e Role of Bamboo, n & Medicinal Plants in Mountain Development

INBAR Technical Report No. 15

The Role of Bamboo, Rattan and Medicinal Plants in Mountain Development

Proceedings of a workshop held at
the Institute of Forestry, Pokhara, Nepal
15-17 May 1996

Editors:
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The International Network for Bamboo and Rattan (INBAR) is a broad-based, multidisciplinary network that develops, provides and promotes appropriate technologies and other bamboo and rattan solutions to benefit people and the environment. A world-wide network, it connects governmental and non-governmental organizations, and the private sector. INBAR provides leadership, coordination and support for research and development. Programs cover natural and cultivated raw materials; genetic resources; processing and utilization; economic and other social aspects; and supporting services. These programs aim to enhance the quality of life of poor and disadvantaged people in developing countries and make favourable impacts on forests and degraded environments.

The International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organization operating under the aegis of the Consultative Group of International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of plant genetic resources for the benefit of present and future generations. IPGRI works in partnership with other organizations, undertaking research, training and the provision of scientific and technical advice and information, and has a particularly strong programme link with the Food and Agriculture Organization of the United Nations. Financial support for the research agenda of IPGRI is provided by the Governments of Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, India, Italy, Japan, the Republic of Korea, Luxembourg, Mexico, the Netherlands, Norway, the Philippines, Spain, Sweden, Switzerland, the UK and the USA, and by the Asian Development Bank, CTA, European Union, IDRC, IFAD, Inter-American Development Bank, UNDP and the World Bank. IPGRI's Head Office is in Rome, with Regional Offices in Italy, Syria, Kenya, Colombia and Malaysia. The Regional Office for Asia, the Pacific and Oceania (APO) is located in Serdang.

Founded out of widespread recognition of degradation of mountain environments and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people. The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States. ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

Contents

Foreword

These proceedings of the workshop held 15-17 May, 1996 in Pokhara, Nepal focus on the roles of three important non-timber forest products–bamboo, rattan and medicinal plant–in the development of mountain areas of the Hindu Kush-Himalaya and beyond

The workshop was sponsored by a group of international organizations involved with development, poverty alleviation and wise use of natural resources: the International Network for Bamboo and Rattan (INBAR) and the IDRC Medicinal Plants Network (IMPN) both hosted and headquartered by the International Development Research Centre of Canada (IDRC); the International Plant Genetic Resources Institute (IPGRI) and the International Centre for Integrated Mountain Development (ICIMOD). The Institute of Forestry of Tribhuvan University in Pokhara readily consented to co-sponsor the workshop and hosted it.

Bamboo, rattan and medicinal plants are renewable natural resources. While rattan is more abundant at lower altitudes, many high-value medicinal plants grow at colder and higher altitudes, and bamboo is common throughout the greater part of the Himalayas. In addition, all three groups of plants are often common property resources and are of direct practical use to rural communities, offering opportunities for income generation, particularly for landless rural households.

Therefore, the scope of this workshop encompassed the whole range of ecological zones in the mountains and involved discussions on the environmental, socio-economic, and cultural value systems in integrated development with a specific focus on bamboo, rattan and medicinal plants.

While we have some understanding of the present use of these keystone commodities, we also know that the increasing levels of exploitation are not sustainable and that rural communities benefit insufficiently from this exploitation. The workshop participants identified the policies and practices for improved management of these groups of plants that would contribute to environmental stability, conservation

of the resources and enhanced utilization for increased incomes and other benefits to the poor mountain households of this region. Innovative mechanisms for improved resource management, processing and trade are required to tap the full potential of these versatile plants.

It was clear that much remains to be done in developing a more comprehensive knowledge base and strategic approaches for not only sustainable but also more productive systems. We hope that the present document can play a role in further promoting collaboration and information exchange in the development of this group of plants.

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Introduction

Inaugural Speech

Hon. Mohan Bahadur Khatri
Asst. Minister of Forest and Soil Conservation,
His Majesty's Govemment of Nepal

On behalf of His Majesty's Government of Nepal, I extend greetings and salutations to all of you attending this august gathering. It gives us great pleasure and satisfaction that the international workshop on the role of bamboo, rattan, and medicinal plants in mountain development is being held in Nepal. The sponsoring organizations, International Development Research Centre (IDRC), International Network for Bamboo and Rattan (INBAR), International Plant Genetic Resources (IPGRI) and International Centre for Integrated Mountain Development (ICIMOD) deserve our gratitude for choosing the Institute of Forestry, Pokhara, as the venue for this important international meeting.

His Majesty's Government of Nepal has attributed highest priority to environmental protection and economic development in the mountain regions, since Nepal is largely a mountainous country. The Forest Policy implemented by our Government gives greater emphasis on community participation in the management of forest resources. The highly liberal small-enterprise development policies adopted by our Government, I hope, will help promote non-timber forest products in our mountain regions. The fast-growing forest-user group system in Nepal will assist in this by providing organizational support.

In our view, this workshop is both timely and of immense importance to the people and environment of the Hindu Kush-Himalaya region. It is timely, because the rapid deterioration of biological resources in the region threatens to impact all of us in very real ways soon. It is of immense importance to the local people, because there is a more urgent need than ever to uplift the sliding socio-economic

quality of the lives of people in this region, which proper management and use of these plants may also serve to accomplish.

Historically, all the three plant groups covered by this workshop are highly important to the lives of the poor people. Bamboo has found ubiquitous use in our daily life. As most of you are probably aware, our ancient traditions fully recognized the intrinsic role played by bamboo and canes, and took steps to ensure that these resources were sustainably managed.

Bamboos are found throughout Nepal; in the hills and mountains, they provide multiple services and products, especially to the poor and disadvantaged people. Cane or rattan-based furniture industries are gradually developing in the urban areas of Nepal where they find ready markets and thus provide employment opportunities and cash income to the urban poor. Medicinal and aromatic plants are high-value and low-volume cash crops which are very suitable to meet subsistence and commercial goals of the mountain economy. Even now, over 90% of the people in Nepal still depend on medicinal plants for treating most of their ailments.

The goals of an integrated development in the mountain region should be the alleviation of poverty, diversification and enhancing employment opportunities, conserving the environment, and creating enabling opportunities for sustainable development. Sustainable development in the mountain context can be viewed as development involving changes in the production and distribution of desired goods and services which result, in a given target population, in an increase in welfare that can be sustained over long periods of time.

All the resources available are not completely documented leaving a large scope for basic and strategic research. Nevertheless, the countries of the Hindu Kush-Himalaya region are rich in bamboos, rattans and medicinal plants. I hope to see the workshop develop approaches to make use of these keystone products for integrated and accelerated development. Such approaches can be planned to favourably improve on currently faced serious circumstances of environmental deterioration and increasing poverty. I am sure this workshop will significantly advance efforts under way in these areas.

Moreover, as representatives of international organizations, development experts and research institutions gathered here, you have

a unique opportunity in this forum to come up with recommendations which, besides helping the governments implement sound programmes, will also enhance the spirit of regional cooperation. I urge you to find ways that we in the region can work together to address issues of mutual concern. As has been recently demonstrated, the SAARC countries have enormous opportunity to cooperate together for mutual benefit, and similar gains are also likely from closer interaction with our partners in East and Southeast Asia throughout the Himalayas.

In closing, I would like to wish you a very comfortable stay in Pokhara - it is truly one of the jewels in the Nepali crown. I hope that you will have time to enjoy the cultural atmosphere and the beauty of the surrounding landscape, and that these will inspire you to every success in the workshop.

I have great pleasure in declaring this workshop open.

Thank you.

Background to the Workshop

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1.0 Introduction

This international workshop has been organized in order to assess the socio-economic, environmental and technical potential of bamboo, rattan, and medicinal plant resources to improve the lives of the people in the mountainous region of the Hindu Kush-Himalaya (HKH). The organization was guided by a committee representing the sponsoring agencies (Annex 1). The deliberations and outcome of the meeting will draw attention of the national governments, donor agencies, and development communities on meaningful resource conservation and sustainable resource management projects based on these important plant commodities. At the same time, they will relate to the economic upliftment of poor and disadvantaged communities that rely on products of these commodities.

Himalayan farmers have been using a range of bamboo species for construction of houses and bridges and for furniture, domestic utensils, baskets, mats, and other subsistence needs since time immemorial. Recognizing the multipurpose uses of bamboos, they have developed a range of plant management systems for bamboos within the framework of the complex mountain ecosystems and prevailing silvicultural and farming systems. Assessment of indigenous knowledge on patterns of variation in species and local propagation methods as well as selective extraction for particular purposes and end-uses could provide pointers for the development of more intensive management systems necessary since demand is now exceeding supply and local systems are becoming unsustainable.

Bamboo and rattan are inseparable when we consider crafts in traditional societies. Rattan utilization in the Himalaya is based on a wealth of indigenous knowledge and skills which may have important bearing on the development of new sustainable utilization systems especially in N.E. India and S.W. China. Rattans provide suitable raw materials for small scale enterprise development in the mountains due to their light weight, versatility, and flexibility of working. We need to gather much more information on the domestication of rattan and their utilization in the Himalayas.

Medicinal plants are valuable components of Himalayan biodiversity. Almost 85% of mountain people's medicines are obtained from herbal resources and many mountain communities (e.g., Tibetan) specialize in the utilization of medicinal plants for primary health care. Many mountain communities earn off-farm income by collecting, transporting, and trading medicinal plants. The commercial importance of medicinal plants has only recently been appreciated, although trade in these plant products is one of the oldest businesses in the Himalayan region.

Despite the importance of the commodities, there is a profound lack of collated information regarding the identification, life-history, propagation, and conservation of relevant species in the Himalayan mountain regions. Some information exists e.g., the description of bamboos of Nepal and Bhutan (Stapleton 1994, 1994a), enumeration of medicinal plants in numerous areas where project work has been focused (e.g., Chen 1990 for China; HMG 1970 for Nepal; and papers in this volume) and study of the rattan flora and its use in Himalayan China. There is an urgent need to assess current knowledge.

Despite the well-recognized importance of bamboo and rattan to rural people, foresters, agriculturists, development administrators and other resource managers often neglect them in their plans. There is still some sort of social stigma attached with the use of unprocessed and/or locally processed bamboo, rattan and herbal products by rural people. More importantly, the lack of reliable supplies, uniform quality, and appropriate technology has hindered desirable commercial development of products. The limited, donor funded activities are uncoordinated and lack a strategic direction. At the same time, the

resources are being depleted thereby threatening the economy and ecology of the region.

2.0 Rationale for the Workshop

The Himalayan mountain region is classified as one of the world's richest ecosystems. The Biodiversity and Genetic Conservation Working Group of INBAR/IPGRI has designated the eastern Himalayan region (Bangladesh-Bhutan-India-China) as a 'hot-spot' for rattan diversity. The Himalayan region, with an estimated population of over 100 million people, some of the poorest of the poor, and an area of over 3.5 million km^2 is believed to be a storehouse of rich biodiversity and ethnobiological knowledge.

The UNCED Agenda 21 has also called for action on sustainable development and conservation of biodiversity in mountainous areas. Hence, it is timely that a specific workshop addresses the issues associated with the most important non-timber forest products.

3.0 Workshop Issues

There are a large number of issues associated with sustainably integrating bamboo, rattan, and medicinal plants in resource conservation and development planning.

A. General Issues:

- Tenurial and property rights.
- Overlapping and conflicting development and conservation objectives adopted by governments.
- Failure of development projects to fully harness the potentials of these commodities.
- Need to encourage non-timber, forest-based industries to practice a culture of 'social contracts' while harvesting the resources.

B. Institutional/Organizational Issues:

- Top-down and highly bureaucratic planning and decision-making systems in devolution of authority to stakeholders and/or awarding usufruct.

- Lack of recognition of community-based resource management systems and groups.
- Lack of suitable extension organizations.
- Poor recognition of the capacity building and empowerment needs of women or tribal and other disadvantaged groups.
- Weak or non-existent networking or twinning mechanism of weak and strong institutions in the region.

C. R and D Issues:

- Lack of technical capability to sustainably manage resources at local level.
- Lack of and/or inadequate infrastructure for R&D.
- Predominance of traditionally large industry-oriented R&D organizations.

D. Economic Issues:

- Poorly documented economic contribution of bamboo, rattan and medicinal plants in the NTFP sector in the mountain economy.
- High values of products of these commodities outside the areas of primary production.
- Lack of markets and economic pricing for products of small scale producers.

E. Human Resource Management Issues:

- Need to develop technical and managerial human resources to focus on sustainable use of plant resources.
- Lack of institutions and/or capacity to provide training and technology transfer guidelines in the area of environment conservation and enterprise development.
- Need to train, empower, and strengthen community inputs.

F. Technical Issues:

- Need to plan and develop integrated resource management systems with innovative mixed cropping, agroforestry, and short rotation cropping.

- Successful integration of bamboo, rattan, and medicinal plants in mainstream forest management.
- Development of appropriate silvicultural systems and post-harvest technologies for the three groups of plants.
- Need to practice more sustainable extraction of the resources.

4.0 Workshop Objectives

The main objectives of the Workshop are to:

A. Exchange information on the resources and their uses especially in relation to:
   (a) traditional extraction systems
   (b) traditional resource management and utilization systems

B. Discuss both *in situ* and *ex situ* conservation needs in relation to development activities. These should:
   a) sustain existing resource-use systems
   b) support development of improved production and processing system
   c) help to preserve ecosystems

C. Identity socio-economic and commercial potentials of the resources in the region's economy.

D. Make recommendations on collaborative action to promote sustainable use of the resources. This will include capacity building, strategic research activities and development schemes.

The Workshop will be of three days duration and includes thematic papers and country reports. A series of Working Groups will discuss and narrow down the specific ideas for future R&D work which could be taken up by participating countries and agencies as a follow-up of the Workshop.

5.0 Output of the Workshop

The recommendations of the Working Groups will be summarized by a drafting committee (Annex 1) and agreed by the participants as the Pokhara Declaration which will provide a framework for the medium-

dium- and long-term actions necessary for the sustainable utilization of bamboo, rattan and medicinal plants in the HKH mountain region.

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Annex 1

Organizing Committee

Principal Coordinator:	Dr. Madhav Karki, INBAR
Co-coordinator:	Prof. A.N. Rao, IPGRI
Members:	Prof. Pei Shengji, ICIMOD
	Mr. Jason Holley, IMPN
	Mr. S.N. Adhikari, IOF
	Mr. J.B.S. Karki, IOF
	Mr. Narendra Rasaili, IOF
	Mr. Mahadev Sharma, IOF

Pokhara Declaration Drafting Committee

Members:	Prof. J.T. Williams, INBAR
	Mr. Jason Holley, IMPN
	Prof. A.N. Rao, IPGRI
	Prof. Pei Shengji, ICIMOD

Thematic Papers

Sustainable Utilization of Alternative Forest Resources in the Himalayas: Opportunities and Constraints

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1.0 Introduction

The challenge of mountain development in the contemporary Hindu Kush-Himalaya (HKH) context revolves around a number of key concerns. The most basic and humane concern is one of alleviating poverty. Conserving the mountain environment and habitat, and ensuring a measure of social justice by addressing the concerns of women, and marginalized and disadvantaged groups are other key concerns. It needs hardly to be emphasized that the comparative advantages afforded by the mountain environment have to be the basis for addressing these developmental challenges. The comparative advantages derive basically from the diversity of micro-environments and consequent high degree of variation in physical and biological attributes of natural resources.

Many of the ecological 'niches' have been exploited traditionally to varying degrees. The diversity of resources needs to be harnessed in such a way that the constraints imposed by mountain environments are overcome. Inaccessibility is one of the most fundamental constraints. Also, a high degree of fragility of mountain resources, i.e. rapid degradation of resources with high intensity use resulting in relatively lower carrying capacities, is another such constraint (Jodha, 1990).

A number of imperatives for development emerge in the contemporary context of high population growth, and the demise of traditional forms of adaptation of the human population to the resources in the mountain areas of the HKH (Sharma, 1993). A major priority is to enhance the productivity and sustainability of mountain agriculture. However, if more comprehensive impacts are to be made on the livelihood needs of a growing population, a more fundamental emphasis has to be in areas that are non-competitive to agriculture. Such areas should address issues of the maintenance of biodiversity and environmental regeneration, and contribute to employment and income generation. They should provide mountain areas with some measure of autonomy in bargaining for the value of their resources, and help in the development of participatory institutions that can assure and facilitate the distribution of benefits to those sections of society that are in most need.

This requires an integrated approach to mountain environments as systems with inter-linked physical, economic, cultural, and institutional dimensions. Integrated development would need to search for complementarities within and among these dimensions: complementarities in terms of physical processes such as land use and watershed management in response to variable slopes, pedological as well as hydro-meteorological conditions and farming systems. Complementarities also need to be strengthened in terms of the economics of production and of exchange that contributes to highland-lowland interaction. This is because the problem of economic and environmental development in mountain areas cannot be addressed in the contemporary world by maintaining mountain areas as isolated, closed entities.

The social and cultural dimensions of the mountains are complex and have imbedded in them a whole system of values and folk knowledge regarding habitats and their resources. This calls for the integration of modern scientific understanding with the symbolism expressed by the extant social and cultural systems and the indigenous knowledge systems so that contemporary problems and issues are better and holistically focused.

Furthermore, there is an institutional dimension with respect to common property resource use and management, and participation in

the development process: decentralized, participatory approaches have perhaps higher relevance in mountain areas than elsewhere.

2.0 Opportunities Provided by Non-Timber Forest Resources

Non-timber forest products (NTFP) link all the desired aspects of integrated mountain development (Sharma, 1995). These alternative forest resources provide a mostly non-competitive and often complementary land use vis-a-vis agriculture in the mountains where one of the main problems is the limited extent of cultivable land. These resources can potentially integrate economic and environmental development, one of the main contemporary challenges in mountain development.

Sustainable reliance on NTFPs also creates the need to maintain and conserve the biomass and biodiversity. As sources of alternative employment and income generation, NTFPs can also support and sustain economic development of poor mountain areas. Indeed, NTFPs have traditionally also been the last resort for the economy of the distressed poor. NTFPs provide a potential basis for highland-lowland interaction and exchange. Value-addition, particularly through processing of NTFPs, can provide mountain communities with better terms of trade and bargaining power. A great deal of folk knowledge has been generated about the range of NTFPs on which mountain communities have depended for their own consumption or exchange. Linking indigenous knowledge systems with modern strategic scientific approaches can enhance the utility as well as conservation of the NTFP resources. NTFPs in much of the mountains, as elsewhere have been and still continue to be harvested from common property resources.

3.0 Sustainable Utilization of Non-Timber Forest Resources

From a cursory survey of extant information (FAO 1995), it is seen that large numbers of people are involved in collecting and gathering, hunting, processing, trading and otherwise producing and using NTFPs. In rural areas in particular, the use of alternative forest products is pervasive and in many instances household livelihood strategies are closely linked to the availability and use of such resources. A large body of literature confirms the great degree of involvement and dependence of the poor on these resources (Jodha 1990). However,

people's involvement in income-generating activities based on NTFPs is affected by a number of factors including access to and links with the market, patterns of demand, competition and process. Also, as much of the trading activities based on NTFPs are tied to agricultural activities and are also influenced by the seasonality of resources, markets tend to grow slowly. The growth of domestic urban markets and improvements in rural infrastructure are significant influencing factors.

There are a number of constraints and issues that need priority attention if NTFPs are to play a meaningful role in mountain development. These are noted below:

i) *Resource Information*: Information is scant on NTFPs, especially the status of the resource base, the trends in harvesting and collecting, biological sustainability of the resource base, the probable impact of existing practices, and area specific, sustainable harvesting. A comprehensive database is needed to chart a strategy for the development of NTFPs and it should be created on a priority basis (Edwards *et al.* 1993). Lack of such a database is often a constraint in the formulation of effective policies and programmes.

ii) *Management Regime of Common Property Resources*: Most of the NTFPs are harvested from common property resources in situations where access appears to be neither restricted nor regulated (Jodha 1990a). Centralized state control and commercialization of NTFPs have had a number of significant impacts: local control on resources has tended to decline, traditional NTFP production and management systems have considerably eroded, common land per capita has tended to decline, and traditional forms of access control, usufruct allocation and conflict resolution have become largely ineffective. On the other hand, privatization or transfer of control to a few individuals can lead to a situation where a large proportion of needy households are denied access to these resources (Arnold 1995). Private use can also result in over exploitation and resource degradation. Commercialization also heightens pressure for quick exploitation of the resource particularly when the price situation is favourable.

Sustainable harvesting and management of NTFP resources is unlikely to be possible without promoting participation of local institutions that oversee, monitor and enforce regulations and sustainably manage and benefit from these resources. For this purpose, successful local control systems need to be adapted to fit local situations. Institutional and tenurial arrangements that can potentially combine the positive features of both collective and individual control may need to be explored. Also, the relevance of the community forestry and agro-forestry experiences needs to be brought to bear in looking at this issue (Chandrasekharan 1995).

iii) *Government Policy and Support*: The policy of most governments with respect to NTFPs and their sustainable utilization has often remained quite ambivalent (Amatya 1995). Small enterprises based on NTFPs are often discriminated against and excluded from access to available incentives and other forms of support. Policies in general tend to favour the large modern sector and often export-oriented industries. The policy environment must therefore be made more neutral so that biases against small enterprises are eliminated.. This is essential because most NTFP-based enterprises are operated and owned by locals in rural mountain areas can only be small scale activities.

