be more virulent on detached leaves and mature fruits. Such distinctions among *Colletotrichum* isolates from mango have not been made before. The great diversity among isolates associated with anthracnose of mango in Florida may help to explain why mango cultivars with reported resistance to anthracnose elsewhere are susceptible to anthracnose in Florida.

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DIAGNOSIS OF PAPAYA BUNCHY TOP DISEASE (PBT) IN PUERTO RICO

F.H. Ferwerda and B.R. Brunner, *Department of Horticulture, University of Puerto Rico, (RUM) P.O. Box 5000, Mayagüez, Puerto Rico 00681.*
M.J. Davis, *Tropical Research and Education Center, University of Florida, 1805 SW 280, Homestead Florida 33031, USA.*

ABSTRACT. Papaya bunchy top (PBT) is a major disease of papaya (*Carica papaya L.*) in the American tropics. Epifluorescence microscopy examination of transverse sections of petiole tissue revealed the presence of fluorescing material associated with PBT between the phloem and the xylem and sometimes extending along the phloem rays. Bacteria were consistently detected within the same region by light microscopy in PBT infected plants but not in healthy plants. PBT is often difficult to distinguish from diseases caused by papaya ringspot virus (PRV), nutritional deficiencies and physiological disorders. Symptom expression may also vary due to genotype PBT infected plants exhibit reduced latex flow from the stem and fruit. A 98% accuracy rate was obtained by diagnosing PBT using visual symptoms in combination with the latex flow test. Field diagnosis using this technique was corroborated using epifluorescence light microscopy.

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BREEDING PROGRAM FOR RESISTANCE TO *PSEUDOMONAS* (BURKHOLDERA) *SOLANACEARUM* IN SOLANACEUOS VEGETABLES

G. Anais, G. Ano, and P. Prior, INRA - UPRV BP 515-97165 - Pointe a Pitre, Guadeloupe, FWI.

ABSTRACT. In Guadeloupe, bacterial wilt is the most important disease in solanaceous vegetable crops. Aiming to select resistant varieties in tomato, eggplant and sweet pepper, the Plant Breeding and Bacteriology laboratories are working since 1966 on the knowledge of the parasite and sources of resistance. Breeding used various origins of resistance and methods: Sweet pepper, resistance was selected in an European population using mass then pedigree selection. In Tomato two different sources of resistance were used: a polygenic genetic control from Guadeloupe and monogenic dominant from the Pacific, and we used pedigree method and back crosses. For Eggplant we used intraspecific and interspecific methods. The intraspecific with the most resistant accessions issued from a far east germplasm. The breeding program made use of recurrent selection and the interspecific cross with the African species *Solanum aethiopicum*. After overcoming sterility problems, two breeding cycles altering backcrossing phases with *S. melongena* and intercrossing phases resulted in families with a good level of resistance. Lines of F1 hybrids originating from our breeding programs are grown with success in many tropical countries.

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THE ROLE OF TELECOMMUNICATIONS IN TECHNOLOGY DISSEMINATION IN THE AGRICULTURAL EXTENSION SERVICE IN PUERTO RICO

J.M. Huerta, University of Puerto Rico at Mayagüez, Agricultural Extension Service, Department of Agricultural Education, Puerto Rico.

ABSTRACT. The role that telecommunication systems will play in the Agricultural Extension Service of Puerto Rico in accomplishing its primary mission of disseminating technology in the new information era will be critical not only for the island, but also for the Caribbean region. In 1994,

the Agricultural Extension Service of Puerto Rico was awarded US$265,000 to develop distance telecommunication technology, and the study examines the attitudes and perceptions of county extension agents toward telecommunications. Findings show that extension agents perceive the value of the new technology in disseminating technology faster and to a broader audience. Nevertheless, extensionists recognize that it is not necessarily easy to use and adopt, specially for the typical low income audience. Both extension personnel and its target clientele should be trained in the new technology.

RESUMEN. El papel que desempeñarán los sistemas de telecomunicaciones en el Servicio de Extensión Agrícola de Puerto Rico en la nueva era de las comunicaciones y de la informática es fundamental para cumplir con su encomienda de difundir la tecnología. La posición geográfica de Puerto Rico, unida a su desarrollo tecnológico y afinidad lingüística y cultural hacen que su liderato se manifieste también en otras áreas de la región. En 1994 se le aprobó una propuesta por US$265,000 al Servicio de Extensión Agrícola de Puerto Rico para desarrollar un proyecto de telecomunicaciones a distancia. El estudio examina las actitudes y percepciones de los agentes de extensión en Puerto Rico hacia las telecomunicaciones. Los hallazgos muestran que los agentes de extensión perciben los beneficios de la nueva tecnología para diseminar la tecnología de manera más rápida y a mayor número de personas, aunque se reconoce que la nueva tecnología es difícil de usar y adoptar, especialmente para la clientela tradicional de recursos limitados del Servicio de Extensión Agrícola de Puerto Rico. El personal de extensión y su clientela deben adiestrarse en el uso de la nueva tecnología.

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BIBLIOGRAPHIC INFORMATION FOR SUSTAINABLE DEVELOPMENT: A SYSTEMATIC DATABASE OF THE IICA-GTZ PROJECT

G. Araya, IICA Project, Apartado 660/2200 Coronado, Costa Rica.

ABSTRACT. The IICA-GTZ Cooperation Project started in 1990 at the Inter-American Institute for Cooperation on Agriculture, Costa Rica, integrating agricultural and natural resources issues within the context of sustainable development. Within the context of sustainable development and interinstitutional cooperation between IICA and GTZ, one of the main goals of the project is to strengthen the systematic database with

bibliographic information on sustainable agriculture and natural resources. Since 1992, the IICA-GTZ Project established a documentary information system and a bibliographic database. This database is an effective means of disseminating information on sustainable agriculture and natural resources to institutional and private users involved in the field of sustainable development, especially IICA's member countries in Latin America and the Caribbean. The information included in the database covers the following topics: sustainable agriculture, agroforestry, tropical forests, resource conservation, economic development, rural development, biodiversity, climatic change, environmental degradation, ecotourism, environmental impact, agricultural policies, environmental policies, forestry policies, development projects, forestry resources, indicators on environment and socio-economics, resources and farming and land-use systems.

RESUMEN. El Proyecto de Cooperación IICA/GTZ se inició en 1990 en la sede central del Instituto Interamericano de Cooperación para la Agricultura-IICA, integrando los temas de agricultura y recursos naturales dentro del marco del desarrollo sostenible. Dentro del contexto de la cooperación interinstitucional, una de las principales actividades del Proyecto IICA-GTZ es el fortalecimiento de una base de datos automatizada con información bibliográfica sobre el desarrollo sostenible, dirigido hacia la agricultura y los recursos naturales. Fue a partir de 1992 cuando el Proyecto comenzó la tarea de procesar y almacenar en forma automatizada la información disponible en la base de datos sobre estos tema. Esta base de datos constituye un instrumento para diseminar la información sobre el desarrollo sostenible, entre usuarios institucionales y personales que estén involucrados en el quehacer del desarrollo sostenible, particularmente entre los países miembros del IICA, en América Latina y el Caribe. La información incluida en la base de datos comprende entre otros temas los siguientes: agricultura sostenible, agroforestería, bosques tropicales, conservación de los recursos, desarrollo económico, desarrollo rural, biodiversidad, cambio climático, deterioro ambiental, ecoturismo, impacto ambiental, indicadores: ambientales, económicos, demográficos y sociales, política ambiental, política forestal, proyectos de desarrollo y recursos naturales, sistemas de explotación y utilización de la tierra.

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