Likewise, government support programmes such as credit should be tailored to the different needs and opportunities of different target groups, particularly the needs of the small entrepreneurs and small and marginal farmers. Experiences such as that of the Grameen Bank in Bangladesh, and SFDP (Small Farmers Development Programs) and PCRW (Production Credit for Rural Women) in Nepal, may help in designing support programmes intended to promote income-generating activities through the sustainable use of NTFPs.

Extension has a major role to play in terms of disseminating ideas and techniques, and supporting the provision of selective inputs and education as well as learning from the farmers. Such a style of extension demands that local personnel are involved in extension activity and that extension is planned with the participation of the local communities. This requires a re-orientation of government policies on forestry extension.

iv) *Marketing and Marketing Institutions*: Marketing is often a primary bottleneck in the promotion of off-farm activities (ICIMOD 1992). NTFPs are one of the most challenging product groups from a marketing point of view because of their number, end-use variation and dissimilarities of the producer base (Lintu 1995). Three basic elements are important in marketing: dissemination of product and price information; creation of local benefit-sharing organizations for marketing the produce, and creation of marketing organizations at different levels. Village traders and middle men appear to be performing a useful role in the marketing of products based on NTFPs (Edwards 1993; Olsen 1994). However, there is considerable scope for cooperative institutional arrangements to share the costs and benefits of direct marketing, to develop a system of regular and up-to-date market information, to ease access to credit, technology etc., to help local producers organize themselves to gain advantage in the market, and to promote specific products with comparative advantage in specific areas/regions. Local Marketing Cooperatives could also engage in basic processing and quality control of NTFPs, particularly medicinal plants. Low-volume, but high-value products can offer good scope for cooperative arrangements particularly in the inaccessible context of the mountains. Such arrangements could also be instrumental in the organization and empowerment of local communities.

v) *Increasing Value-Addition in the Areas of Collecting/Harvesting*: The sustainable utilization of NTFP resources has to be appreciated in the context of the expansion of income-earning opportunities for often poor mountain communities. Collecting and transporting alternative forest products is not going to bring in great returns unless attempts are directed to increase value-addition in the areas of origin. In the case of medicinal plants it may be through proper cleaning, sorting, packaging and through simple processes of distillation or extraction at the village level. In the case of bamboo and related products, it may be value-added through weaving and the production of a number of necessary household essentials, and for furniture and handicrafts with a wider market.

vi) *Human Resource Development*: Human resource development is an essential corollary to any effort directed at sustainable utilization

of NTFPs. Literacy levels in many mountain communities are extremely low. Creation of conditions for universal literacy is the first step to human resource development. In many areas, traditional uses of many NTFPs have been forgotten or lost. In such cases, the need may be to popularize the uses of such products and link them with existing or potential markets. Adaptation of traditional uses to contemporary needs, and introduction of new skills and products are areas that need to be emphasized. An inventory of traditional skills has to be established and ethnobotanical knowledge and traditional skills need to be adapted to contemporary requirements.

Human resource development will also need the creation and nurturing of the latent entrepreneurial capabilities of mountain communities. Skill-training programmes designed to induce self-employment need to be linked up with entrepreneurship development. This is essential to inculcate a sense of business and economics to the activity; ultimately, the real test of the sustainability of an activity lies in the extent to which it is economically viable and can contribute to improve the livelihoods of mountain communities.

There is a need for training on environmentally sound NTFP harvesting/collecting practices and relevant technologies. Such technologies may relate to energy, transportation, storage, preservation, processing, construction etc.

vii) *Better Access to Resource and Distribution of Benefits*: The shrinking of the common property resource base has serious implications for the livelihood strategies of poor and marginalized households in terms of access to NTFP resources. This requires looking at the processes that contribute to protect the access rights of the poor to the resources. Organizing poor households for the sustainable utilization of NTFPs by forming User Groups may be one method of ensuring better access by the poor. Using part of the royalties derived from specific NTFPs, such as medicinal plants from specific areas, for local community development and conservation work (something that is being tried using returns from tourism in Protected or Conservation Areas in Nepal) may be

another method. The royalty system also needs to be rationalized and tied to the resource situation.

viii) *Gender Issues*: While women are involved in collecting and basic processing of most NTFPs, their involvement is restricted to low return, labor intensive activities. Women tend to be systematically displaced in high value-added activities. However, there are some areas where the role of women could be enhanced. The potential of specific NTFPs in contributing to women's income within households needs to be particularly assessed and enhanced.

ix) *Promotion of Cultivation on Private Land*: There are a number of NTFPs, particularly medicinal plants, that show potential for cultivation on private land. These need to be identified, market potential assessed, and promoted at the farmer level. Cultivation can be encouraged and indeed may be essential for unmanaged and threatened species. In particular, it is believed that cultivation of high altitude medicinal and aromatic plants is necessary to assure sustainable harvests. Aspects of extension (see (iii) above) as well as research and demonstration would therefore require priority attention. Similarly, species of bamboo and rattan need to be identified for cultivation.

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Gender and Environment-Balanced Eco-Technologies for Sustainable Mountain Development

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1.0 Introduction

The importance of this workshop stems from the fact that we are discussing ways and means to enhance livelihoods of mountain people in an ecological and equitable manner. Enterprises based on bamboo, rattan and medicinal plants are a natural choice for bringing about sustainable development in mountain areas. These renewable resources have provided sustained livelihoods to a number of indigenous mountain communities for centuries. This paper looks at gender and environmental issues and the need for them to be incorporated into development plans.

Two topics are discussed : 1) the conceptual background to develop an economic plan which is ecologically friendly, socially equitable and economically viable, and 2) a framework to ensure that the technologies introduced do indeed enhance equity between genders and are at the same time environmentally sound.

2.0 Background to an Economic Plan

The twentieth century has witnessed remarkable progress in every field of human endeavour resulting in uncommon opportunities for achieving the hitherto unfulfilled goals of "food, health, education and work for all by the year 2000". Yet as we approach a new millennium, we witness increasing social and environmental degradation, widening economic inequity, feminization of poverty, and damage to the basic life support systems such as land, water, the atmosphere, forests and

biodiversity. These trends threaten both the present and future well-being of humans.

Creating avenues for remunerative employment in rural areas has become the major challenge facing development planners. UNDP's Human Development Reports of 1992 and 1993 have brought out vividly the growing rich-poor divide and the phenomenon of 'jobless growth'. The UN Conference on Environment and Development (UNCED), held at Rio de Janeiro in June 1992, highlighted the need to re-orientate economic development in an ecologically sustainable manner. The UN Social Summit held at Copenhagen in March 1995, emphasized the urgency of taking steps to promote opportunities for gainful employment and to arrest the growing trends towards social disintegration. The 1995 Human Development Report of UNDP contains detailed information on the trend towards feminization of poverty. Thus, the new paradigm of development should be based on a 'jobs for all' strategy which is economically viable, socially equitable, gender-sensitive and environment-friendly (Hoon *et al.* 1995). Job creation is now an important cornerstone of public policy all over the world. The challenge is even greater in mountain areas of the developing world because of poor infrastructure and lack of purchasing power.

Technology has so far been a part of the problem; nonetheless, it has the potential to provide sustainable solutions to the negative features of contemporary developmental pathways provided it becomes rooted in the principles of ecology, equity and ethics, in addition to economics. Such a paradigm shift in strategies and policies related to technology development and dissemination will lead to the growth and spread of a self-replicating eco-technology movement.

2.1 The Need for Gender and Environment Balanced Eco-technology in Mountain Areas

The mountain districts of the Hindu Kush-Himalaya are rich in natural resources and these include both human cultural and biodiversity genetic heritages. Natural resources constitute essential components of the life support system. The Himalayan mountain region is a set of complex ecosystems that has been under-sustained, but with intense exploitation by humans especially since the turn of the century. The threat from humans from within as well as from outside is constantly

increasing. Maintaining the ecological integrity of these mountain ranges is not only important for the well-being of the Himalayan peoples, but the destiny of the Indian sub-continent itself is directly linked to the health of the Himalayas (Ramakrishnan *et al.* 1994).

Despite nature's bounty, Himalayan people remain poor and often have lower life expectancy than people living in the plains. Males migrate to cities and towns to look for jobs and leave a majority of the farm operations in the hands of women. Women form the backbone of the mountain economy. They contribute to the sustenance of the household by growing food, fetching fuel and fodder, looking after animals and spinning and weaving woollen cloth. Life is hard and the women have to cope with diverse situations, often alone. The status of women in the middle and lower Himalayas is low; they are not consulted in major decision making. This is in contrast with the Bhotiya tribal society where women have equal status and take part in decision-making.

A visitor to any Himalayan village will normally note that women are always busy at domestic chores, animal husbandry, weaving or utilizing non-timber forest products. On the other hand the men seem to have plenty of time for gossiping, playing cards and socializing. This made us feel that the approach for mountain development should be: add value to women's time and add work to men's time.

2.2 The Mountain Economy

Livelihoods in mountain areas are largely linked to the primary sector. Land and water form the backbone of the resource base on which cultivation, animal husbandry, fisheries and forestry activities depend. A high dependence on traditional agriculture is in part a result of the resource realities of the areas. There is evidence that the natural resources of land and water have already been degraded to an alarming extent. At the same time, there is a need to raise the land productivity to meet the demands of the growing populations since in the past decade the pressure on cultivated land has intensified.

Although most livelihoods are in the primary sector, a rising proportion of income is from off-farm activities, but in the mountains this is closely related, including processing and marketing of resources.

Much of this income is derived from activities in informal sector (including plant collecting).

It is no longer realistic to pursue an idyllic and self-sufficient life in the countryside in this overpopulated, competition-dominated world. In the past, people in mountain areas were self-reliant, and natural resources constituted an important component of their life support system. Until recently the following philosophy of mountain peasants in China described the sentiments and values of mountain people all over the world:

"Raising swine for the Spring Festival.
Keeping two chickens to exchange for salt;
Planting crops to feed family's mouths.
Holding a cow to plough a plot;
with a firepan in my hut.
I am happy next to God.

But now their illusion has vanished and they remain in poverty" (Song Jian 1993)

Progress as seen through development of infrastructure, such as roads, telecommunications, television and radio, in mountain areas has now shattered this old fashioned dream of natural economy. Values of the younger generation are changing as they are sucked into a more material and consumer-oriented world. The market dominates and decides what people should produce.

In a recent study to prepare an employment strategy in the Himalayan mountain district of Pithoragarh, we selected 9 enterprises based on the untapped potentials in individual locations and based on a project design incorporating the paradigm of ecological sustainability, social and gender equity, and economic viability. It involved extensive participatory rural appraisals, personal interviews and group discussions with over 400 farm men and women in 30 villages. The enterprises included: 1. medicinal and aromatic plants, 2. legume farming, 3. nut and fruit cultivation, 4. *ringal* agro-forestry, 5. *baree*-traditional food processing, 6. cold water fisheries, 7. vegetable cultivation in polyhouses, 8. distillation of essential oils and 9. community eco-tourism. They were assessed for their banking viability with the help

of lead bank officers and the National Bank for Agriculture and Rural Development (Hoon and Rawat 1995).

It is of special interest that developing *ringal* agro-forestry and medicinal plant cultivation as employment-creating enterprises were proposed by the Bhotiyas (main herb collectors) and basket weavers (*ringal* users) of Pithoragarh. Both communities were feeling the pressure on the wild resources available in forests and felt the need to produce stocks of raw material by cultivation to ensure continued availability. Some of them have started experiments on an ad hoc basis themselves.

3.0 Eco-technology for Sustainable Development

Recent history has shown that rural poverty can be eliminated by raising sustainable production. This can be done by focusing on diversified commodity production, exploiting local resources of comparative advantage and by disseminating highly efficient and environment-friendly agricultural, silvicultural and industrial technologies.

The importance of environmentally sound technologies has been given an important focus in Agenda 21 of UNCED, which argues that the scientific community is now confronted by a twofold responsibility: first, to search and develop new science and technologies appropriate for rural people to raise their productivity; and second, to diffuse and propagate scientific and technological knowledge, thus fostering and training environment-friendly entrepreneurship among rural people, particularly young men and women.

The reality is that survival and development come first. Environment, education, family planning and so forth, however important, all depend on the two prerequisites. It is not realistic to expect people struggling to survive to be concerned about future generations and about conserving nature for sustainable development.

Eco-technology offers specific technological interventions for sustainable development. It implies the blending of traditional wisdom and technologies, which are the products of the ecological prudence of the past, with frontier technologies such as biotechnology, information technology, renewable energy technology, new materials or space technology (Swaminathan 1993). *Ecotechnology is not merely a*

technology, but also defines the process of strengthening the codes of practices and guidelines within the framework of sustainable development (MSSRF 1996).

Agenda 21 describes environmentally sound technologies. These are not just individual technologies, but total systems which include know-how, procedures, goods and services, equipment and organizational and management procedures. This implies that when discussing transfer of technologies, the human resource development and local capacity building aspects of technological choices should include gender-relevant aspects. Environmentally sound technologies should be compatible with nationally determined socio-economic, cultural and environmental priorities.

For a technology to be classified as an eco-technology, the technology has to be environmentally friendly, scale neutral and gender neutral.

The range of potential environmentally sound technologies can include agricultural and forest-related technologies if the following guidelines are taken into consideration:

1. Agricultural and plantation development should take into account the particular ecological and social conditions of mountain environments which often make use of lowland-oriented techniques undesirable and in particular, work against the successful methods based on continued heavy imports of energy and materials.
2. The cultural practices for species selected for cultivation should be adapted to local environmental conditions.
3. A thorough knowledge of traditional farming systems could form the basis for more modern agro-forestry systems.
4. Particular attention should be given to the development of alternative technologies for mountain farms, which will make the best possible use of locally available resources (such as water, solar and wind power, and organic wastes) both for energy and material needs.
5. The range of critical issues include questions related to the nature of developing country technology needs, the generation of more appropriate technologies to meet those needs, the expertise needed to ensure effective transfer, and the factors affecting adoption, assimilation, and adaptation of imported technology.

At the M.S. Swaminathan Research Foundation, a participatory approach with rural communities is suggested for transforming eco-technologies from a unique to a universal status. A genuine participatory method involves the following:

Step 1: Undertake a bench mark survey of current technologies used in a village, applying a participatory rural appraisal methodology. Be careful to assess whether the technologies in vogue are gender neutral.

Step 2: Identify areas where technologies currently in use have ecological and employment advantages. Help to improve them further so that both men and women can use them comfortably.

Step 3: Identify areas where either the direct introduction and/or blending of existing technologies with appropriate bio-information: space, renewable energy, and management technologies will help lead to eco-friendly and economically desirable technologies. The aim of the technology should be the promotion of a job-led economic growth strategy characterized by economic viability, environmental sustainability, gender and social equity.

Tables 1 and 2 provide a framework and methodology for technology selection (Hoon and Rawat 1995). Conscious compromises will be necessary if livelihood security and food security are the immediate needs: promulgating ecological sustainability will be fruitless. Yet if a high value is not placed on ecological sustainability, the long-term impact on livelihood security and food security will be disastrous.

It can be seen that it should be possible to develop and introduce technology and management systems which will enable rural communities, particularly women, to derive full benefit from technological progress.

4.0 Women and Eco-technology

To bring about sustainable mountain development, the immediate need is to work towards making women equal partners in development. Instead of being a silent presence in the rural areas, they should be

Table 1. Illustrative framework for the assessment of environmental soundness for the technology selected

Enterprise Example	Land & Soil Management	Water Management	Plant Protection	Energy Management	Post-harvest Technology
Medicinal & aromatic plants	Terracing, contour ploughing	Pot watering poly-lined tank	IPM strategies	Composting and use of farmyard manure	Drying, grading, packaging,
Ringal agro-forestry	Terracing, contour ploughing	Hand watering and percolation tanks	IPM strategies	Mulching & composting, superior planting material	Drying, storage, transport

IPM = Integrated Pest Management

Table 2. Illustrative methodology for the assessment of environmentally sound technology*

Technology Options	Economic Efficiency	Ecological Sustainability	Social Equity
Chemical fertilizer/pesticide	8	1	8
Soil & water management	8	10	8
Biotechnology for adapting plants to a specific location	8	10	6
Tissue culture	8	10	6
Gathering planting material from the wild for cultivation	8	9	8
Gathering raw material from the wild	8	2	8

* On a 1 (low)-10 (high) scale

involved in the process of policy making. Participatory research therefore needs to take into account existing workloads of women, time budgets, priorities, facilities like day care for children etc. To use women efficiently, the work timings need to be flexible and as far as possible, the work place should also be easily accessible. In this way, the productivity of women can increase.

The factory approach to employing women needs to be re-evaluated. Participatory research has shown that other things being equal, women in rural areas prefer to work at home where they can keep an eye on their children and take care of domestic chores. A women's co-operative system of marketing and collection will ensure that the goods produced by these women are sold and an equitable income is received. Income generation activities like weaving, poultry raising; hybridization of plants; gardening; bamboo, rattan and medicinal plants activities/processing are some of the technologies that can help the economic advancement of women.

Financial institutions should recognize the need to provide credit facilities and thus encourage those projects which will build a stronger path to the economic advancement of women.

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Research and Development Opportunities on Bamboo, Rattan and Medicinal Plants in the Himalayas

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1.0 Introduction

Mountain ranges tend to show great human cultural diversity, especially of tribal farmers and pastoralists. Probably far more than the lowlands, which for millennia have been transformed by humans, mountains provide many opportunities for jointly conserving human diversity and natural resource diversity. Apart from the fact that one tenth of humanity lives in mountains, another two billion people live downstream from them and rely on them for supplies of water, trees, grasslands and minerals (UNCED 1992). Over 150 million people live in the wider Himalayan region and over 400 million people are interdependent downstream.

Conservation of biological and human resources requires that attention be paid to patterns of resource extraction and to the availability of land, which in turn is related to control of public resources and to land ownership and rights. The biological ecosystems are widely considered to be "fragile". Hence, sustainable mountain development requires management of fragile ecosystems and alternative strategies for resource use: most of these will need R and D.

There have been major debates in recent years on how to characterize and delimit mountain areas in terms of physical and environmental characteristics. There are two reasons for this: first,

their ecological complexity, in terms of slopes and niches, results in a very wide range of microenvironments, and this poses problems in developing sustainable development strategies; second, the natural mountain environment has led to the people being considered "marginal" in terms of economics, politics and cultures. Poverty is indeed widespread and is exacerbated by attempts for cultural assimilation (Byers and Sainju 1994).

Bamboo, rattan, and medicinal plants are, to a large degree, associated with forest vegetation. In the mountain areas, deforestation is a serious threat because it involves degradation of fragile forest ecosystems, conversion of forest lands to other uses with deterioration of quantity and productivity of remaining forests, and depletion of biological resources. Deforestation not only affects the local environment, but affects soil erosion and flooding in areas of lowlands. At the local level, it disrupts livelihood systems of production which may on the one hand be highly productive and sustainable, but on the other could well be less productive and less sustainable. Almost certainly, these types of changes mean that beneficiaries of the new system are rarely those people who were sustained by the more traditional livelihood systems which have been replaced.

It is important therefore to focus on the availability of supplies of forest products for local people; and these are inevitably reduced by deforestation. Such supplies include firewood, materials for construction, medicinal plants, fibres, fodder and food in some cases. Diminution in supply has serious impact on the poorer people of local communities. And exactly the same impact results from land alienation, population growth at the local level, or immigration. The ecological and social impacts of deforestation cannot be separated (Barraclough and Ghimire 1995).

In addition, conservation efforts to maintain the biodiversity essential to continuing supply and use of bamboo, rattan and medicinal plant resources, the research to enhance and sustain their utilization has to go hand-in-hand with the prime goal of improving the livelihoods of the rural poor. This could result in greater self-sufficiency in producing the forest products and is a basic tenet of social and farm forestry as currently promoted by international agencies. Nonetheless, it can never be successful if based solely on a technical basis; it is overwhelmingly a socio-economic, policy and political issue.

No local society is identical to another and all societies are changing especially in the mountain zones. Our obligation is to try to see that plant resources are maintained at levels which will assure maximum net flow of benefits to current societies and to their successive ones in the future. Since social systems imply networks of social relations, there are conflicting goals of the different stakeholders. Thus, development of broad strategies which are socially and ecologically sustainable may be utopian as stressed by Barraclough and Ghimire (1995). We expect to hear far more about these problems as the NGOs involved with mountain development take the next steps forward on Agenda 21 and as government discussions review national programmes on integrated conservation and development in mountain areas and feed these discussions into a global conference on sustainable mountain development in 1997 (ICIMOD 1994).

2.0 Defining the Research Agenda

In order to develop a framework for a research agenda on bamboo, rattan, and medicinal plants, it would be logical to build on existing case studies. However, there is a lack of synthesis of those case studies which exist for mountain areas and there are far too many exhortations on what is "good" because it is traditional. It is necessary to sharply focus any research agenda onto viable development interventions rather than research because it is viable scientifically.

There are five basic issues relevant to developing R & D strategies and each is discussed below:

2.1 Understanding the Resource Base

The information on species used is widely scattered in the literature and almost certainly we need a synthesis. This meeting can provide much useful information on which this can be built and it is clear that there is a need to focus on a limited number of species. People become unduly worried by setting priorities - but this is needed because many people who sustain livelihoods through primary processing of non-timber forest products (NTFPs) may do so due to lack of alternatives and preferences, not out of choice. Choice of species for harvesting by local people relies frequently on overall

availability and general properties rather than on quality characteristics, and peoples' decisions on what to harvest are linked to their subsistence requirements rather than to any scientific consideration of species. This pattern is complicated by illicit entrepreneurs making money by wholesale extraction and by great diversity in degree of interest in the plants by different ethnic groups in the same area.

Species are often used in a multipurpose way, and the value of any one species differs from any other. Take, for example, two mountain bamboos of the genus *Thamnocalamus*. *T. aristatus* grows on moist slopes and in ravines under broken forest cover in NE India and Nepal, at elevations of 3000-3600 m. The culms are used for pipes and young shoots are eaten by shepherds. *T. spathiflorus* of NW India grows gregariously as a common undergrowth in evergreen coniferous forest and the culms are used for pipes and also for baskets and mats. There is a pattern of traditional transport of the second species to the plains and it would therefore seem to rate a higher priority for attention than the forest species.

Compare other bamboos used for mats and baskets and also fodder in the cool temperate areas as undergrowth in forests and in patches in a wide range of ecologies. These include *Yushania jaursariensis* and *Himalayacalamus falconeri*. The former is becoming rare, the latter not. We need to know why and which should be promoted.

Clearly those species which are primitively cultivated, or known to be protected by local people in some way are considered by them to be more valuable than others. Data exist, but are scattered. Some are concise as in the case of rattans in Yunnan, China (Shanyang *et al.* 1993). Data tend to be clearer for medicinal plants than for bamboos and rattans. But we have to recognize that harvesting from the wild is largely done by people from the economically less-favoured section of the population, without any training or sure scientific basis; demand driving the extraction. Hence local and other markets far away are a determinant in setting priorities.

In all cases, indigenous plant resources may be substituted by those from elsewhere. Both India and China, with vast markets for medicinal plants and their products, have introduced species to replace certain local ones when the product is in great demand. Similarly, it would not be sensible to develop a bamboo or rattan species locally

in the mountains if the markets for its products were elsewhere and if the species could be cultivated better in areas nearer the markets; and this is certainly the case for numerous species with a wide ecological amplitude and distribution.

Species with very narrow ecologies would rate lower priority for development than species with wider amplitudes. If the ecology is understood in relation to the two key features of mountains (slope and altitude), then broad adaptability is needed because potential climate change, especially threatens mountain ecosystems. A 2°C increase in annual temperature would cause most ecosystems of the Tibetan uplands to disappear (Zhang Xinshi 1993). The result of warming would be plant migration upwards by anything up to 300-500 m in a short time of maybe less than 2 decades (Peters and Lovejoy 1992). This timeframe would coincide with projects to expand the use of priority species and hence the priorities have to be not only acceptable, but broadly correct scientifically.

2.2. Conserving the Resource Base

There is virtually no long-term conservation experience dealing with medicinal plants nor bamboos and rattans in protected areas. Hence, rather than experience, modern established principles of protected area management are needed (McNeely and Thorsell 1991).

With the wide diversity in the species in which we are interested, protected area conservation is obviously very important. Historically, creation of reserves and their management deprived marginal people of sources of livelihood and generated antagonism. Many changes have occurred in recent years in defining multiple-use objectives although many forest authorities still act in disregard of local community use. Local participation in management is becoming recognized and needs to be built into national development policies. This is a huge problem beyond the scope of this meeting. Nevertheless, we have to recognize that however inadequate the protection of ecosystems, this will be the only major way to conserve the species and their genetic diversity, except in a very few cases. Almost certainly it will be the only way to conserve the endemics properly.

There are some relevant case studies which integrate conservation and development. Noteworthy are the Hill Area Development

Foundation in Chiang Rai province of Thailand which develops community forests; the Bauda Bahunipati Family Welfare Project in E. Nepal with effective plant nurseries; and the Annapurna project in C. Nepal. The latter area includes 60% of the medicinal plants of Nepal, has a population of 116,000 of 14 ethnic groups and covers over 750,000 hectares of land. The people are largely subsistence farmers and depend on depleted NTFPs (Biodiversity Support Program 1992), but the project aims at a comprehensive sustainable resource development plan. Whether it will be valid as the population grows at about 3% per annum remains to be seen.

The basic principles have been discussed with special reference to the Hindu Kush-Himalayan region (McNeely and Thorsell 1985) and the strategies broadly outlined (Dhar 1993).

2.3 Develop Appropriate Technologies

The major technology needed is the cultivation of priority species as the only major alternative to harvesting plants from the wild. It is an integral tenet of farm and social forestry where the least controversial aspect is the biological and agronomic/silvicultural practices. Essentially, the basic principle is to identify useful species suitable for a range of soils and ecologies, develop suitable propagating systems and cultivate the plants in suitable systems. Much of this is low-key research based on traditional resource management practices and local knowledge (Ramakrishnan *et al.* 1992).

The more controversial aspects relate to socio-economic implications, understanding beneficiaries' goals and constraints and the policy and institutional background. Institutional backgrounds can affect, for instance, the sustained supplies of planting materials, an essential component of cultivation system. Similarly, a favourable policy environment with government support can help greatly (Singh and Ghosh 1993).

The two aspects-scientific and socio-economic policy–cannot be separated because market surveys of products are needed in relation to supply systems, and establishing supply systems without due attention to marketing, storing and grading infrastructure could be worthless.

The added advantage of cultivation is that it provides much better opportunities for selection and genetic enhancement. To a degree

this is happening when medicinal plants are cultivated (Xu *et al.* 1985) Cultivation can readily reduce unwanted heterogeneity and provide better and more controllable harvesting and better quality products. Cultivation can readily be adapted to improve quality and quantity through specific agronomic treatments allowing better control of the cost of products than in the case of wild-collected material where availability; quality and yield are unpredictable (Bonati 1991).

Cultivation brings in another aspect of conservation-that is the purposive genetic conservation of a range of germplasm stocks. At present we have little information on which to develop programmes, although evaluation of botanic garden collections, if they are fairly comprehensive is a first step. Specific *ex situ* conservation measures might also be needed for any priority species which are thinly scattered over large areas and where the reserve concept is inadequate to ensure survival.

Well-designed cultivation systems coupled with adequate processing, distribution and sales lend themselves to commercialization and development opportunities will have to take into account the viability of strategic micro-enterprises.

2.4 Local Infrastructural Aspects

If the research results are aimed to have impact on low-income communities, then the framework for the research has to involve such vulnerable groups. This is true whether research focuses on developing more sustainable harvesting of wild plants, or management of anthropogenic natural stands or on cultivation systems.

Any strategy for sustainable harvesting needs to incorporate ways of controlling over-exploitation and permitting exploitation sufficient to meet needs. A community approach is valid and McNeely and Thorsell discussed 6 points with reference to harvesting medicinal plants. They are:

1) Introduce a territorial element so that harvesting relates to a specific community
2) Harvesting rights need to be related to resident households and their descendants
3) Those with harvesting rights should appoint a management committee

4) The committee should agree quotas, payments to hire labour if needed and devise a fair system of labour inputs
5) Quotas need agreement with the relevant area authority
6) Records should be kept including marketing of cash products.

Many communities have local rules which control communal resources. These should form the basis of the infrastructure. Some financial support is likely to be necessary. Experience has shown that collective community action, in concert rather than in conflict with government, really only is effective when the groups link to an industrial-based national system. Many tribal groups are members of pre-industrial societies and the development of an appropriate infrastructure is not easy.

Collective well-being is only likely to be assured when micro-enterprises are expanded. Although such enterprises are increasingly dependent upon non-local markets, they help people to avoid having to seek alternative livelihoods locally and short-term profits at the expense of long-term sustainability of the resource base. Market relations are integral to considerations of infrastructure. This is vividly illustrated by a refreshing analysis presented at this meeting by C.S. Olsen (see page 189). Such analysis permits the definition of valid development interventions as well as providing clear assessments of policy (see below).

R & D on this topic requires cognizance of the various state programmes of community empowerment, technical assistance, establishment of nurseries and credit systems. Each country has differing experiences and degrees of success.

2.5 Socio-economic and Policy Research

Production, consumption, storage, processing and distribution are key processes which characterize NTFP resource dynamics and are reflected as key social and economic indicators of development. Policies are also relevant e.g., governments used to realize a royalty on marketable quantity of NTFPs rather than on harvested quantity.

Where markets are far away, profit margins can be eroded by such royalties. Margins can vary from 30-50% depending on the degree of evasion.

Cultivation of resources in an area directly affects the local communities. For instance state lands for community use are ideal for cultivation of bamboos and medicinal plants, maybe cultivation of medicinal plants would be better than the others on forest land managed by villages. Even better for the community would be use of degraded community lands especially for demonstrations (Rao and Saxena 1994).

Land tenure affects who will benefit from managing resources on a sustainable basis. There are an infinite number of land tenure systems and rights which in turn regulate relations between individuals, families, social groups and castes, communities, and the government. There are major policy issues, especially in relation to the usual assumption that forestry is an inferior land-use compared to agriculture and in relation to the rights of people whatever the ownership system.

When INBAR was formalized in the early 1990s, the over-riding need for socio-economic research was central to its current and future operations. Most investment decisions for development are made by economists with little regard for either biological diversity or cultural diversity. Few comprehensive socio-economic studies (including gender issues) exist for mountain peoples and NTFP systems. Targeted studies will, of course, show a wide range of site-specific systems. Nonetheless, few international agencies or development banks address these, although, one co-sponsor of INBAR, IFAD, does indeed focus in Asia on poverty alleviation in mountain areas. Focused research on socio-economics would help other agencies in their priority interventions.

There are therefore two needs in this area: 1) synthesis and comparisons of existing studies; and 2) new strategically targeted studies.

3.0 Other Considerations Relevant to R&D

This brief review has looked at principles and resultant practices which might shape a research agenda. However, there are numerous other factors which are basic to development interventions and options. Five may be itemized:

1. Research on plants usually has a time frame way beyond anything considered by government agencies or donors for funding. However well-planned the research may be, if it is likely to occupy

a time frame of 10-20 years, it may not attract support. Hence, strategic sub-projects of shorter duration are advisable.

2. Quality of data is essential to good research planning. There is a great need to upgrade this, especially in ethnobotanical research and in socio-economic research.
3. Regional market analysis is poorly understood. We need a handle on the regional/subregional use of NTFPs based on official statistics and educated guesses on illicit trade. Only then can the magnitude and importance of the sector be made clear to government. The number of studies such as that of Edwards (1996) – but limited to Nepal – are few.
4. A series of proforma for decision making would help researchers in various countries and diverse institutions. These are obviously needed for prioritizing plant species, for conservation, and for identification of physiographic/agroecological zones for priority attention.
5. No one organization can cope with all the tasks needed to develop a comprehensive research agenda, monitor the research and act as a facilitator. Essential is the buy-in to a strategic programme by national programmes, but more essential will be some innovative networking to act as the major catalyst in partnership with a whole range of institutions, agencies and governments.

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Sustainable Management of Non-timber Forest Products (NTFPs) in Ecological and Economic Rehabilitation of the Himalayas

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1.0 Introduction

The Himalayas are the repositories of rich natural resources and a heritage for humankind. Their dazzling crowns, resplendent verdant slopes, enchanting dales and foot plains have sustained and inspired some of the world's ancient civilizations and cultures. The mountains extending from the Pamirs knot in N.W. Pakistan as an unbroken chain of mountain-wall of about 2,500 km length, smoothly curving towards the east to form the northern borders of India, Nepal, Bhutan and again India with the northern slopes of its inner ranges over a larger run being situated in Tibet, China are traditionally known as the Himalayas.

The Himalayas are one of the most recent mountain formations of the world and much of the geological material was derived from the north continent called "Angara Land". The outer and middle Himalayas have mostly sedimentary rocks and are therefore, in the geological sense, unstable and also in the active earthquake zone. The Shiwaliks or sub-Himalayas are constituted of loose boulders and conglomerates and are highly fragile. However, small parts in the inner Himalayas have ancient rocks like granite and gneiss.

Another geological feature of the Himalayas, of botanical interest, is the dip formation towards northeast and north. This gives rise to two distinct habitat types. The south and southwest faces have huge escarpments and north and north eastern gentler dip slopes. The direction of the monsoon winds influence the precipitation received by the northern and southern faces or aspects and the climate. Similarly, the eastern and western Himalayas differ climatically. The differentiation is also marked by the latitude and attitudinal changes which are abrupt over short distances.

The glaciation of the past has also influenced the geology and soil features of the Himalayas: there are rounded mountain tops, U-shaped deep valleys, lake deposits, side by side with unglaciated V shaped valleys formed by streams and flood deposits. Coupled with the climatic and geological features and to an extent human action, the Himalayan flora has tended to be extremely diverse and interesting, differing from east to west and between adjacent valleys, forming a wide range of ecosystems. The evolutionary history is about 65 million years old.

2.0 Natural Forest Resources of the Indian Sub-continent Himalayas

The Himalayas comprise a wide variety of resources of great significance, particularly the green renewable resources which ecologically and economically sustain the region's population. The Himalayas overlap four countries in the Indian sub-continent: India, Nepal, Bhutan and Pakistan. All possess rich biodiversity.

2.1 India

According to the 1993 assessment by the Forest Survey of India, the forest cover in the country was 640,107 km^2, of which 145,077 km^2 (i.e. 22.7% of the total forest cover) was in the Indian Himalayas.

The main forests occurring in the western and central divisions of Indian Himalaya are Sal forests (dominated by *Shorea robusta*), Khair-Shisham forests (dominated by *Acacia catechu* and *Dalbergia sissoo*) and Chir pine forests (dominated by *Pinus roxburghii*) in the sub-montane or sub-tropical region; Oak forests (dominated by *Quercus*

spp.), High level coniferous forests (dominated by *Cedrus deodara, Pinus wallichiana, Abies pindrow* and *Picea smithiana* at different elevations); and Mixed broad-leaved forests (consisting of *Aesculus indica, Juglans regia, Rhododendron* spp etc.) in temperate region; Alder forests (dominated by *Alnus nitida*), Birch forests (dominated by *Betula*) and Moist alpine scrub forests in the alpine region; and Neoza pine forests (dominated by *Pinus gerardiana*), Dry juniper scrub (dominated by Junipers) and Dry alpine scrub forests in the trans-Himalaya region. The main forests in the eastern Himalaya of India are Sal forests, Kayea and *Mesua* forests and Semi-evergreen forests in the sub-montane region; Oak forests (dominated by *Quercus lamellosa, Q. fenestrata, Q. lauginosa,* etc.) and Fir forests (dominated by *Abies delavayi* and *A. densa*) in the temperate region; and Sub-alpine forests, Moist alpine scrubs and Dry alpine scrubs in the alpine region.

2.2 Nepal

About 800 km long from west to east and about 200 km wide, Nepal has a geographical area of 147, 480 km^2. More than 85% comprises rugged hills and mountains, including eight highest mountain peaks in the world. On the south lies, a narrow belt (20 to 45 km wide) of almost level land known as Terai which is geographically an extension of the vast gangetic plain bordering the mountains. The human population of Nepal, estimated in 1988, was 17.1 million and the livestock 21.39 million (Malhotra 1984).

The forest cover in Nepal has been recorded as 62,210 km^2 (i.e. 42.2%) which is composed of 55,120 of forested lands and plantations and 7,090 of shrublands and degraded forests. The extent of forests occupying various physiographic zones are: 2,200 km^2 or 3.5% of the forest area in the Trans-Himalaya; 18,150 km^2 or 29.2% in the Main Himalaya; 22,140 km^2 or 35.6% in the Lower Himalaya, 14,690 km^2 or 23.6% in the Shiwaliks and 5,030 km^2 or 8.1% in the Terai. The forests of Nepal represent a transition zone between the western and eastern Himalayan forests.

Some of the main forests of Nepal are Sal forests, Khair-Sisham forests, Terminalia forests (dominated by terminalias), Chir pine forests and Semi-evergreen forests in the sub-montane or sub-tropical region;

Oak forests, Fir and Spruce forests in the temperature region; and Alder forests, *Populus* forests, *Hippophae* scrub, Moist alpine scrub and Dry alpine scrub in the alpine region.

2.3 Bhutan

Bhutan is a mountainous country with elevation varying from 300 m to 7,550 m. Its land area is 45,600 km^2 and has a population of 1.2 million (1986 estimate) making it the most sparsely populated country in South Asia. The total forest area of the country is 28,399 km^2 which is 70.6% of the total land area. In relation to population, the per capita forest area is 2.37 ha in Bhutan as compared to 0.36 ha in Nepal, and for Indian Himalayas: 0.84 ha in Sikkim, 0.51 ha in Himanchal Pradesh, 0.36 ha in Jammu & Kashmir and 0.05 ha in Garhwal/Kumaon.

The important forest types and their principal species in Bhutan are Sub-tropical forests (*Shorea robusta, Gmelina arborea, Bombax ceiba*); Chir pine forests (*Pinus roxburghii, Ficus oligodon*); Evergreen oak forests (*Quercus lamellosa, Juglans regia, Castanopsis hystrix*); Blue pine forests (*Pinus wallichiana, Rhododendron arboreum, Zanthoxylum armatum*); Spruce forests (*Picea spinulosa, Larix griffithiana*); Hemlock forests (*Abies densa, Tsuga domasa, Betula utilis, Juniperous pseudosabina*); and Dry alpine scrub (*Primula calderiana*).

2.4 Pakistan

A small fragment of Pakistan falls in the Himalayas (less than 2% total land area of the country). However, this mountainous region is rich in green natural resources. Nearly 10% of the total forest area in Pakistan lies in this region.

The recorded forest area in two mountain districts of Swat and Dir is 3,830 km^2 or 27.2% of the land area of the two districts and about 9.3% of the total forest area of Pakistan. These areas are arid and trees exist only on the edges of human habitation and on high and inaccessible slopes.

3.0 Non-timber Forest Resources of the Himalayas

NTFP resources of the Himalaya are described under two aspects:

3.1 Economics

NTFPs consist of goods of biological origin other than wood and could be used for food, income, farm inputs, fodder as well as to meet social, cultural and religious functions (Anonymous 1995). In the Himalayas, many plant species yield valuable NTFPs and their economic returns often exceed the value of timber in many localities. Sadly, systematic studies are lacking. In West Bengal, the NTFP production per ha, on an average, values Rs.2,720 (about US$ 80) per year (Malhotra *et al.* 1991) contributing about 17% of the annual household incomes to rural folks, significantly more than contributed by wood.

It has been estimated that in India over 50% of forest revenue and 70% of earnings from export of forest products is contributed by NTFPs, most of which is in the form of unprocessed raw materials (Campbell 1996). In India, forest-based cottage industries, many of them based on NTFPs, provide up to 50% incomes for 20-30% rural labour force which excludes NTFP collecting, processing, use and trade (Campbell 1988).

The use of medicinal plants and their formulations in the Himalayan region for curing ailments is age-old. In Nepal only, over 85% of the population still relies on them (Dani 1996). Numerous reports enlist use of plant species and their formulations for curing human and cattle ailments and also as prophylactics against insect pests for stored grains and agricultural commodities (Jain 1996). Many plant species distributed wide apart have been reported for use to cure similar ailments in different localities. Saklani and Jain (1996) reported 13 species common to northeastern Himalaya and Western Himalaya used for curing the same or similar ailments-diseases. The use of some medicinal plants and their formulations has, however, remained localized. The Naga sub-tribes of India, are believed to be knowledgeable on about 150-200 medicinal plants, but zealously guard the information, rarely passing it to others. The belief is that if the details are divulged to others, the efficacy of the medicine would be lost (Rao 1996). Only a few of these plants have been screened for their active constituents. In the Western Himalaya, out of 3,000 plant species, 300 are known for their medicinal value; in Nepal, about 700 species are reported to be of medicinal value.

Himalaya is also rich in wild edible plants, in upland Nepal about 400 wild plant species are used as food (Manandhar 1986; Regmi 1982). A large number of mountain people draw a significant proportion of their food requirements from wild trees, shrubs, herbs and fungi. In fact, many plant species used as regular or distress food in the inner or remote parts of the Himalayas are not yet documented and need immediate attention. Some of these plants could be alternative sources of nutritive food in the near future. Depending upon the plant, fruits, seeds, leaves, flowers, rhizomes and roots are consumed by the people in the different regions. Such exotic foods can also be pickled, made into jams and jellies, and used as preserves and spices for flavouring. Walnuts, wild apricots, chilgoza pine, *Punica granatum* (anardana), edible bamboos and mushrooms are some of the high value plants/products eaten by local people and also traded profitably in the market.

Animal husbandry is an important vocation profession in the entire Himalayan belt. The cattle population in many areas exceeds that of humans and mostly depends on natural forests for fodder and grazing. This dependence on natural forests significantly increases in lean periods when animal fodder is rarely available from the agricultural fields.

There are 21.39 million cattle in Nepal (Malhotra 1984) of which nearly 14 million animals graze in the forests and pastures (Pudasaini 1992) and 35% of the animal feed is derived from the forests (Bhattarai 1984). In the entire Himalayan belt of Pakistan, India, Nepal and Bhutan, the population of nomadic and migratory grazing is sizeable. Gurjjars and Bakrawalas of Kashmir; Gaddies, Kinnauras and Lahaulies of Himanchal Pradesh, Bhotias and Khadwals of Uttar Pradesh are known to rear large herds of animals and seasonally migrate between the higher mountain pastures and foothills in search of nutritious grasses for their animals.

Resin extracted from pine trees occurring in the lower Himalayan belts in Pakistan, India, Nepal, Bhutan and China, is another important NTFP. China and India are the major resin producers in the region. Resin tapping, collection, transportation and processing is labour intensive and contributes significantly towards rural economy and employment. In Himachal Pradesh, a small Himalayan State in India, a revenue of about Rs.100 million (about US$ 3.1 million) is earned by

farmers from tapping of chirpine trees growing on their farm lands (Dhiman and Joshi 1994) and the resin industry provides gainful employment to thousands of workers almost throughout the year. According to one estimate, the activity has a potential of absorbing 18 million person days by the year 2000 in India alone (Singh and Asokan 1994). Additionally, chirpine supports horticultural production in the State by providing needles for moulding, and poaching, branches for staking vegetable cross and bark for firing teracotta articles.

Katha is extracted from khair trees (*Acacia catechu*) and is an important forest-based industry in the Shiwalik region of Himalaya. In Himachal Pradesh, farmers earn about Rs.150 million as revenue from the sale of trees for katha extraction (Dhiman 1996). An expenditure of about Rs.40 million is incurred for felling the khair trees, their conversion, uprooting, transportation, slicing and chipping of heartwood, providing substantial employment to rural populations. The growing realization on the adverse effects of chemical dyes, gums, perfumes, etc. on human/animal health will restore the importance of the natural products, which chemicals replaced not too long ago, and open up new markets for their natural substitutes.

3.2 Ecology

The Himalayan forests have come in for some harsh treatment mainly due to increasing need for fuelwood and grazing lands. Construction of hydel projects, roads, dams and reservoirs, and the necessity to meet the rising demands of wood for various commercial needs of the country have further worsened the situation in the Himalaya. A study indicates that 5 to 12 ha of well-stocked forest are needed per ha of cultivated land to meet the fuel and fodder demand of villages. Against this requirement only 1.66 ha of forest is available per ha of cultivated land in the Uttar Pradesh Himalaya. Many observers have noted that where once there were verdant pine and oak forests, there are now bare hillsides or degraded forests. The situation is similar in other parts of the Himalayas.

The midlands of Nepal, ranging from 1,000 to 3,000 m, are densely populated and suffer from a great deal of ecological degradation. The environmental rehabilitation of this region warrants special attention.

Pakistan's Moorre hills and the catchments of Mangla and Tarbela

dams have suffered heavy deforestation in the recent past. The environment and conditions in Pakistan's Himalayan region being drier and harsher, degradation is faster than most of the other Himalayan regions.

Environmental degradation in Bhutan has been minimal compared to India and other Himalayan regions. However, it must be noted that Himalayan ecology in Bhutan is extremely vulnerable to natural and human-induced changes. Since the 1960s, far reaching changes have been set in motion due to developmental activities which have prompted population growth and redistribution of land use, substantial areas being thus lost to farming and other uses. The development programmes copted from the West have imperilled not only the forests and NTFPs, but the basic resources themselves: soil and water upon which depends all production. Unless greater consideration is given to conservation and sustainable use of natural resources, the future of the mountains will not remain secure.

The landscape of the moist tropical zones in the eastern Himalayas, which in the not long past was once resplendent with a verdant coat of priceless natural vegetation, today lies bereft of its cover by the relentless assaults of shifting cultivation, thus reducing availability of NTFPs and other forest resources. The land areas stressed beyond the recuperative capabilities of nature are ever on the increase.

The Himalayan ecosystem, with increasing biotic interference inflicted thereon, is rapidly changing, resulting in the decline of species' habitats and diversity. The poverty of the mountain people coupled with the loss of indigenous knowledge, will accelerate the pace of environmental degradation; unless immediate attention is paid to the socio-economic upliftment of the hill folks being based on ecologically sound principles. Economic development programmes in the hills should endeavour to provide incentives to farmers and local users to undertake and assist in conservation and regenerative measures of NTFP resources.

NTFPs based forestry development projects have an immense potential for the upliftment of rural economy. The sector holds a distinct advantage over others because of low investment required for creation of jobs; it is more benign to nature than agricultural operations and suited for backward regions; it can provide employment to villagers

at or closer to home; it does not require very high skills and presents a wide spectrum of job requirements particularly suited to women. NTFP development in the mountains can therefore open up new vistas of employment to a large unemployed labour force in the Himalayan region which has to seasonally migrate away from home to seek a livelihood. Gunnar Myradal in his work 'Asian Drama' considers the large volume of unutilized labour as a "productive potential capable of creating capital and increasing production, thereby making possible higher levels of consumption - in short, a potential that can be used to eliminate poverty". Maybe, his dream could come true by encouraging the propagation, production and processing of NTFPs. The old concepts, theories and developmental orthodoxies on social, cultural and religious values are rapidly on the way out due to their inability to guide an orderly and balanced development. Yet, economic and material parameters cannot be the sole guide for development; it must encompass the larger issues of environment and cultural variables. The new development, therefore, must be made sustainable and enduring, and thus calls for new approaches, policies and practices.

Heavy grazing of forests and pasture lands in the mountains have also reduced their productivity and biodiversity. Nepal alone is estimated to lose 240 million m^3 of soil annually as a result of grazing and other land abuse (WHO 1993). A wise management of the grazing can increase meat and milk production without jeopardizing the forests/ pastures and many NTFPs. Introduction of nutritive fodder and grass species in the villages and on barren mountain slopes could remarkably increase returns from animal husbandry and contribute in the protection of NTFPs.

The rich natural heritage of the Himalayas is presently facing a grave threat of extinction because of unmindful plunder and smuggling by a network of legal and illegal traders. According to a survey out of 80,738 tonnes of medicinal plants imported by western countries, India topped the list of exporters with a share of 10,555 tons. In Nepal, about 50 species collected from natural forests are exported annually (Manandhar 1980). As per an IUCN report, these medicinal plants are exported to Europe and America, where in recent decades plant-based drugs have gained popular acceptance. Consequently, a host of medicinal plants are being threatened while many have already

been wiped off the face of earth. Rules and laws governing the collecting of medicinal plants from the wild are inadequate and difficult to enforce thereby rendering rare plants susceptible to the greed of unscrupulous traders.

Mishmi tita (*Coptis teeta*), a plant found in Eastern Himalaya, and used to control fever by tribals has in recent times been exploited indiscriminately for export to Japan and Switzerland bringing only petty income to the tribal collectors, while traders earn huge sums for a kilogram of the material. Himalayan yew (*Taxus baccata*) which yields 'Taxol', a curative for some types of cancers, has also become a victim of this greed; trees being stripped of their leaves and bark without compunction. Himalayan May Apple (*Podophyllum hexandrum*), an ally of American May Apple (*P. peltatum*), is also eagerly collected, probably providing raw material for a 'superstar' drug used in treatment of testicular cancer. Agarwood (*Aquallaria agallocha*), raw material for Agar oil, was until recently, plentiful in the forests of N.E. States of India, but the axe of illegal traders has made it rare in the whole region except Arunachal Pradesh. Indian ginseng (*Panax pseudo-ginseng*), a rare medicinal plant with a commercial potential, has been recklessly hunted to drive it to the verge of extinction. Chirayata (*Swertia chirata*), Ashok (*Saraca indica*) and many other plants have met the same fate.

The World Conservation Monitoring Centre, UK has issued warnings to enforce strict conservation measures for the protection of this dwindling heritage. The medicinal plants of the Himalayas used in Indian and Tibetan medicine systems are the centre of interest of the whole world today. They must be conserved and sustainably managed to provide a regular flow of income to the mountain people. In this direction, the Indian Ministry of Environment and Forests, and Convention on International Trade on Endangered species of Flora and Fauna (CITES) have identified threatened species needing immediate measures for conservation. Some of the medicinal plants worth mentioning in this category are; Himalayan spikenard (*Nardostachys grandiflora*), Mishmi Tita (*Coptis teeta*), Kuru (*Picrorhiza kurrooa*), Indian Aconite (*Aconitum* spp.), Hirantuliya (*Colchicum luteum*), Indian Gentian (*Gentiana* spp.), Kashmal (*Berberis lycium*) and Kuth (*Saussurea costus*). To date, three Biosphere Reserves and

one National Park have been set up in the Indian Himalaya to preserve the habitats of rare and endangered species of flora and fauna.

4.0 Conclusion

Wood is better recognized as a forest product, contributing to the economy, even though NTFPs have no less a role in the well-being and prosperity of the common people, perhaps also providing raw materials for luxury products of commerce. The better known among the NTFPs of socio-economic importance are fodder, bamboos, gums, resin, leaves, oils and fruits. Their contribution to the economy is largely unquantified as more than 60% of such production is locally consumed. The harvesting and utilization of non-timber produce is an individual enterprise for meeting day-to-day needs while some high value items like medicinal herbs and other natural produce are bartered or sold by villagers in small to medium quantities to village shopkeepers (who prefer not to reveal the quantities collected, for various reasons). The subject of quantification of such produce has failed to attract the attention it deserves, relegating the scientific management of these valuable resources to an insignificant place. The non-timber products have an edge over wood products in being able to contribute more towards investments in the forestry sector because of shorter gestation periods and production cycles. Though NTFPs are not harvested on commercial scales yet the increasing number of individual collectors has led to their over-exploitation.

The loss of resource base due to over-use and the consequent threat to many rare species is a cause for concern and calls for immediate rehabilitation measures. The new environmental consciousness has prompted a growing demand for utility products based on natural raw materials. The adverse effects of modern medicines and cosmetics based on toxic chemicals have forced big pharmaceutical concerns to substitute some with more benign raw materials such as natural herbs. Popularization of herbal products and the growing market for them nationally and internationally open up new hopes for the mountain people, but also threaten further the existence of many rare plant species. The old medicinal systems of the Orient are witnessing a renaissance. The growing demand for herbal medicinal products has the potential to generate large scale rural employment for the poor by

their collection, cultivation and processing, simultaneously providing industrial opportunities in the production of value-added products from NTFPs.

The forest policies of Himalayan countries incorporate as a basic objective the conservation of the natural heritage by preserving natural forests along with their biological diversity and genetic resources. The policy also directs protection and enhanced production of minor forest produce (which provides sustenance to tribal populations and other communities residing in and around forests) and aims at conservation and management of forest resources and increasing productivity of all forest produce by application of modern scientific and technological methods and survey of resources for scientific management. NTFPs were previously not considered important and efforts towards survey, documentation, distribution and quantification were insignificant. A step towards saving the natural genetic material base endowed to us would be the creation of Biosphere Reserves in the various ecological regions of the country.

The documenting and identifying of useful NTFPs and their conservation *in situ* and *ex situ* is a major task for researchers. The *ex situ* conservation calls for research not only on cultivation and cultural practices of identified plants but also detailed studies on growth cycles, flowering and seed peculiarities, quantification of active ingredients, to ascertain the best provenances, and plant improvement. Some useful plants with an enlarging demand will need standardization of cultural practices for commercial cultivation and knowledge extended to tribals and rural poor for adoption in the region. The potential contribution of non-timber forest resources to the economy of the Himalayan States, and in particular to that of poor people associated with forests, is immense. Only systematic research can translate this potential into reality.

The Himalayas are highly fragile hill ecosystems and excessive disturbances can cause irreparable damage to their health and ecology. Increased human and cattle populations resulted in extended settlements and cultivation on steep slopes. Forest management interventions in hills, to date, has concentrated on management and utilization of major forest produce mainly timber. Much higher economic returns from NTFPs are possible if an integrated approach can be adopted.

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Mountain Bamboos and Rattans: Their Genetic Resources and Conservation

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1.0 Introduction

Bamboo and rattan are common, useful, tropical plants. Bamboos are woody grasses with the stems used for many purposes and the young shoots of many species edible. Rattans are climbing palms, less common than bamboos, but the stems are most useful in the furniture industry and other household uses. The traditional uses of both plants have become part of Asian culture. Bamboos worldwide are classified into 75 genera and 1,250 species; while rattans have 13 genera and 600 species.

For practical and focused research promotion, the long lists of useful bamboo and rattan species were shortened to include a limited member of species selected on a priority basis (Williams and Ramanatha Rao 1994). Many of the mountain bamboos and rattans are within the priority lists. Apart from improved cultivation, production gains can be improved by focusing attention on the genetic potential of species. However, it is realized that existing knowledge is very limited on patterns of variations of the bamboo and rattan species. Detailed correlations are lacking between the growth of the species and the geography, climate, soil, latitude, altitude and other environmental conditions. Nevertheless, what limited ecological information is available for the priority bamboo and rattan species has been enumerated in-

cluding soil type, soil fertility, drainage, rainfall, number of rainy days per year, and other details (Rao 1994). The idea of exploring and understanding of bamboo and rattan in mountainous regions was started at that time. Upon further scrutiny, it was realized that species of bamboo and rattan growing at high altitudes have not only their own ecological niches, but also provide a wide variety of natural resources that are used by the people of mountainous countries. Resources are fast disappearing and natural regeneration of bamboo and rattan is a relatively slow process at high altitudes. In addition to UK-ODA's work on bamboos of Nepal and Bhutan, hardly any attempts have been made to identify and develop high altitude bamboo and rattan. Both for ecological and socioeconomic reasons, the relevant species of mountainous regions should be conserved and used on a sustainable basis, and these were the main objectives of this international meeting.

2.0 Perspective of Mountain Regions

The Himalayan mountain region extends from Afghanistan in the west to Myanmar in the east, a distance of 3,500 km, and about 300 km wide from north to south with a total land area of 591,000 km^2. The region includes eight countries: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. Average rainfall is 1800 to 2100 mm with seasonal monsoon climate. Bamboo and rattan are present in all the countries except Afghanistan and only very few bamboos in Pakistan. About 120 million people live in this region (ICIMOD 1995; 1996). The situation in Nepal and Bhutan is described below, a situation comparable in mountainous regions of other countries in this Himalayan zone.

Nepal has a total land area of 147,181 km^2 supporting monsoon subtropical forests in the south and deciduous and coniferous temperate forests extending to arctic conditions in the north. Many different forest types and eleven ecological regions are recognized based on bio-climatic conditions; thus demonstrating the extreme ecological variations of mountainous regions. In all, there are 5,400 species of vascular plants with 245 endemics and 700 species of medicinal plants. Valley vegetation is rich with undisturbed forests. Firewood is the primary energy source in the rural households which explains defor-

estation of easily accessible areas. Overgrazing has destroyed many valuable plant species, degrading the ecosystems along with many other operations including shifting cultivation. It is said that during the last two decades, more than half a million ha of forests have been destroyed in Nepal. Eleven bamboo genera with twenty nine species are recorded with five genera having a single species (Stapleton 1994b). Regarding rattan, 5 species of *Calamus* have been recorded with four species identified and one unidentified (*Pers. comm.* Chowdhary 1995).

Bhutan, a land-locked mountainous country has a land area of 46,500 km^2. Subtropical and temperate forests occupy 64% of the land area. More than 10,000 specimens are registered in a database. Volumes 1 and 2 of Flora of Bhutan are published (Grierson and Long 1983). About 2.6 million ha are covered by nine national parks and protected areas. Twenty nine species of bamboo belonging to 14 genera have been recorded with 8 genera having a single species (Stapleton 1994a). About twenty species of rattan are said to be present (Biswas and Dayal 1995).

Similar details need to be enumerated for other countries in the Himalayan region.

Almost 90% of the world human population lives in lowlands occupying 75% of earth's land surface while the remaining 10% of the people live in highlands that occupy 25% of the total land area. Slope and altitude variations are the main features that distinguish the mountainous countries. People settle down in valleys and in places with less slope. Mountain farming and terrace cultivation are common agricultural practices in mountainous countries. Removal of covering vegetation and ground cover on the slopes increases soil erosion and landslides.

The fragile nature of mountain ecosystems and saving the biodiversity has received great attention of many world bodies. Many suggestions are offered to improve the conditions from time to time (Rao and Saxena 1994). The traditional systematic inventories to survey biodiversity require trained human resources, capital investment and proper plans of work. Lack of adequate knowledge about tropical ecosystems are legion and to date only 5% of the biodiversity of the rain forests is known to science–including the main bamboo and rattan growing areas (McNeely *et al.* 1990; Hamilton 1992). To solve

some of these problems, easy and quick methods to measure biodiversity are needed (di Castri *et al.* 1992; Pei and Sajire 1995). Such methods may tentatively be adopted for preliminary data collection on bamboo and rattan growing in very remote and unexplored areas.

The northeastern part of the Himalayas is a border zone to which Southeast Asian plant species extend, including some of the bamboo and rattan species. More than 50% of the 125 recorded bamboo species are present in N.E. India with a high degree of endemism and population density per given land area (Tewari 1992; Kochar *et al.* 1992; Thomas *et al.* 1985). More studies are required to determine the actual number of species involved and floristic survey in this area is far from complete (Haridasan and Rao 1985). Nearly 30% of the flora in this region is endemic and conservation of the resources is important for sustainable development.

Many definitions are given for sustainable development, but in most of them the conservation aspect is not included. For example, "sustainable development is a process that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNCED). The conservation aspects should be explicitly included in all the definitions of sustainable development. Without the conservation of representative genetic diversity of valuable species, there can be no meaningful development.

3.0 Environmental Degradation

Environmental degradation is a common phenomenon in mountainous regions. The hill slopes are cleared and terraces are built as land for agriculture. Opening up exposed slopes leads to the washing away of soil. The incessant actions caused by rain, storms, lightning, earthquakes, mining, overgrazing, burning of vegetation and other operations greatly contribute to soil erosion and environmental degradation. In Royal Chitwan National Park of Nepal, the Rapti river washed away 100 ha of agricultural land on the north bank after monsoon rains. The south bank, part of the national park, remained intact since it was covered with natural vegetation binding the soil (Roberts and Johnson 1985). Six billion tons of soil are washed away from the Himalayan region each year.

Cultivation of bamboos on the exposed degraded slopes can help to abate many human-made disasters. The availability of bamboo and rattan resources has to be critically assessed against a background of the fragility of mountain slopes and the loss of biodiversity. Hardy bamboo species growing naturally in such areas or ones cultivated for a long time should be properly conserved and perpetuated.

4.0 Bamboos

There are no studies done to understand population structure, variations within populations, or intraspecific variations of bamboo, whether cultivated or not.

4.1 Mountain Bamboo Species

In a recently published monograph on bamboo, 23 genera and 112 species are described (Tewari 1992). Of these 12 genera and 29 species are mountain bamboos growing at 1,000-3,600 m. Six species grow at very high altitudes namely, *Arundinaria maling* (1,600-2,800 m), *A. racemosa* (2,000-3,700 m), *Himalayacalamus falconeri* (Syn. *A. falconeri*) (1,800-2,400 m). *Chimonobambusa griffithiana* (Syn. *A. griffithiana*) (2,400-3,000 m), *Semiarundinaria pantlingii* (Syn. *A. pantlingii*) (2,400-3,000 m) and lastly, *Thamnocalamus aristatus* (Syn. *A. aristatus*) (3,000-3,600 m). These bamboos are used for many purposes by local people; for construction, food, fodder, thatching, handicrafts and other domestic purposes. Their usefulness is very much appreciated by the people who live at such high altitudes. In addition to the above mountain species, many of the other better known species common in lowlands are also cultivated up to about 1,000 m. These include *Bambusa bambos, B. striata, Dendrocalamus brandisii, D. strictus* and *Drepanostachyum khasianum.* In most cases, the sources of the original material planted or the genetic history of the plants is unknown, and many of the species were introduced for cultivation 100-200 years ago. About 18 bamboo species of Southeast Asia grow at high altitudes and many of them are large, especially the species of *Gigantochloa* (Dransfield and Widjaja 1995). In all, 74 species are listed and differences in the height of certain species are obvious, perhaps due to atitudinal variations (Table 1).

Table 1: Mountain Bamboos in South and Southeast Asian Countries

	Species	Height (m) x diameter (cm)	Altitude (m)	Uses
1	*Ampelocalamus patellaris**	12 x 5	1,200	Weaving, baskets
2	*Arundinaria microphylla*	1.2 x 3	Subalpine zone	Fodder
3	*A. racemosa*	2-4 x1-5	2,900-3,600	Mats, roofing, fodder, garden support, arrows
4	*Bambusa bambos**	30x18	1,200	Most useful multipurpose bamboo, medicinal
5	*B. balcooa*	25 x16	Up to 1,600	Weaving, slope stabilization
6	*B. clavata*	18 x 9	1,600	Edible shoots, fodder, weaving
7	*B. longispiclata* (reed)	15 x10	Up to 1,500	Biomass, general use
8	*B. multiplex**	7-10 x 2.5-4	1,500-2,000	General use, paper pulp.
9	*B. nepalensis*	20 x 10	1,500	Edible shoots, construction weaving
10	*B. nutans**	15-23 x10	Up to 1,500	Construction, paper industry, general use
11	*B. pallida*	20 x8	Up to 2,000	Household articles
12	*B. striata**	8 x 8	1,000	General use
13	*B. tulda**	15-23 x 7-10	1,200-1,500	Edible shoots, fodder, construction furniture
14	*B. vulgaris**	20 x10	1,200	Most useful bamboo, paper, furniture, edible shoots
15	*Borinda grossa*	10x4.5	3,200	Weaving, general use

* cultivated

16	*B. chigar*	10 x4.5	3,200	Wildlife protection, general use
17	*B. emeryii*	10 x4.5	3,200	Weaving, general use
18	*Cephalostachyum latifolium*	15 x 5	2,000	Fodder, weaving
19	*Chimonobambusa callosa*	6 x4	2,000	General use
20	*C. jaunsarenisis* (reed)	12 x8	3,000	Mats and baskets
21	*Dendrocalamus asper**	30 x 36	1,500	Edible shoots, building materials, for bridges
22	*D. brandisii**	30-33 x20	1,300	Building, furniture, household articles, edible shoots
23	*D. calostachys**	25 x10	1,000	Building and domestic use
24	*D. giganteus**	30 x 25-30	1,000-1,200	Construction, fodder, edible shoots
25	*D. hamiltonii**	30 x5	1,200	Edible shoots, fodder, weaving
26	*D. hookeri*	25 x 13	2,000	Construction, weaving, bitter shoots
27	*D. latiflorus**	25 x 20	1,000	Edible shoots, handicrafts
28	*D. membranaceus*	24 x10	1,000	Building, furniture, handicrafts
29	*D. pendulous*	30 x 12	1,000	Baskets, handicrafts
30	*D. sbnii*	3 x 3	1,800	General use
31	*D. strictus**	6-20 x 3-1215	1,000-1,200	Most important bamboo, many uses
32	*Drepanostachyum annulatum**	5 x 3	2,200	Fodder, basket making, soil stablization
33	*D. falcatum**	4 x 2	2,200	Fodder, basket making, soil stablization
34	*D. intermedium**	4 x 2	2,200	Fodder, weaving, soil stabilizer

* cultivated

35	*D. khasianum**	4 x 1.3	1,800	Construction and other uses
36	*D. khasianum**	5 x 1	2,000	Fodder, weaving, soil stabilizer
37	*Gigantochloa albociliata**	16 x 7	1,300	Edible shoots, household thatching
38	*G. apus**	30 x 13	1,500	Edible shoots, construction, musical instruments
39	*G. atter**	25 x 10	1,400	Building, edible shoots, household articles
40	*G. hasskarliana**	10 x 6	1,500	Prevents soil erosion, basketry, general use
41	*G. ligulata*	15 x 8	1,500	Construction, furniture, edible shoots, paper pulp
42	*Gigantochloa manggong*	15 x 7	1,500	Edible shoots, construction, household articles
43	*G. nigrocilata*	20 x 6	1,400	Edible shoots, household articles
44	*G. pseudoarundinacea**	30 x 13	1,200	Building, furniture, household articles
45	*G. robusta*	20 x 9	1,500	Construction, handicraft, edible shoots
46	*G. scortechinii**	20 x 20	1,000	Construction, basket, paper, household articles
47	*Himalayacalamus asper*	8 x 3	2,300	Weaving, general use
48	*H. brevinodus**	9 x 3	2,200	Edible shoots, fodder
49	*H. cupreus**	9 x 3	2,800	Edible shoots, many uses
50	*H. falconeri*	8 x3	2,500	Weaving, edible shoots
51	*H. fimbriatus**	8 x 3	1,800	Weaving, fodder
52	*H. hookerianus**	7 x 3	2,500	Weaving, fodder, basket making

* cultivated

53	*H. porcatus**	6 x 3	2,300	General but limited use
54	*Indocalamus wightianus*	3 x 1-2	1,800	Mats, baskets and fences
55	*Melocanna baccifera*	22 x 8	1,400	Construction, mats, many uses
56	*Neomicrocalamus andropogonifolius*	Not stated	1,800	Weaving, mats, baskets
57	*Ochlandra setigera (reed)*	6 x 2	1,000	Paper making, general use
58	*O. travancorica*	6 x 2	1,000	Paper making, general use
59	*Phyllostachys aurea**	12 x 9	2,000	Edible shoots, furniture, handicraft
60	*Pseudoxytenanthera bourdillonii*	4 x 3	1,500	Handicrafts
61	*P. monadelpha*	3.5 x 2.5	1,850	Fencing, thatching, basket making
62	*Pseudostachyum polymorphum*	16 x 3	1,200	Weaving, roofing, panelling, fencing
63	*Schizostachyum beddomei*	6 x 4	1,500	Mats, baskets, handicrafts
64	*S. grande*	21 x 12	1,000	Edible shoots, household articles
65	*S. latifolium**	6 x 2.5	1,000	Baskets, mats, household articles
66	*S. lumampao**	15 x 8	1,500	Handicraft, construction, paper pulp
67	*Sinarundinaria longispiculata*	6 x 2	1,300	General use
68	*Teinostachyum dullooa*	10 x 4	1,500	Weaving, general use
69	*Thamnocalamus spathiflorus*	5 x 2	3,500	Fodder, general use,wild life

* cultivated

70	*Yushania hirsuta*	8 x 2	3,800	Fodder, fencing, general use
71	*Y. maling*	3 x 2	3,000	Fencing, walling, general use
72	*Y. microphylla*	3 x 2	3,500	Fodder, wild life, general use
73	*Y. pantlingii*	8 x 2	2,600	Biomass, general use

Source: Tewari, 1992; Stapleton, 1994a, 1994b; and Dransfield and Widjaja, 1995

Distribution: (refer table for explanation of numbers)

Bhutan 6, 15, 32, 56, 68, 70

Nepal 8, 9, 16, 31, 33, 47, 48, 49, 51, 53

Bhutan and Nepal 1, 3, 5, 7, 10, 13, 17, 18, 24, 25, 26, 30, 34, 36, 50, 52, 55, 62, 69, 71, 72, 73

India 2, 3, 4, 8, 10, 11, 12, 13, 14, 20, 21, 22, 23, 24, 31, 35, 54, 57, 58, 60, 61, 63, 67

Southeast Asia 4, 27, 28, 29, 37-46, 64-66.

Both Bhutan and Nepal are mountainous countries. There is a total of 15 genera and 40 species of bamboos recorded for these two countries (Stapleton 1994a). Twelve and eleven species, exclusively from Nepal and Bhutan respectively and 27 species that are common to both countries. *Arundinaria racemosa, Borinda grossa, B. chigor, B. eucoryii, Thamnocalamus spathiflorus, Yushania hirsuta, Y. maling* and *Y. microphylla,* grow at altitudes of 3,200-3,800 m. Some of them are temperate and subalpine extending to the cold climate areas of Tibet. These bamboos are used for a variety of purposes, including food, fodder, etc. Because of high altitude and the other environmental conditions, certain species remain dwarf, reaching 3-4 m in height and others grow up to 10-15 m.

Mountain bamboos play a very significant role in soil conservation and stabilization of slopes. The surface roots which are relatively short grow to form dense clumps which hold the soil together, preventing surface erosion. Variability in forms of rhizome and root

systems of different species and their relative roles in soil conservation need to be properly analyzed.

5.0 Rattans

Rattans in Asia are distributed from India to Southern China including all the countries in between. The majority of rattan species occur in Malaysia. Some species are also common in the lower Himalayas including countries like Nepal, Bhutan and the Yunnan province of China. The mountainous species have evolved over a long period of time and form a special group. Basic biological details are limited for most of these species.

Most knowledge exists for species of lowland tropical forests (Kong and Manokaran 1986). No physiological or ecological experimental studies have been done so far on any rattan species. Only recently, a few experimental studies were conducted on topics relevant to establishing nursery practices (Wan Razali *et al.* 1992). From reviewing the published literature, a list of rattan species growing at altitudes of more than 1,000 m is shown in Table 2.

The list includes 12 species of *Calamus*, 2 each of *Daemonorops* and *Plectocomia* and one species of *Korthalsia*. *Calamus gibbsianus*, a mountain species grows at an altitude of 1,400-3,000 m, in Mount

Table 2: Rattan species growing at high altitudes

Species	Cane diameter with sheath (cm)	Altitude (m)	Countries/Places
Calamus			
acanthospathus	5.0	2000	N.E. India, Bhutan
gamblei	1.5	2000	S. India, endemic
gibbsianus	3.0	3000	Mt. Kinabalu, Sabah
guruba	2.5	3100	Assam, Meghalaya, Manipur, Thailand
gracilis	2.0	1500	N.E. India, Bangladesh
javensis	1.0	2000	Sumatra, Palawan

latifolius	3.0	1000	N.E. India, Bangladesh
manan	11.0	1000	Malasia, Sumatra, Kalimantan
merrillii	7.0	1200	Philippines
ornatus	4.0	1000	Sumatra, Philippines
ovoideus	8.0	1500	Sri Lanka
pseudotenuis	2.5	3100	S. India, Sri Lanka
simplicifolius	5.0	1100	S. China and Hainan
Daemonorops			
jenkinsiana	4.0	1000	E. Himalaya
margaritae	3.0	1000	S. China
Korthalsia			
laciniosa	4.0	1100	Peninsular Malaya
Plectocomia			
assamica	3.0	2000	Assam, Arunachal (endemic)
khasiana		1200	Khasia hills
3 genera, 17 species			

Source: Basu 1992; Dransfield and Manokaran 1993.

Kinabalu, Sabah (Dransfield 1984). Leaf characters; vary, thin and delicate leaves at lower altitudes and very thick leaflets at higher altitudes. *C. guruba* extends up to 3,100 m, but no comparison is made between lowland and highland forms. *Calamus javensis* is said to have 8 varieties and the plants of these species grow up to 2,000 m, but no distinguishing characters are recorded for different varieties. Since many of the species grow from sea level to high altitudes, there should be some diagnostic features to recognize the attitudinal variations in plants of various species. Obviously, the whole group needs a critical study to recognize the ecotypes and their varieties at different altitudes.

Some interesting details are recorded with regard to trees that support the climbing rattans in India. Most of them are tall timber tree

species of *Dipterocarpus, Ardisia, Shorea, Calophyllum, Pterocarpus, Garcinia, Amoora, Hopea, Mesua* and others. Other lianas and climbing bamboos compete with rattans to reach the tree canopy. Rattans in such conditions easily attain a height of 100 m or more. Some differences exist in different areas with regard to the species of supporting trees. Cases have been recorded in which rattans fail to compete with aggressive climbing bamboos (Basu 1992). The above details are very important and interesting since very little is known about the eco-sociology of rattans. Loss of natural rattan populations has reached critical levels in the mountainous countries. It is imperative that problems connected with mountainous species of rattans are critically examined and steps are taken soon to remedy the situation on a priority basis. Enrichment of rattan resources will help to improve the income and quality of life of the rural people and *ex situ* conservation of the disappearing germplasm is equally urgent.

6.0 Importance of Taxonomy and Ecology

Bamboo and rattan taxonomists in the tropics are few. They also need modern interdisciplinary training. It is very difficult to find such persons since most present day researchers tend to specialize in a narrow area. The modern taxonomist should be well-versed with population genetics and biotechnological methods like isozyme analysis, DNA finger printing and others. Another reason that has hindered research on bamboo and rattan is the inaccessibility of the material. In addition, very little information is available on heritabilities of characters, genotype and environment relationships; also, genetic relationships between species and variants are unknown.

Two patterns of reproduction are common among ecotypes: 1) Each ecotype is well adapted to the environment in which it is growing and reproduces well with other ecotypes in the same vicinity and community. 2) Ecotypes of a population may have similar morphological characters, but may remain infertile without hybridizing with others. Both ecological and physiological barriers intervene with reproduction. The former group is fertile and the latter is partly fertile with infrequent reproduction. Such general patterns of variation in reproduction are common among both bamboo and rattan species, but the details of

phenology and reproduction are yet to be investigated and properly understood.

Such research is urgently needed on major economic species of lowland forests as well as for mountainous species. Without such research, selection of types with desirable characters will be hit or miss. Some of the ecotypes identified from various geographical locations certainly would reveal a spectrum of variation. Similarly, the indigenous knowledge and the details on species cultivated by rural people for a long time should be properly enumerated and compared *vis a vis* the scientific details. Inadequacy in indigenous capabilities in biosystematics is well known and to remedy the situation, certain capacity-building programmes in the regions are needed (Jones 1995).

Plants of the same species that grow in different environments and altitudes display variable characters. The approach taken by Clausen would be useful for bamboos and rattans (Clausen *et al.* 1960; Clausen 1950).

Cytological studies are very few in both the groups of plants and not more than 5-10% of species have been investigated to determine the basic chromosome numbers. The majority of bamboo species so far studied are polyploids which is said to facilitate further specialization. Species evolution through polyploidy is said to give rise to many unique forms that are said to be very stable (Devi and Sharma 1993). Some of the tentative hybrids developed in China also support the above inference (Zhang 1987; Zhang and Chen 1987).

7.0 Tapping the Resources

Whether they are bamboos or rattans, only a small portion of the species resources are so far are used systematically. While certain species are exploited, threatened or almost on the verge of extinction, others have not even been investigated to determine their distribution, uses and commercial potentials. Those species in danger should be conserved on a priority basis following both *in situ* and *ex situ* methods. The scientific literature needs more focus for this to be feasible.

In this respect, there is an interesting case study. Revenue villages in Kaptok development block in India, very close to the north eastern Nepal border, were selected to determine cultivation and us-

age of four mountain bamboos growing at varying altitudes of 800-4000 m. Two of them are of the genus *Chimonobambusa* and two are of *Thamnocalamus*. The common and botanical names, their attitudinal zones, culm characters, durability, preferred uses, leaf, inflorescence and culm sheath characters are recorded. Uses for human purposes and use as fodder have to be balanced. The study shows that one species, especially at the highest altitude, is decreasing and that some selection is now needed to promote sustained use and conservation. It is very necessary to study such details for other mountainous species to conserve the indigenous gene pools and propagate them widely on a sustainable basis for the benefit of the people who live in such mountainous regions (Rao and Saxena 1994).

8.0 Conclusion

The scientific work in progress is inadequate to save the biodiversity of bamboo and rattan in mountain regions. Many improvements must be made. These groups of plants should be studied well to understand their distribution, quantity and quality of plants available, selection of superior plants and to establish proper methods of conservation. Great challenges lie ahead to select and save germplasm of good quality bamboo and rattan. More research input is necessary and many of the modern methods have to be adopted for mass production of good quality plants to increase production and economic value. With such inputs, chances are good that higher altitude bamboo and rattan will be saved and be used on a sustainable basis.

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Country Reports

Priority Bamboo Research for Denuded Hills of Bangladesh and Other High Rainfall Zones of South Asia

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1.0 Introduction

In general bamboos are the fastest growing plants occurring naturally in all the inhabited continents except Europe. They are very unevenly distributed in the tropics, subtropics, and mild temperate regions of the world. Besides the latitudinal distribution, the vertical distribution of bamboos on the land is also remarkable. *Arundinaria racemosa* grows up in the mountains to 4000 m in the sub-alpine zone of the Himalayas in Sikkim and Bhutan, and some species of Arundinaria such as *A. aristata, A. falconeri and A. hirsuta* reach to 3000 m elevation in the high mountains (Gamble 1896; Varmash and Bahadur 1980). It is reported that genera Fargesia, Indocalamus and Leptocanna occur in the warm-temperate and subtropical zones at 2000-3000 m in the Yunnan and the southern region of Quambo in the Tibet plateau (Watanabe 1987). Occasionally, in a specific locality some small-sized or dwarf bamboos form dominant bamboo forests. Some examples are *Bashania fargesii* in the mountains of the northeastern Sichuan basin in China, *Oreocalamus ulitilis* in the highlands of eastern districts in Sichuan provinces of China, and *Yushania nittakayamensis* in high mountains in China-Taiwan and Luzon Island of Philippines (Watanabe 1987). There are uplands in South and Southeast Asia with particular bamboos e.g. the highlands such as Mt. Kinabulu (Malaysia) at 1500 - 3000 m in Borneo are the growing zone of climbing bamboos like

Racemobambos gibbsiae; another bamboo at elevations of 2,300 m in Sri Lanka is *Chimonobambusa densiflora* (Syn. *Arundinaria densiflora*).

Other than indigenous bamboos, localized in distribution in uplands, some bamboo species form pure bamboo forests such as *Thyrsostachys siamensis* in western Thailand. Sometimes, it forms a large community as a dominant species and covers 850,000 ha of land along with other bamboo species (Watanabe 1987). Another upland species, *Melocanna baccifera* is another gregarious bamboo extensively distributed in the north eastern hilly forest parts of India (Assam, Arunachal, Meghalaya, Tripura, Nagaland, Manipur, Mizoram); Chittagong Hill Tracts and Sylhet of Bangladesh and Arakan hills of Myanmar. It occurs in continuous or pure patches as well as mixed vegetation covering a large tract of land. The species is also cultivated in south-eastern Tarai of Nepal, probably introduced from the then East Bengal (now Bangladesh).

It is believed that the natural home of *M. baccifera* is Chittagong Hill Tracts of Bangladesh where it grows gregariously covering large tracts of land (Prasad 1948; McClure 1966). This species constitutes 70-90 percent of the total bamboo forest of Bangladesh and forms both pure and scattered bamboo vegetation extending over 70,000 ha of pure vegetation in the hill forests. This species in the hilly forests of N.E. India constitutes about 80% of the total bamboo forest of Assam, Meghalaya and Manipur.

This paper summarizes research on *Melocanna*, largely carried out in Bangladesh, since the species is clearly of value for more scientific exploitation, especially on denuded hill areas.

2.0 Biological Attributes of *Melocanna baccifera*

In most of the tropical bamboo species, the rhizomes are more or less densely clustered together, and the culms arise in clumps or tufts, producing the caespitose type of bamboo. But *M. baccifera* is very different from other clump-forming bamboos. In this species, the culms are erect and arise singly at a varied distance (0.5-2.5m) from a common creeping rhizome system. However, the young clumps (usually up to 2-4 years of age) are usually densely caespitose at first, becoming more open at the periphery as they develop. So a mature, well-developed clump is diagnostically open and diffuse.

The subterranean part of the plant possesses a pachymorph diffuse rhizome system. Individual culms in a clump connect with each other at the base through short, thick rhizomes and elongated rhizome necks. The neck is slender and elongated. In a well-developed clump, the length of a rhizome neck varies from 1-2.5 m. Watanable (1986) termed this form of rhizome system as *woody-pachymorph-diffuse* type. The rhizome structure of *M. baccifera* is unique. Some of the structural and growth characteristics are compared with more 'typical' clumping species in Table 1.

Table 1. Comparison of rhizomes of *Melocanna baccifera* and *Bambusa/ Dendrocalamus*.

Melocanna baccifera	*Bambusa/Dendrocalamus*
1. The rhizome is pachymorph and diffused. It has elongated internodes and an apex that continues to grow vertically to become the culm.	1. The rhizome is pachymorph and sympodial; has short internodes and an apex that grows vertically to become the culm.
2. Rhizome neck is up to 2.5 m.	2. Rhizome neck is very short, 3 to 10 cm.
3. Rhizome necks form net-like structures below the ground.	3. No large net-like structure is formed.
4. Development of daughter rhizome starts forming the newly emerging (2-3 weeks old) culm.	4. Development of daughter neck rhizome starts from the fully elongated (9-12 months old) culm.
5. Each clump covers large land area.	5. Each clum covers only small area.

Thus, the rhizome system of *Melocanna* has structural advantages for invading deforested hills. The long rhizome necks have the ability to spread and quickly cover vacant space by producing culms within a short period, provided the plant is not heavily disturbed. In the forest, it is impossible to demarcate the boundary of a clump as the rhizomes of many different clumps intermingle with each other forming an underground network.

All the natural areas of *M. baccifera* forest have high annual rainfall (3,000 to 6,350 mm) with a long dry season each year, November

March. They are all extremely vulnerable to soil erosion. However, this species of bamboo acts to stabilize the soil (Banik 1989).

It is observed from a case study (Banik 1988) that in *M. baccifera* the average production of full grown (FG) culms was 2.5 in the first year and from the third year the number increases rapidly to 12.5. Culm production rapidly increases in subsequent years reaching 35.7 after the tenth year. Unlike other clump forming bamboos, *M. baccifera* produces culms at varying intervals in all directions, forming a diffuse and open clump which accommodates the increased number of FG culm production in subsequent years. Due to this, both the rate and the pattern of clump expansion in *M. baccifera* are very rapid. The rate and pattern of clump expansion in *M. baccifera* are more or less the same as *Bambusa* species for 4-5 years of clump age. After that period, clump expansion in *M. baccifera* increases rapidly every year and continues even up to the 10th year. This ability of rapid expansion permits the species to invade and cover exposed deforested hills in a short time.

It appears from research (Banik 1991) that the movement and elongation of the rhizome neck of *M. baccifera* proceeds throughout the year irrespective of seasonal variation. However, the rhizome neck elongation is slow when the mother culm exhibits growth and produces branches and leaves. But when (August to November and March to May) the culm exhibits little growth, rhizome neck elongation is either normal or rapid (1-2 cm per day). The buds on the basal part of the culms under the ground start enlarging from the end of autumn and grow into rhizomes in the spring. One of the rhizomes protrudes out of the soil and develops into a culm, during May to November, while the remaining rhizomes cease to grow. In contrast, most of the tropical clump-forming bamboo species exhibit seasonal growth of rhizomes only in the spring.

The seeds of *M. baccifera* are green and fleshy, unlike the seeds of other bamboo species, where seeds are usually small and grain-like, *Melocanna* seeds are dispersed far away from the mother clumps by rolling over the hill slopes. Thus, the seeds and seedlings of the species are dispersed widely and can cover a large tract of land (Troup 1921).

The species thrives equally well on moist sandy and clay loams, alluvial soils, well-drained residual soils, sandy rough slopes and even

to the summits of low sandstone hills. It grows as undergrowth in high forest as well as practically pure stands after clear felling and burning of natural forests. The species seems to be both partially shade-tolerant and fully light-demanding and is therefore hardy.

3.0 Advantages of *Melocanna* Forests on the Deforested Hills

In the hill forests of Bangladesh, and of eastern India and Myanmar, tribal people have long practised shifting cultivation. Once the hills are deforested, it become difficult to create green cover and, in many cases, man-made plantations fail. *Melocanna baccifera,* with its wide ecological amplitude and the structural advantages of its rhizome system, can quickly invade and cover exposed hilly areas, and thus can conserve the soil and water in catchment areas. As a result, siltation downstream is minimized and flash floods are controlled in the valleys and plains.

It is important to realize that the fire set to burn the debris following the clear felling of high forest, prior to starting plantations, progressively destroys the rhizome systems of bamboo species (*Bambusa tulda, B. polymorpha, Dendrocalamus longispathus, D. hamiltonii, Schizostachyum dullooa, Melocalamus compactiflorus, Oxytenanthera nigrociliata,* etc.) in the hill areas. However, *M. baccifera* can survive (McClure 1996).

4.0 Economic and Socio-economic Importance

Melocanna bamboo plays a significant role in the national economy of Bangladesh and neighbouring countries. Exploitation is summarized below:

A. Raw material for pulp and paper mills, and for rayon mills: About 75 years ago, it was demonstrated that *M. baccifera* has excellent pulping quality (Raitt 1929). The fibre of the species has 2.68 mm length, 14.37 µ diameter, 4.08 µ lumen diameter, and 5.15 µ wall thickness. Bangladesh has a number of pulp and paper mills, of which Karnafuli Paper Mills (KPM) and Sylhet Pulp and Paper Mills (SPPM) mainly depend on bamboo as raw material. The present annual raw material requirement for KPM and SPPM is about 48,000 air dry metric tons (30 million culms), and 45,000 t (26 million culms) respectively. *Melocanna*

baccifera alone meets 70% of the total raw material demand.

For rayon pulp production, about 15 million culms are required annually and this species has been meeting the demand.

B. **Housing and construction**: The lives of different hill tribes in eastern India and Bangladesh are integrated with *Melocanna* bamboo. The species supplies all the roofing and thatching material for constructing houses. Although culms are thin-walled, they are strong and durable, and have the advantage of being straight and having only very slight knots. Other bamboo and tree species are mainly used for construction.

C. **Household**: The culms are extensively used for handicrafts, mats and hats. People of nearby plains also prefer thin *Melocanna* culms for supports for climbing vegetables.

D. **Shoots**: The shoots of *M. baccifera* are a very important vegetable used locally by hill tribes of Bangladesh, eastern India and Myanmar. People of these regions harvest shoots from the forests not only for their home consumption, but also to sell in the local markets for cash income. The use of shoots as food is also an important cultural espect of local hill people.

E. **Containers**: Culm internodes are used as containers for collecting and carrying water and food.

4.1 Employment

It has been estimated that every year about 0.3 million hill people are employed as part-time labourers in harvesting, processing and transporting bamboos from the forests of Bangladesh. *Melocanna* constitutes 90-95% of the total harvest.

5.0 Conclusion

Considering the biological attributes and economic and socio-economic importance, *M. baccifera* has attained the highest priority as a bamboo species in the region. Nonetheless, human encroachment, repeated fire, grazing, exploitation, uncontrolled felling and unscien-

tific management have drastically reduced the *Melocanna* forest areas. Reforestation and sustainable silvicultural operations are needed to green the denuded hills and manage the existing stock.

BFRI has developed appropriate technology (Banik 1994) for seed germination, storage, seedling development and nursery management of *M. baccifera*. A 50 ha of demonstration plantation of the species has been raised in Chittagong forests in association with the Forest Department and an NGO. Necessary training programmes are arranged every year to train private planters, foresters and field level workers of different NGOs. In this regard, a Bangla (local language) bulletin on cultivation and management has been published. It would be helpful if diverse seed sources from India, Bangladesh, Nepal and Myanmar were to be used to assess overall variability and broaden the genetic base in large plantings. With this safeguard, combined with large scale reforestation programmes conducted with hill communities and forest-fringe communities in a participatory system of resource management, employment and income can be more readily generated to meet the needs.

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Integrated Approaches and Existing Policies for Mountain Development in China with Special Reference to Bamboo, Rattan and Medicinal Plants

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1.0 Introduction

China has 6.6 million km² of mountainous land, accounting for 69.13% of its total land area. Excluding Taiwan, China has 1,561 counties located in mountainous areas with a total population of 656 million (56.0% of the total population of the nation). About 542 million rural people live in the mountainous areas, accounting for 59.5% of the total rural population.

Mountainous areas are rich in biological resources. Of the 32,800 plant species and 4,400 animal species known in China, most of them occur in the mountainous areas. About 90% of China's forests (117 million ha) are distributed in the mountainous areas with a total standing timber volume of 8,142 million (80% of the nation's total). The large area of forests provide non-timber products for a wide range of produces such as fruits, tea, plant oils, medicinal herbs, rattan, and others. Besides the biological resources, mountainous areas have rich mineral and hydrological resources.

According to the statistics of 1992, the total GNP of the rural areas of the 1,561 mountainous counties was 1206.16 billion Yuan (47.5% of the national total rural GNP). Of this, 508 billion are from agriculture and 103.18 billion from forestry.

1.1 Economic Characteristics of the Mountainous Areas

The rich natural resources for forestry, animal husbandry and mining are inefficiently used and production is low. The 1992 data showed that only half of the rural income came from agricultural/forest production. Most of the agricultural/forest products have not been commercialized. At the same time, these production activities are threatened from an increasingly degraded natural resources base.

Another feature of the mountainous areas is their under-developed infrastructure and the difficulty of access for education, training, information, marketing and other public services.

The production structure of most of the mountainous areas is not well established. The major indicator is the poor development of the rural industries which process locally produced materials. Most of the products are in the form of raw materials with very low prices in the markets.

In general, most of the people living in mountainous areas are poor and their development is slow. Of China's 80 million people living below the poverty level, 80% are from mountainous areas.

1.2 Governmental Initiatives for Mountain Development

Starting in the early 1980s, China started economic reforms and began opening the door to the outside world. The most successful early reform was agricultural reform in rural areas. A new management system, called the "family contract system" replaced the old collective management system. It became the most successful story in China's economic reforms and further promoted economic reforms in other sectors.

After the success in agriculture, similar approaches were used for forest development. Due to the special characteristics of forest management, failures outnumbered successes. Obviously, the unsuccessful stories in forestry reform became one of the major obstacles to the mountain development.

By the early 1990s, the government pinpointed its target group, the poor people. The central government launched a so-called "8.7 Poverty Alleviation" programme. Through this programme, the government will take action to help the 80 million poor people to uplift their living standard in the last 7 years of the 20th century. Since 80% of the poor live in remote mountainous areas, mountain development became a priority in the government development policy. The Ministry of Forestry became the key governmental agency to implement the mountain development programmes. For this purpose, the Ministry of Forestry launched a National Programme of Integrated Mountain Development (NPIMD).

This paper summarizes the key points of the NPIMD. At the same time, some new ideas for implementing NPIMD from the scientific community will also be mentioned. A case of mountain land management will be given to illustrate the models of natural resources management, followed by a discussion on the role of bamboo, rattan and medicinal plants in mountain development.

2.0 The National Programme of Integrated Mountain Development

The general objective of the programme is to speed up the development of the mountain economy and raise the living standard of the local people. The following describe the programme:

- forests and other mountain resources-the basis of development;
- market-oriented economic system-direction;
- science and technology-backbone;
- high yield, high quality, high efficiency and sustainable forest management system-principal component;
- non-timber forest products-breakthrough;
- forest industry and processing-key for the value-added, and
- adjustment of agricultural and forest production structure-measures

According to the variations in biophysical and socioeconomic conditions, eight development regions are identified with the following characteristics:

2.1 Northeast Development Region:

The region includes 128 mountain counties of the 3 NE provinces and Inner Mongolia Region. The development direction is to establish a NE commercial timber production base and forest industrial base. The development and wider use of wild vegetables, wild fruits, edible fungi, and other green foods and medicinal plants (ginseng in particular) are also listed as key development contents.

2.2 North China Development Region:

A total of 198 mountain counties in N China are in this development region. The direction of development is reforestation of the mountains for erosion control and environmental improvement (especially in Tainhang Mountains), and development of both production and processing of fruits (chestnut, Chinese date, apple, pear, etc.).

2.3 Loess Plateau Development Region:

In the 139 counties in the Loess Plateau, the goals are erosion control and the development of high quality and special fruits and other economic plants.

2.4 Jiangnan (in the south of Yangtze River) Development Region:

This region has 464 mountain counties. The main advantage of the region is good natural conditions suitable for a wide range of forest and economic plant species. It is the major collective forest area of the country. The development direction will be the establishment of fast-growing and high-yielding timber production bases and integrated development of bamboo, tea, orange, mulberry, tea oil and other economic plants.

2.5 Southeast Coastal Development Region:

The 197 counties belong to the tropical and southern subtropical areas. The development direction is to establish bases for the production of industrial raw materials, integrated development of tropical fruits (litchi, longan, cashew etc.) and other economic plants (such as camphor, cinnamon, pepper, etc.). It is also important for this region

to take advantage of its easy access to markets, capital and technology, and to develop bases for export.

2.6 Southwest Development Region:

A total of 323 counties are located in this region. The region is the source for the Yantze and Zhujiang Rivers. It is also the main base of timber production. The development direction must be the combination of production and protection. The integrated development projects may include some traditional products such as industrial raw materials (tung oil tree, lac, etc.) and medicinal plants, as well as some special and valuable timbers and tropical fruits.

2.7 Northwest Development Region:

Twenty six mountain counties are located in arid and semi-arid regions. The main development task is water conservation and other protection functions of forests and to establish bases of fruits and medicinal plants.

2.8 Qinghai-Tibet Plateau Development Region:

The 86 counties in this region belong to the cold uplands. There are a lot of rare wild animal and plant resources. The direction of development is to develop upland medicinal materials and fresh and dry fruits, both associated with efficient conservation of the wild biodiversity. Hence, cultivation and animal husbandry should be major approaches.

2.9 Approaches and Policies

A major approach for the mountain regions is to develop and promote new technologies that are simple and efficient. Identification of key technologies will include:

* Improved planting materials and cultivation techniques for high yields.
* New varieties of valuable and special economic plants and technologies for their conservation, as well as storage and processing.

* Technologies for improving the yield of low yielding tea oil plantations.
* Mass propagation systems.
* Cultivation techniques for fast-growing bamboo plantations.
* Bamboo based artificial board production.
* Water-saving and reforestation in arid and semi-arid areas.
* Wood utilization and chemical processing of forest products.
* Pest and disease control.
* Forest fire management.

New technologies and management models will be tested experimentally and demonstrated in demonstration areas. This will be linked to the capacity building of the local farmers to adopt the new technologies.

3.0 New Approaches for Implementation of Mountain Development Projects

In implementing the NPIMD, a host of research projects are carried out in different fields, from purely technical research to integrated approaches in rural development. Participatory research has become more and more important.

In most cases, a mountain development project needs the participation of local people, grassroots level government officials and scientists. Since there are diverse and varying conditions in mountainous areas, any decision needs in-depth studies of the local conditions. A bottom-up approach is advantageous in reaching the right decisions.

For any natural resources management project, the first, and foremost objective is to provide local people with necessary goods and services for their basic needs. Sustainable development becomes important. As defined by the UN Commission on Environment and Development, sustainable development is "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Capacity building of the participants in a mountain development project must also help the local community to establish necessary institutional mechanisms for sustainable learning and development.

Knowledge is a driving force in development. For better natural resources management, both the knowledge of the natural resource base itself and the knowledge of how to manage the base are important. So we need the indigenous knowledge from both the local people and scientific knowledge through research for a better understanding of people's needs. In this way, better technologies can be developed to solve land use problems. In this respect, the results from on-farm research are more useful than those from on-station research.

4.0 An Example of Integrated Mountain Development

Xinhuang County is located in the west part of Hunan Province. It is a poor county with average annual per capita income of 600 Yuan (about US$85.00). Of the total land area of the county, 66% is forest (100,000 ha). In 1976, the total standing timber volume was 2.03 million m^3. In 1982, forest lands were allocated to individual households for management. By 1986, the new timber market and price policies had caused rapid reduction of timber resources and the total standing timber volume was only 0.93 million m^3.

The mountainous lands are very steep, so it is difficult to reforest them through tree planting. Natural regeneration is therefore the main approach, but this necessitates closing all kinds of human activities to promote natural regeneration. Because the forest lands were divided into small pieces for use by individual households, it is difficult to adopt reforestation through closure. Also, other constraints identified were: gaps in decision-making between farmers and lack of capital and technologies. The farmers needed help from the government, technical extension and the scientific community.

The constraints were overcome by a newly formed management system, called a share-holding collaborative forest farm. Under the supervision of the county forest bureau or township forest station, several farmer households put their forests together and formed shareholding collaborative forest farms. The shares in the farms are:

* Shares of capital investment: 20%, mainly for the expenses of production materials and management.
* Shares of resources: farmers put their forests into the farm and will get profit according to the quality of forests (20-60% of the total profits).

* Shares of labour management. A group of labourers will work on the forest farm and get salaries. The farm profits range from 20%-60% according to the status of the managed forests.

The operation of the shareholding collaborative forest farms are quite similar to the traditional forest farms. The first type of forest farm was established in November 1990, and since then another 35 have been established. These manage 20% of the county's forests. From the operation of this management system, the county accumulated the following experiences:

* Combination of conservation and utilization: the traditional complete closure meant local farmers could not use the forest resources. In the new system, the farm adopts measures to promote the growth of the forests and use the non-timber forest products to support their operation. The government only invests about 15 Yuan/ha/year for management expenses; the other capital comes from the farms' own production of non-timber forest products.
* An economic body rather than an administrative body: The traditional forest farms were established by certain administrative levels of the government, and were difficult to operate because of non-economic interventions from the government. In the shareholding collaborative forest farm, the shareholders of resources can come from different administrative units (even different provinces) thereby avoiding the interventions of non-economic forces.

5.0 Roles of Bamboo, Rattan and Medicinal Plants in Mountain Development

From the above information, it can be seen that the Chinese government is concerned with the role of non-timber forest products in mountain development. Bamboo, rattan and medicinal plants are the major non-timber forest resources in China. In recent national meetings on mountain development, the development of non-timber forest products were identified as the breakthrough in mountain development.

Bamboo and rattan occupy a decisive position in forest resources of China. China has about 500 bamboo species in 40 genera, with a total bamboo area of 7 million ha. Some 3 million ha are natural groves. Bamboo forests in China have a very wide geographic distribution, stretching from Hainan Island in the south to the Yellow River reaches in the north, and from Taiwan Island in the east to Nielama Area of Tibet in the west.

China has 40 rattan species in 3 genera. They are mainly distributed in secondary natural forest of tropical and sub-tropical zones, which are located in the south and southwest. By rough estimates, the area of natural forest with distribution of rattan in China is 0.3 million ha, and the annual output of raw rattan canes is 4,000-5,000 tons (the highest output reached 65,000 tons).

Bamboo, rattan and medicinal plants are all valuable resources for mountain development, because most of these grow in mountain areas. The development of bamboo, rattan and medicinal plants utilization is fast. The utilization of bamboo, for example, has already exceeded traditional use essentially in the sectors of construction, paper-making, light industry, food, furniture, packing, transportation, and gardening. Bamboo is one important raw material for industry and handicrafts in south China.

According to statistics, the output and value of bamboo products in 1992 were as follows: 200,000 tons of machine-made bamboo pulp, with a value of 0.28 billion Yuan, 0.169 billion pieces of bamboo farm tools, the output value of bamboo woven products was 79.3 million Yuan and the output value of bamboo and rattan furniture was 518 million Yuan.

Bamboo, rattan; medicinal plants and other non-timber forest products will play a major role in mountain development. Another advantage is their tremendous potential for promoting natural resources/ biodiversity conservation.

In most cases, the use of non-timber forest products is based on the natural resources base and it is important to avoid degradation or depletion of the resource base. The general principles are that :

* the rates of collection from natural resources do not exceed the rates of regeneration;

* where for some products, the rates of natural regeneration may not meet the needs of development, cultivation or other artificial measures must be undertaken to provide additional materials.

For systems to be sustainable, further research work must be undertaken to overcome problems of natural resources degradation, conservation of biodiversity and efficient use of products.

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Indigenous Management of Bamboo and Rattan Resources in the Chinese Himalayan Mountains

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1.0 Introduction

Although mountains and upland areas comprise about 20% of the world land surface and provide the life support base for 10% of the total human population, access to mountain resources, direct or indirect, is vital for at least half of all humankind. The Hindu Kush-Himalaya (HKH) as the largest mountain system in the world, stretches 3500 km from west to east and sustains more than 120 million people in the mountains and provides support for three times that population in the plains.

Mountain ecosystems in the HKH region have long been neglected, because of their inaccessibility and economic deprivation. Understanding how mountain people conceptualize their ecosystems is particularly useful when combined with studies of resource use patterns, appropriation systems, decision-making and so on. Basically, the mountain economics of the region are characterized by self-sufficient and self-reliant systems that are agroforestry-based and have extremely diversified land use, biological resources and human cultures (Pei 1995).

In traditional societies of the HKH mountain areas, forest lands in the past were managed as life support systems for subsistence of

mountain people and for environmental protection. Bamboo and rattan are the most important non-timber forest products (NTFPs) for both home consumption and marketing in the HKH region, particular in the eastern Himalayas. In addition to the harvest of timber, fodder, and fuel wood, the collecting of bamboo and rattan, as well as of medicinal plants and edible plants is daily done by local people involving all the farm households in the mountain forest areas.

The traditional utilization of bamboo and rattan resources along with its management reflects a diverse resource use pattern and land management system which differs from region to region due to differences in species in each locality, and to the local knowledge on use of bamboo and rattan. Understanding the indigenous knowledge of mountain people in relation to resource management is one of the key issues for sustainable development of the HKH mountain region. Natural resource management systems are localized systems and all the productive systems in the HKH region operate under indigenous systems; they are not only of value to the culture with which they evolved, but also to scientists and planners striving to improve conditions in rural societies (Warren 1990).

Indigenous systems are those generated by internal initiative within a local community itself and any indigenous system may be a new development (Fisher *et al.* 1989). Indigenous knowledge is often considered as informal knowledge that exists in local societies in comparison with formal knowledge developed by universities and research institutions of modern society. The indigenous knowledge system of a local society covers a wide range of its member's perceptions on universal phenomena occurring in their immediate environment, and on practices affecting social, economic and cultural activities taking place within the society. Indigenous management of bamboo and rattan in the Chinese Himalayas is described below:

2.0 Case Studies in Southwest China

A large portion of Southwest China is mountainous since it is located in the mountain ranges of the eastern Himalayas. The Hengduan mountains stretch from the north in Tibet to the south in Yunnan province and are the major mountain ranges of the Chinese Himala-

yas. Xishuangbanna is located in the southeast of the Hengduan mountains at 21°10′-22°40′ N, and 99°55′ - 101°50′ E. Approximately 94% of the total land of 19,220 km², Xishuangbanna consists of mountain and hilly terrain and river valleys make up the remaining 6%. The Lancang (Mekong) river and its tributaries form the major river system. Elevation of the region ranges from 420 to 2800 m. Tropical forests account for 33.8% of the total land cover. Some 36,321 species of higher plants have been recorded in the area. Thus, one-seventh of the total species of China can be found in Xishuangbanna alone, although it constitutes only one-five hundredth of the total land area of China (Figure 1).

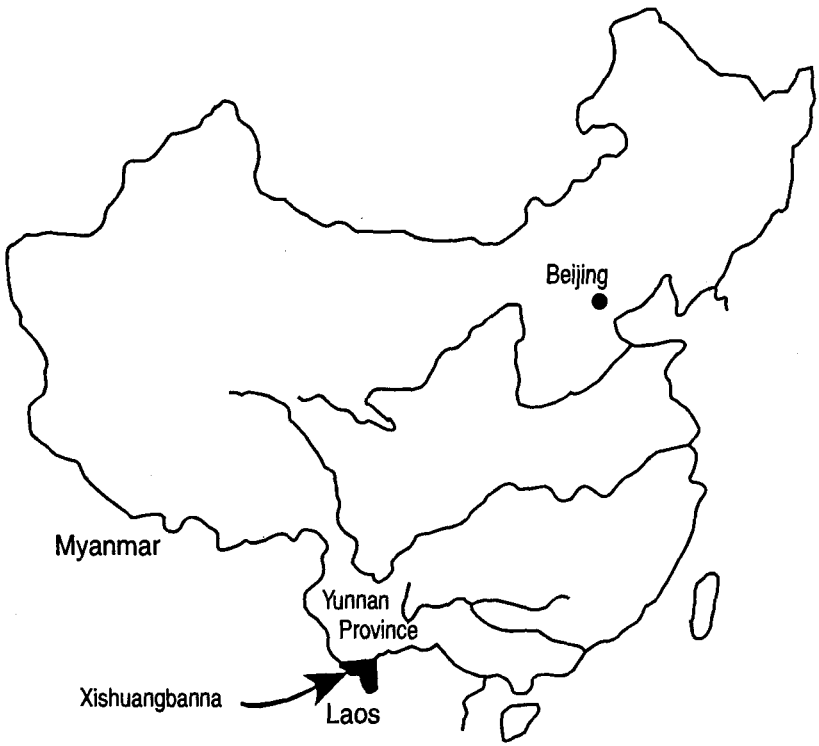

Figure.1 Location of the Xishuangbanna Dai autonomous prefecture. Yunnan Province, China

Administratively, Xishuangbanna is one of the eight autonomous prefectures in Yunnan Province and was established in 1952 to allow for regional autonomy and the preservation of ethnic traditions, as the prefecture is inhabited by groups of non-Han ethnic status with considerable cultural and economic diversity. In the prefecture, there are 13 different ethnic groups with a total population of 760,000; and Dai with over 226,000 (35%) is the largest group, and the Han, Hani, Jiro, Bulong, Yao, Miao, Lahu, Yi, Wa and others are smaller groups. Traditionally, people in this mountainous region are engaged in swidden farming, forest production, tea plantation and agroforestry in the mountain areas and paddy rice farming and home garden agroforestry in the valleys. Modern plantation technology has been introduced into the area for rubber, tea, fruits, and medicinal and aromatic plants since 1960.

2.1 Bamboo and Rattan Resources

Bamboo is widely planted by local communities of all ethnic groups of the prefecture and wild bamboo forests are distributed over the region. Bamboo species are managed by local people as multipurpose plants, and have a more important role in rural life than rattan. There are 93 taxa of bamboo in 17 genera in the area. This is about one fifth of the total species in China (500 spp. in 40 genera) and half of the total number in Yunnan Province (93 out of 200 species). Bamboo forest covers about 91,800 ha, making up 4.18% of the total forest cover in the prefecture (Pei *et al.* 1996). Bamboo is valued for stems (culms), edible shoots, weaving materials, ornamental gardening and environmental protection. Thus, bamboo products are the most important NTFPs in the region. Natural bamboo forests are structured by species: *Dendrocalamus membranaceus, D. peculiaris, D. semiscandens, Cephalostachyum pergracile, Pseudostachyum polymorphum, Schizostachyum funghomii, Thyrsostachys siamensis, Gigantochloa albociliata, Indosasa longispicata; Melocalamus compactiflorus* and others.

Rattans are found in Xishuangbanna from 420 to 2,000m. Twenty nine species and varieties of *Calamus, Plectocomia*, and *Daemonorops* have been identified from the Xishuangbanna area alone. Mountain communities of Xishuangbanna have names in their own languages

for most of the rattan species found in the area. In the folk classification systems, there are 12 names for 13 different species of rattan used by the Dais. Rattan is another important NTFP after bamboo, and it has played a unique role in forest protection and sustaining swidden farming systems in the mountain areas. The commonly used species in the natural forests are: *Calamus gracilis, C.* aff. *multinervis, C. platyacanthus, C. wailong, C. palustris; C. rhabdocladus, C. yunnanensis, C. nambariensis* var. *xishuangbannaensis, Plectocomia himalayana* and others.

2.2 Indigenous Use of Bamboo and Rattan

Traditionally, rattan and bamboo are used for various purposes among all ethnic groups. The common uses of rattan in Xishuangbanna are for making baskets, chairs, tables, suitcases, winnowing trays, handicrafts, ropes and ties for utensils and constructions. Fruits of some species are edible and growing tips of rattan plants are served as high value vegetables. Cane is also used by the Hani people during traditional festival days for constructing swings.

Bamboo is commonly used for house constructions, agricultural tools, furniture, supporting poles, containers, utensils, mats, and musical instruments, as well as tools for traditional medical treatment (acupuncture) and materials for daily life of mountain people. Many species produce edible shoots of large to small size with fresh or bitter tastes; these are usually served as fresh or preserved vegetables and are a major vegetable for rural people during the monsoon. Chinese traditional culture, has the axiom: "One can live without meat in the diet, but cannot reside in a place without bamboo". Each cultural group of the area has its knowledge and practices on use of bamboo resources.

The wide utilization pattern of rattan and bamboo in the area has led to the development of management practices on rattan and bamboo resources.

2.3 Managing for Sustainable Production of Bamboo and Rattan

In traditional mountain societies, forests are managed as multiple use systems to meet the needs of the people. The needs range from timber, fuelwood, food, fodder, medicinal plants, aromatics and dye-

ing materials to many others. Indigenous people of the mountain regions have old traditions, to maintain forests as sustainable resource systems characterized by NTFPs management, in which bamboo and rattan are included.

In Xishuangbanna, there are 91,800 ha of natural bamboo forests and a large area of bamboo/tree mixed forests belonging to the state/ communities, and individuals are managed and harvested for bamboo shoots and bamboo culms in such a way as to protect the watersheds and gene pools. The traditional harvesting for bamboo shoots and culms from forest lands was sustainable when it was basically harvested for villagers' home consumption, and not for commercial purposes. In recent years, with rapid population growth and better market linkages established between villages and towns, demand for bamboo products has increased, over-harvesting of bamboo from natural forests for pulp-making, furniture-making and construction as well as bamboo shoots for food became common practice in the region. The need for better management of such common property resources is critical.

Protected rattan forest by the local community in the study area was a local response to rattan cane-harvesting. In Mengsong community of the Xishuangbanna, the Hanni (or Akha) people have developed a traditional rattan forest protection system since about 200 years ago, which is called "Sangpabawa" (Chen *et al.* 1993). It is a Hanni word for a rattan forest, belonging to the local community but placed in the name of the headman of the village. Under traditional regulations of the village administration, the rattan and trees in the Sangpabwa were not allowed to be harvested except for community needs, and yet small quantities were sanctioned. Violation would result in a penalty levied (a pig in most cases). Now Sangpabawa forest is maintained on a natural forest land (app. 350 ha producing 10 ton of rattan cane). The cane harvested from the Sangpawa is utilized to make baskets, tables, and chairs by the local artisans. The forest also acts as both a water source for domestic use and for irrigation and a refuge of biodiversity. It is a community-managed natural sanctuary in the tropical mountain rainforest and evergreen broad-leaved forest in the swidden area. It also serves as a source for collection of naturally growing food.

3.0 Bamboo and Rattan in Swidden Systems

Swidden cultivation is practiced among all the mountain ethnic groups in the eastern Himalayan region as a traditional knowledge system of indigenous mountain people. Indigenous people have developed a highly complex and very specific knowledge of their local vegetation and many of them depend on plants for their livelihood. It is important to note that both bamboo and rattan have played an important role in swidden systems and in restoration of soil fertility and vegetation in the fallow period.

Rao and Ramakrishnan (1988) reported on the role of bamboo in secondary succession after slash and burn agriculture at lower elevation in NE. India. Bamboos prevail on the fallow lands for a longer period of time due to their longevity and fast growth. Bamboo species were *Dendrocalamus hamiltonii, Neohouzeaua dulloa* and *B. khasiana* in the swidden fallow fields. Bamboo follows a strategy of fast uptake and storage of essential elements and quick turnover to supplement the soil flux, thus efficiently dominating the stress-tolerant shrubs and tree species for a long period. The study concluded that bamboos promote stability of this function like other competitive early successional species.

Another study on the indigenous Talun-kebun system, a modified shifting cultivation in West Java has also revealed the important role of bamboo in functioning of a man made forest in tropical hilly areas. In the Talun system, the bamboo forms the lowest canopy and above it are found the canopies of coconut palms and *Albizia* or other trees. Under the trees and bamboo, crops planted are lablab beans, tobacco, sweet basil, black night shade, chilli pepper, tomato and cassava. The bamboo culms, *Albizia* trees, fruits, and other products are harvested giving an important economic benefit to farmers. At the transition between the dry and the wet seasons the people clear an opening by clear cutting the bamboo without disturbing the rhizomes. The opening is 500 m^2 - 100 m^2 land area. The leaves and small twigs are dried in the sun and then burnt, the ash is mixed with manure. Soil preparation is minimal only making small ridges along the contours. The opening is called kebun. Since the Talun-kebun system retains the essential features of shifting cultivation, it should be useful to consider it as a possibility for the resettlement of shifting cultivators who need a large

area of forest to make their practice sustainable. The Talun-keban system in West Java can survive with about 2 ha per family (Soemarwota 1984).

The Hani people of the Mengsong Community in the case study area of Xishuangbanna, practise a 'Qaiya-aneya' cultivation in the swidden farming systems. The qaiya-aneya is an indigenous rice rattan agroforestry system practised by Hani swinddeners for a period over 100 years. Upland rice and maize are intercropped with tuber crops like yam, taro, and cucurbits (*Cucumis hystrix* and *Benincasa hispida*). The 'Qaiya' stage takes two or three years, when soil fertility is exhausted. The Hani rotate by planting of rattan and bamboo in the rice-rattan field with species like *Calamus yunnanensis* var. *densiflorus*, *C. nambariensis* var. *xishuangbannaensis* and *Plectocomia himalayana*. Bamboo species such as *Demdrocalamus hamiltonii, D. membranaceus* and *Indosasa longispicata* are planted in the swidden fallow. They also plant other perennial crops on the boundaries of the swidden fields while they prepare the land for rice in the first year of the swidden cycle (7-13 years). With succession, the Qaiya gradually evolves into Aneya, or rattan forest mesh system. The farmers can still continue collecting rattan cane and growth-tips for a hundred years while the upland rice planting is done every 7-13 years in the same field based on the site condition and demands for food production by the family. According to a survey of 31 households in the community, each household had 28.5 clumps of rattan in the swidden field. The annual rattan production from swidden fields of the community is approximately 10 ton (Pei *et al.* 1996).

4.0 Discussion and Conclusion

Historically, the indigenous practices of managing bamboo and rattan resources in the forests in the mountain environment of the region have helped in maintaining bamboo and rattan production, regeneration, and conservation of mountain ecosystems in a sustainable manner despite the radical socio-economic and ecological changes witnessed. The indigenous people in the case study area had technologies not only for their own future development, but also with the potential to transfer to other mountain areas, particularly areas where

bamboo and rattan resources and swidden land systems have already been degraded (Pei 1994).

The production of rattan and bamboo by rural communities is insufficient to meet the increasing demands of urban and rural societies. Rattans appear to have a greater potential in mountain areas of the region,particularly for swidden communities, because it provides high value products for marketing and swidden alternatives.

Although bamboo resources are being managed as sustainable NTFPs in the region for subsistence of rural communities, it is still at a low level of production. The future development of bamboo in the region depends on further development of cultivated bamboo in plantations and gardens. Based on the ethnobotanical information, the following species are recommended as priority species for cultivation in southern Yunnan: 1) *Dendrocalamus giganteus*, 2) *Dendrocalamus hamiltonii*, 3) *Dendrocalamus membranaceus*, 4) *Thyrsostachys siamensis*, 5) *Schizostachyum funghomii*, 6) *Indosasa longispicata*, and 7) *Cephalostachyum pergracile*. Superior genotypes will be needed.

Further research is needed on the biological and ecological characteristics of the threatened groups of rattan and bamboo, and their economic importance to rural people. Their conservation and development are very closely linked with their ethnobotanical significance. There is no doubt that control of the exploitation of wild stocks is essential. But given the problems of policing forests, this will not be the final remedy. Thus, cultivation of better-yielding species and superior genotypes is seen as the only long-term method of rattan conservation and development. The following is a list of local rattan species found in Yunnan that are recommended for cultivation.

Section A: Suitable for localities below 1000m in the hilly areas of the region: 1) *Calamus gracilis* 2) *Calamus multinervis* 3) *Calamus platyacanthus* 4) *Calamus wailong*, 5) *Calamus rhabdocladus* and its variety *globulosus*.

Section B: Suitable for 1500 to 2000 m in the mountains of the region: 6) *Calamus yunnanensis*, including var. *densiflora*, 7) *Calamus nambariensis*, var. *xishuangbannaensis*, and *Plectocomia himalayana*.

The development of rural cottage-processing technology for rattan and bamboo is urgently needed, not only for improving the quality of products, but also as a way to increase benefits to the villagers through increased commercial value from the processing of raw materials. So far 50 family enterprises – small-scale cottage workshops for making rattan furniture-and several bamboo processing factories have been established in the Xishuangbanna prefecture. These need to be promoted.

Indigenous management of rattan in protected rattan-forest, the Sangpabawa and cultivation of rattan in swidden systems, the Quiya aneya system of Dongya as well as the Talun-kebun system of West Java are highly recommended as replicable models for rattan and bamboo in the region. Technologies for propagation, cultivation and management as well as conservation of threatened species, must be further developed and supported by institutions at the policy level.

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Medicinal and Aromatic Plants in Mountain Development in China

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1.0 Introduction

Chinese traditional medicine has been based on plants since time immemorial. The numbers of species documented have now reached approximately 6,000 herbals and about 250 species of aromatic plants. For Chinese medicine, the Eastern Himalayan mountainous region is extremely important, because a large number of the species used come from this region.

The region includes parts of three Provinces of China: Sichuan, Yunnan and Tibet. The Chinese use words recognizing the origins of the herbs such as "Yun" from Yunnan, "Chuan" from Sichuan. Also, almost half of the Chinese minority groups live in the region: in Yunnan alone there are 23 ethnic minorities, each with special uses of medicinal plants.

This paper reports on the rich diversity of the medicinal plants of Yunnan and describes resource management systems.

2.0 Important Traditional Medicinal Plants

The following list shows the wide diversity of species used:

Panax: Indigenous species are *P. pseudoginseng* var. *notoginseng* (Syn. *P. notoginseng*); and *P. zingiberensis*. Both are related species and form a gene pool with *P. japonicum* (Hu 1976). Other species have been successfully introduced: *P. ginseng* from Asia and *P.*

	quinquefolius from N. America. The species contain saponins of several forms.
Coptis:	There are two species native to Yunnan: *C. teeloides* and *C. omeiensis*, as well as one introduced species, *C. chinensis*. There are ecological variants.
Fritillaria:	Local species are *F. delavayi, F. pallidiflora* and *F. cirrhosa*; bulbs are harvested and wide variation in shapes and weights is found. They are used for a variety of medical conditions.
Taxus:	There are three species with high contents of taxol. *Diphylenia* and *Sinopodophyllum* are very closely related and have similar active chemicals.
Amomum:	There are several wild species but *A. villosum* and *A. xanthioides* are important.
Other genera:	Over 30 other genera and their species are used as medicinal plants. Eleven other genera have species yielding essential oils.

The plants of interest range in habitat from tropical or subtropical forests to plants of open slopes in hot-dry or cold grasslands. Some are subalpine or alpine.

Although many medicinal plants may be somewhat threatened, at least in terms of populations, the high demand for some causes significant erosion of the gene pool. This is the case for *Taxus* which is being overcut for taxol extraction – even roots are dug up because they are high in alkaloid content. *Cordiceps* has been over-harvested in Tibet and Yunnan, the resultant medicine has become rare and expensive. Similar situation occur for *Aconitum brachypodium, Paeonia delavayi* and *Saussurea* species.

3.0 Resource Management Systems

In the Western mountainous rural areas of China, pure stand management of medicinal plants is virtually non-existent. Local people regard medicinal plants as a gift of nature and whoever collects the plant material becomes the owner. This can lead to exploitation; however, only a few species are protected by laws managed by a

government unit–usually a local forestry officials. Along highways, checkpoints look for proscribed plants which are confiscated.

Medicinal plants which are cultivated, including introduced species, are managed from sowing or planting to harvest. Cultivation gardens usually belong to medical companies or supply and marketing cooperatives.

In Yunnan, there are 102 companies at the county level, 16 of regional and one of provincial. Fifty eight factories employ 7,636 people. There are 1,258 commercial units and traditional Chinese medical gardens that cover 28,000 ha. Through these, Yunnan can commercially produce ginseng in Lijiang, and vanilla in Xishuangbanna. Specialists in both Yunnan and Sichuan are trying to produce *Cordiceps* in high mountain areas.

There is a range of systems for enhancing production. In Xishauangbanna, the Jino people produce *Amomum villosum* in the tropical rain forest by clearing undergrowth. The Miao and Yao people produce *A. tsaoko* in a similar way in Wenshan. *Coptis teetoides* is produced similarly by the Dulong and Lahu people. These systems often become part of shifting cultivation systems and plots can be changed to beans, onions or buckwheat.

There is clearly great potential for cultivation in more scientifically designed agroforestry systems, especially when these take into account the major variations in phenology that occurs at different elevations.

The harvesting system depends mainly on supply mechanism such as marketing cooperatives and indigenous practices. When a factory or research unit needs plants, the Cooperatives send a team to villages to show specimens and tell villagers how and when to harvest, and the price. Any company or individual is free to follow this method. However, materials planted in gardens for commercial production may be private.

4.0 Utilization

Traditional Chinese medicine is not homogeneous. There are several classical systems each with their own theory and practice. The integration of traditional medicine along with Western medicine has become a major policy of the Government. As a result, modern scientific research is being applied to traditional medicine.

Utilization in traditional systems have a link to the quantity of plants harvested and the quality relations of the plant materials. We know very little about the medicinal plants of the upland areas.

Even when efficacies of extracts are known better, the utilization may change drastically, as for instance, the production of materials in cell and tissue cultures.

For the benefit of local people, the Cooperatives are an important cornerstone, since they are able to share/hand out packages of knowledge about cultivation, harvesting and utilization.

5. 0 Discussion and Conclusion

Sustainable use of medicinal and aromatic plant resources is vital to the people of the mountainous areas of west China. There are no socioeconomic constraints caused by social taboos or ethnic beliefs in the area, unlike the situation in some other regions of the world. Additionally, there are no policy or institutional constraints from government, except as they impinge on pricing. Nonetheless, control of prices tends to promote production, especially through cultivation, when prices rise too high, and this is to the benefit of the local people. There is a down side also, when the prices are too low, and this occurs in some cases. Then there is a lack of incentive to collect plant material.

From a research point of view, there is no lack of manpower resources. Extension needs to be accelerated in certain areas, especially on domestication and enhanced production of particular species.

There are some technological gaps between Chinese technicians and those in other countries. For instance, China introduces medicinal plants from other countries for cultivation when necessary, as do other major producers of medicinal plants. Frequently, Chinese scientists are not familiar with the management of these plants. Hence, much could be gained through the frequent exchange of information and visits.

The government has committed itself to modernizing traditional medicine slowly. The rationale behind this policy is fully explained in Wang (1983). At the same time there is a policy to protect the natural resources. Hence, as threats occur in the Himalayan region,

harvesting is managed better and plants are conserved in, for instance, the Xishuangbanna Medical Institute, and *in situ* reserve areas as at Wenshan.

A harmony between cultural diversity and biodiversity developed over centuries, resulting in the current pattern of utilization systems. Understanding these systems permit sustainable developments; for instance, the gradual transformation of the swidden system into an integrated intercropping/agroforestry mountain production system (ICIMOD 1993).

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Endangered Biodiversity of Bamboo, Rattan and Medicinal Plants of Indian Himalaya

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1.0 Introduction

Out of a land frontier of approximately 15,200 km, Indian Himalaya extends over a distance of about 2,500 km with a varying width of 240-320 km and rising over 8,000 m. The region comprises Jammu & Kashmir, Himachal Pradesh, parts of Uttar Pradesh (Garhwal and Kumaon Himalaya) and West Bengal (North Bengal Himalaya); Sikkim and Arunachal Pradesh, The Northeastern Region with Assam, Nagaland, Manipur, Meghalaya and Mizoram is the extension of Himalaya, and differs with specific orientation from the real Himalaya. High reaches of this region hold over ten thousand glaciers which contribute towards the gigantic watershed river system. The principal rivers of Indian Himalaya are Ganga, Bhagirathi, Yamuna, Indus, Beas, Sutlej, Chenab, Jhelum, Tista, Lohit, Subansiri and Brahmaputra. The rivers and their tributaries contribute towards most of the forests of the Himalayan and adjoining states. The eastern part of Himalaya experiences higher rainfall, seasonal temperature and relative humidity than the western Himalaya, and thus there is enormous diversity among the species. The forests of the Himalayan region have not only contributed by providing life support systems to agriculture and industries of the local people and of adjacent areas, but also have provided ecological security by maintaining the stability of soil strata, climatic characteristics and the resultant vegetation of the entire Indian sub-continent.

Indian Himalaya is floristically endowed with a rich diversity of plants. Out of nearly 15,000 flowering plant species occurring in India, nearly 4,000 are endemic to Himalaya. The Eastern Himalaya, together with NE region, supports over 6,000 species. A large proportion of the species typical of this part of the country yields non-timber forest products (NTFPs) in the form of medicinal and aromatic plants, rattans, bamboos, food, fodder, dyes, lac, gum-resin, fibres etc. The floristic diversity of the Himalayan region is unique with spectacular plant groups such as conifers, primulas, saussureas, rhododendrons, orchids, oaks, saxifrages, *Berberis*, rattans, bamboos etc. (Biswas and Dayal 1995). Local knowledge on utilization, cultivation and management of species of socio-economic importance is little understood. This may be due to non-accessibility, lack of scientific data on local technologies and their application in newer technologies.

Floristically, NW. Himalaya, Eastern Himalaya and Eastern India fall into distinct botanical regions and these are described below:

2.0 N.W. Himalaya

The principal forest types of this region are covered by moist sal (*Shorea robusta*) forest of different sub-types such as lower Himalayan, bhabar, siwalik and dry types; northern dry mixed deciduous forests, dry riverine forest/khair (*Acacia catechu, Dalbergia sissoo*) forest, Chir (*Pinus roxburghii*) pine forest covering ecologically fragile zones, lower scrub and dry bamboo brakes with *Dendrocalamus strictus* and *Bambusa bambos*. Chir pine forests of Siwalik and Himalayan types occurring between 700-1,800 m of elevation are subjected to heavy biotic pressure.

Ban oak (*Quercus leucotrichophora*) forests found between 1,700-2,200 m in lower temperate zone are also under heavy biotic pressure. This type provides perfect ecological niches to numerous medicinal plants and other NTFPs yielding species. At higher elevation *Arundinaria* (reed like) bamboo is commonly found. Other oaks occur successively towards higher elevation: *Quercus himalayana* (moru), *Q. lanuginosa, Q. serrata* and *Q. semecarpifolia* (kharsu).

Moist deodar (*Cedrus deodara*) forest occurs between 1,700-2,500 m. Temperate forest with species of *Acer* (maple), horse-chestnut (*Aesculus indica*), Ash (*Fraxinus* sp.), *Taxus baccata* is found between

1,800-2,800 m. The outskirts of this type are flanked with fodder yielding grasses and medicinal plants such as species of *Saxifraga, Nardostachys, Viola, Podophyllum, Gentiana, Saussurea, Berberis* etc. Intense biotic interventions give rise to upper scrub or secondary form of forest. Between 2,400-3,000 m or higher, temperate mixed coniferous forest occurs with species like *Abies pindrow* (fir), *Cedrus deodara, Pinus wallichiana* (blue pine) and *Picea smithiana* (spruce). The open aspects of this type of forest provide sites for a large number of aromatic plants, particularly of family Lamiaceae. Oak-fir ecosystems occurring above 2,600 m are typical of the upper catchment areas of some of the main rivers of Western Himalaya like Chenab, Ravi, Beas, Sutlej, Jhelum, Bhagirathi, Alkananda and Pindar.

Cypress (*Cupressus torulosa*) forest with species such as *Berberis, Prinsepia utilis, Cotoneaster, Caragana* contributes significantly in rehabilitating ecologically degraded tracts between 1,800-2,800 m.

Alder forest (*Alnus* species), Himalayan poplar (*Populus ciliata*), elm (*Ulmus* sp.) bushes of *Prinsepia, Berberis* species, *Salix, Spiraea, Lonicera, Hippophae salicifolia, Sacroccocca, Wikstroemia, Daphne* etc. eco-rehabilitate fragile banks of streams and rivers in upper reaches. Blue pine forest in moist temperate zone has in its ground flora bamboos (*Arundinaria*), *Berberis, Rubus, Rosa* and *Indigofera* species.

Dry temperate forest occurs in the rain shadow zone of the main Himalayan range. The main species are *Acer pentaponicum, Celtis australis, Fraxinus micrantha, Pinus gerardiana* (Chilgoza pine)–an important NTFP of NW Himalayan flora. Chilgoza pine is found in the dry tracts of the higher and trans-Himalaya which remains under sub-zero temperature for a considerable period. Here ecological degradation is due to cold dessicating winds. Other sub-types of dry temperate forest above 3,000 m contain the species of *Juniperus* (*J. communis, J. macropoda, J. wallichiana*), birch (*Betula utilis*), *Ephedra* spp. Many of the species of economic value occurring in this zone are threatened due to their habitat destruction and indiscriminate exploitation.

The sub-alpine zone is demarcated by the snow line above 3,000 m and by different sub-types such as upper fir forest with species such as *Abies spectabilis, Pinus wallichiana, Taxus baccata* and ground flora of *Strobilanthes* spp., *Berberis, Hippophae tibetana, Rhododendron* sp. etc. The growth of tree species is stunted. The ecological

habitat of the alpine zone, by and large, remains under the cover of snow for a considerable period of the year. Dry alpine scrub has scrubby growth with species such as *Artemisia, Juniperus, Primula, Myricaria* and *Sedum.*

3.0 Eastern Himalaya

Botanically, this part of Himalaya is one of the richest of all the varied vegetation. The forests have species typical of tropical wet evergreen, semi-evergreen, tropical moist deciduous, dry/moist/ deciduous/mixed temperate, sub-alpine and alpine types. The area is drained by mostly north to south flowing rivers viz. Tista, Brahmaputra and the tributaries of the latter. For distribution and density of bamboos in Eastern and N.E. India, humidity or precipitation is one of the main factors governing the enormous genetic diversity, growth and distribution of bamboo brakes in N.E. India, and also the development of complex and varied ecosystems. The present climax condition of different ecosystems of the region support the fragile ecological balance which is upset by various biotic factors.

Tropical forests comprise moist and dry deciduous, evergreen and semi-evergreen type of vegetation. These types may be categorized into sub-Himalayan tropical, semi-evergreen, eastern Himalayan sal forests and moist mixed deciduous forest types. The main bamboos in this bioclimatic zone are *Dendrocalamus hamiltonii, Bambusa balcooa, B. tulda, B. pallida, Melocanna baccifera* and *Schizostachyum dullooa.* It is observed that where a great deal of the area has been affected by shifting cultivation it has degenerated into bamboo brakes with species of *Melocanna, Bambusa balcooa, Schizostachyum polymorphum* and *S. dullooa.*

The semi-evergreen and evergreen forests contain the species of *Amoora, Canarium, Castanopsis, Chukrasia, Cinnamomum, Dysoxylum, Michelia, Dipterocarpus, Garcinia, Shorea assamica, Lagerstroemia speciosa,* orchids, palms etc. The open areas in this type of forest particularly in precipitous and swampy situations provide perfect habitats for several rattans (*Calamus tenuis, C. leptospadix* etc.), *Salix tetrasperma, Bischofia javanica, Trewia nudiflora* and *Barringtonia* species.

The montane sub-tropical forests experience 1,200-2,500 mm of rainfall. Broadly, the forests fall under sub-tropical·broad-leaved hill forests of Sikkim, North Bengal and Arunachal Pradesh. The dominant tree species are *Engelhardtia, Quercus, Castanopsis* and *Betula.* Among the NTFPs yielding species of this type are *Terminalia, Emblica* (Amla), *Elaeocarpus*, bamboos, rattans and medicinal plants (*Rauwolfia serpentina, Dioscorea* spp., *Costus* spp. etc.). Among the bamboos, *Dendrocalamus hookeri, D. sikkimensis, Chimonobambusa* spp. *Schizostachyum dullooa, S. polymorphum, S. capitata, S. fuschianum, S. griffithii, Thamnocalamus* spp. and *Phyllostachys* species are common. Rattans are represented by *Calamus acanthospathus, C. erectus, C. flagellum, C. floribundus, C. latifolius* and *C. leptospadix.*

Temperate forests range between the elevations of 1,700 and 3,000 m. These forests may be further classified into Lauraceous, high level Oak-Hemlock (*Tsuga*), Coniferous and Birch-Rhododendron forests. Darjeeling montane temperate forests of N. Bengal Himalaya enjoy rainfall of ca 3,000 mm. Oak forests, laurel forests, Oak-Hemlock forest, *Tsuga-Abies* and *Abies-Rhododendron* associations are represented by the species of Lauraceae (*Persea, Litsaea*), *Betula utilis, Quercus lamellosa, Q. lineata, Alnus nepalensis, Acer* spp., Magnoliaceae (*Magnolia, Michelia, Talauma*), *Castanopsis* spp. and *Rhododendron* spp. Coniferous forests with potential of gum-resin are represented by *Pinus wallichiana, Pinus kesiya* (cultivated), *Abies pindrow, A. densa, Junipers, Larix griffithiana* and *Picea* spp. Among the bamboos common species belong to *Arundinaria, Chimonobambusa, Thamnocalamus* and *Semiarundinaria.* Absence of rattans is quite conspicuous. Ecological degradation in this part is due to heavy lopping for fodder, sliding snow on steep to precipitous slopes and other biotic factors.

Alpine and sub-alpine type of vegetation is confined to higher ranges from 3,000 m to 45,000 m with *Abies densa, Betula utilis, Juniperus* spp., *Rhododendron* (shrubby spp.), and *Larix griffithiana.* Medicinal plants like *Cassiope fastigiata, Hippophae* spp., *Anemone* spp., *Aconitum* spp., *Berberis* spp. etc. are commonly found. Bamboo species of *Arundinaria, Sinobambusa, Chimonobambusa, Phyllostachys, Thamnocalamus* and *Pleioblastus* occur in the sub-alpine zone of E. Himalaya. Avalanches cause heavy damage to this

type. Ecological degradation also occurs due to migratory flocks of cattle. In alpine scrub type (3,500-4,500 m), trees are found with stunted growth, and ground flora is composed of grasses and mosses.

Endangered Biodiversity and Genetic Resources

The floristic diversity of the Himalayan region is unique and many species yield value-added products. Orchids, *Magnolia, Michelia, Primula*, Rhododendrons, Hedychiums, *Impatiens*, Saussureas, Oaks, Conifers, *Elaeocarpus*, Saxifragas, bamboos, rattans etc. are specific groups found in Indian Himalayan region. The Indian floristic region has an admixture of Indo-Malayan, European, Sino-Japanese and Mediterranean elements. These elements have produced enormous variability through intermixing. Genetic diversity in bamboos, rattans and medicinal plants typical of the Himalayan region is clearly prevalent. Species richness among the NTFPs yielding species include *Arundinaria sensu lato* (21 spp.), *Dendrocalamus* (13 spp.), *Bambusa* (25 spp.), *Phyllostachys* (3 spp.), *Schizostachyum* (11 spp.), *Thamnocalamus* (2 spp.), *Calamus* (25 spp.), *Costus* (15 spp.), *Dioscorea* (10 spp.), *Saussurea*, (31 spp.), *Aconitum*, (33 spp.), *Bergenia* (*Saxifraga sensu lato*, 5 spp.), *Geranium* (10 sp.), *Polygonum*, (15 spp.) and *Rheum* (7 spp.). Out of 130 species of bamboos occurring in India, 60 species are found in different bioclimatic regions of Himalaya.

4.0 N.E. India

N.E. India covering Himalayan flanks can be referred to as a centre of genetic diversity for the genus *Calamus* (25 spp.), *Arundinaria sensu stricto* (5 spp.), *Bambusa* (25 spp.), *Dinochloa* (5 spp.), *Dendrocalamus* (12 spp.), *Schizostachyum* (11 spp.) and *Drepanostachyum* (7 spp.). Traditionally old cultivation of several bamboos such as *Bambusa vulgaris, B. wamin, B. balcooa, Dendrocalamus hookeri* var. *parishii, D. sikkimensis, Pseudoxytenanthera* spp. and *Oxytenanthera* spp. are cultivated in this region. In several parts of N.E. and N.W. India seems to have reduced the flowering incidence. Studies being carried out reveal morphological infraspecific variants can be distinguished with regards to the branching patterns, culm-sheath, rhizome and young shoots.

The potential resource of Himalayan rattans has been depleted due to indiscriminate extraction of immature canes,destruction of their natural habitats and insufficient knowledge on the biology and phenology of species. Since the genetic diversity of rattans has not been measured thoroughly. *Calamus acanthospathus, C. inermis, C. latifolius* occur in E. Himalaya as an admixture, and systematic taxonomic and genetic evaluation are needed.

In the N.E., most of the *Calamus* species occur between 1,000 and 200 m. *Daemororops* and *Pletocomia* species are represented also. Most of the rattan gene pool is under severe threat due to intense environmental interference.

5.0 Social Background

The following stark points are characteristics of the Himalayas:

- Himalaya has given shelter to a large number of ethnic groups with diverse cultural identities and social formation.
- Tribals have a higher dependence on food-gathering, medicinal plant collection, shifting cultivation and hunting.
- One-third of the land area of Himalaya has become totally unproductive due to:
  - Expansion of agriculture indiscriminately on unsuitable slopes;
  - uncontrolled grazing;
  - intensive logging for fuel and timber;
  - clear felling and burning for shifting cultivation;
  - construction of roads, dams and other infrastructure programmes; and
  - open cast mining.
- The majority of the people are living below the poverty line. Thus, poor people and poor areas have simply become locked into a vicious cycle of synergistic mutual destruction.
- Environmental deterioration and economic decline have started feeding on each other causing social decay and tribal unrest.

- For the alleviation of poverty and hunger, greater equity in income distribution, human resource management and sustainable management of natural resources are major challenges.
- Eco-rehabilitation, employment generation, energy supply and biodiversity conservation have to be given top priority.
- Joint forest management, control of shifting cultivation, broad-based community forestry, development of medicinal and aromatic plants and integrated development of watersheds need urgent attention.

6.0 Threatened Species

Studies on the flora of Indian Himalaya reveal that as many as 350 species are rare and endangered. These species have been listed in the Red Data Book prepared by Botanical Survey of India under the guidelines of IUCN. Bamboos of the Himalayan region, to be considered endemic, are threatened through their restricted distribution. Twelve species of bamboos have been marked as rare and endangered due to biotic pressure coupled with biological phenomena such as periodic flowering, poor seed setting and indiscriminate exploitation. N.E. India represents a high proportion of Indo-Malayan species of bamboo. Elements such as *Phyllostachys, Pleioblastus, Semiarundinaria, Sinobambusa, Thamnocalamus, Chimonobambusa* occurring in Himalaya are Sino-Japanese in origin. Himalaya has served primarily as a route of emigration and colonization from the east and north-west, secondarily of endemic development. Topographical features particularly the hilly terrain, deep valleys, slopes and river systems have restricted the distribution of several species of bamboos in the region. Phenological studies carried out in the case of *Dendrocalamus longispathus, D. strictus* var. *argentea, D. somdevae* and *Schizostachyum polymorphum* show insufficiency or non-availability of pollen for crossing and poor seed production. As a consequence of synchronous senescence of clumps following flowering and due to poor regeneration, the distribution of the species may become disjunct, isolated or narrowly confined.

Several other species such as *Phyllostachys mannii, Schizostachyum arunachalensis* and *Sinobambusa elegans* have not been yet surveyed

thoroughly and their status of occurrence is not well known. But on the basis of the impact of biotic pressure, it appears they are becoming scarce and restricted in distribution.

Of the rattans, the following need conservation due to threat : *Calamus erectus* in Sikkim, N. Bengal, Assam and Manipur, *C. erectus* var. *schizospathus* in Sikkim, N. Bengal, AP; *C. floribundus* in AP and Meghalaya; and *C. inermis.*

Of the medicinal plants, ca. 120 species are in the category of rare, endangered and threatened.

7.0 Policy and Research Needs

Apart from the overriding need to develop sustainable management systems of the three groups of NTFPs, policy is needed to address adequate conservation of gene pools. Research is urgently needed on population biology and genetic variation in target species. There needs to be a priority listing of taxa and this should be backed by good sources of information well-collated and well-analyzed. Although many of these aspects are dealt with in India by a range of institutions, there is no comprehensive strategy for safeguarding the biodiversity of bamboo, rattan and medicinal plants of the Himalaya. It is hoped that this workshop will provide some guidelines and shared experiences.

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Economic and Ecological Rehabilitation through Sustainable Commercialization of Medicinal Plants in the Indian Himalaya

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1.0 Introduction

The Himalayas comprise the highest mountain system in the world. About 100 million people live in these mountains and 450 million people of the vast Indo-Gangetic plains also depend to some degree on these mountains. The pressures exerted by the rapidly growing human and cattle populations, coupled with unsustainable management policies have resulted in severe ecological degradation which has already rendered almost one-third of the land area totally unproductive.

The degradation results from a mix of the following factors: indiscriminate expansion of agriculture on unsuitable slopes; uncontrolled grazing; intensive logging for fuel and timber and lopping for fodder; unscientific exploitation of medicinal plants; clear felling and burning for shifting cultivation; constructions of roads, dams; and extensive open cast mining. Rapid destruction of the natural resource base has impoverished the poor and powerless and pushed them down the poverty line. People of the Himalayas are migrating in large numbers to the cities and plains in search of jobs.

The botanical wealth of the Himalayas comprises more than 8,000 species belonging to about 80 families, both sub-tropical and temperate. About 30% of the Himalayan flora is endemic. Documented

information on wild edible plants of India (having medicinal value also), shows that over 250 species occur in the Western Himalayas, and the diversity is more pronounced in the Eastern Himalayas with over 300 species. More diversity in medicinal plant species tends to occur in the Western Himalayas.

The Himalayan region also shows a high diversity of traditional medical knowledge due to cultural and environmental diversity. In this vast mountain area, Ayurveda, Tibetan, Chinese and Unani medicine systems are practised by ethnic groups.

A programme on medicinal plant R and D including conservation and cultivation can have a major impact by increasing community participation, income generation, poverty alleviation and guaranteeing affordable health care. Given adequate research and policy support, they could potentially become high value crops. They have great promise for fragile habitats where conventional farming is fraught with hazard.

2.0 Medicinal Plants

Simply defined, medicinal plants "are plants that are commonly used in treating and preventing specific ailments and diseases, and that are generally considered to play a beneficial role in health care."

Medicinal plants constitute an important group among economic plants. They have been used since ancient times: countries such as China and India have traditions of plant remedies dating back to 5,000-4,000 BC (Ramachandaran and Mehtani 1990a). The traditional systems of medicine have a heritage of community acceptance (Ayensu 1986), and the experience and knowledge of local herbalists, who can utilize enormous diversity of plants, which is much sought after and patronized. The use of the local flora for plant cures is in fact inherent in rural societies.

India has recognized 2,500-3,000 species of which 540 find major use as herbal drugs (about 200 of these are used in bulk quantities and are articles of commerce). India has a special position in the world today, as it is one of the few countries which is actually capable of producing most of the important plants used both in modern as well as traditional systems of medicine. This is because the country has a vast area with a wide variation in climates, soils, altitudes and latitudes.

India is a major exporter of medicinal plants. Germany, UK, France, Switzerland, Japan and USA are major importers of Indian medicinal plants, together accounting for 75% of total exports. The total export value of medicinal plants products in 1991/92 was US$3.56 million and in 1994/94 US$4.38 million (APEDA 1995). An important fact is that these statistics do not account for a huge volume of undocumented, illegal medicinal plant trade. In addition, the values quoted are the returns to India only. In reality, the plant materials would sell in foreign markets at significantly higher prices.

The World Health Organization (WHO) estimates that approximately 80% of the developing World population meet their primary health care needs through traditional medicine (Bannerman 1982). Medicinal plant demand is steadily increasing, not only in developing countries, but also in the industrialized nations. In both Europe and North America, for example, the demand is being fuelled by an outburst of consumer interest in products that are all natural as well as by aggressive marketing of herbal remedies (Lewington 1993), even if they are sold simply as diet supplements to avoid regulatory constraints.

Jain (1987) identified 120 medicinal plants that can be classified as endangered or rare. Vigorous measures are needed to stop genetic erosion and extinction of species due to habitat loss, ill-advised selection and ill-planned genetic improvement. Special attention should be paid to Himalayan ecosystems, because of the many endemic species and the important medicinal plants found there. Conservation and cultivation of medicinal plants under agroforestry, rainfed agriculture, watershed development, joint forest management, control of shifting cultivation programmes and reclamation of mined areas are vital to the ecological and economic rehabilitation of the Himalayas.

Conservation and development have to be partnered in the process of environmental protection. Biological diversity has to be maintained to achieve sustainable development. Conservation is therefore integral to development and not a constraint to it. Strategies that seek to integrate conservation and cultivation of medicinal plants are likely to be an important sustainable income source.

An important first step would be to carry out a detailed inventory of known medicinal plant species and to document their distribution and uses. Existing data need to be standardized. With good documentation, strategies and policies can be clarified. For instance, as a

safeguard, the Directorate of Foreign Trade has already prohibited the export of plants, plant portions and derivatives of 46 species. In the Himalayan region such prohibition may not be very effective if trade is permissible across the Indian borders with Nepal, Bhutan and China.

For commercial viability, medicinal plant production should be located in the regions where the yield and production are usually high, environmental conditions suitable and pests, pathogens and weeds more easily controlled. Successful production systems in suitable areas would be enhanced by encouraging and utilizing knowledge and labour of local people, especially women.

In the short term, *in situ* and *ex situ* conservation coupled with cultivation of representative samples of threatened species provides the most viable option until the time when appropriate genetic enhancement can be developed.

In situ conservation can build on the network of protected areas which includes national parks, sanctuaries, biosphere reserves, preservation plots, religious groves and ethnological protection areas spread all over the Himalayan mountains. The Indian Forest Act, 1927 and Indian Wild Life Act prohibit illegal removal of plants from the protected areas.

Ex situ conservation can build on efforts by the Botanic Gardens Conservation International, in cooperation with IUCN and WWF, to establish an effective network of botanic gardens for medicinal plant conservation. However, in some cases broader germplasm collections and gene banks will be needed.

In 1994, IDRC Canada initiated a Medicinal Plants Network to address conservation and use (Bajaj and Williams 1995). The network has adopted a proactive, user-based biodiversity conservation strategy and efforts are targeted at undertaking research partnerships with existing users of the resource base–local communities and indigenous industries. In the Himalayan region, IDRC is working with the Indian Council of Forestry Research and Education ICFRE, involving Forest Research Institute, Dehra Dun, and Himalayan Research Institute, Shimla.

The Forest Research Institute, Dehra Dun has started a medicinal plant nursery at Chakrata for *ex situ* conservation and supply of medicinal plants of the Western Himalayas. Some of the State Governments have established medicinal gardens for *ex situ* conservation of endangered species.

'UTTHAN', an NGO, has listed all the protected areas, gardens and institutions in the Himalayan region. There is a need to inventory, survey, and evaluate medicinal plants in these protected areas. Accordingly, the human population from the protected areas is being shifted which may cause numerous problems. After all, only through involvement of local inhabitants in conservation and development of medicinal plants will eco-restoration, sustainable development and poverty alleviation in the Himalayas be assured.

3.0 The Continuing Role of Medicinal Plants

Medicinal plants, used by billions of people of the world, are one of the most powerful economic resources of our times. As we enter the twenty first century, it is readily apparent that the vast majority of the human population will continue to depend on plants for their primary source of health care.

It is well known that there is much valuable indigenous knowledge about the medicinal use of plants among the many tribal societies, especially those living in remote areas of the Himalayas. An education programme developed in collaboration with local collectors, dispensaries and beneficiaries should be a priority. This programme should clearly identify the value of medicinal plants, reasons for the need to protect and conserve them in ecosystems, the close links to individual and family health needs, and economic incentives accruing from protecting the plants' resources.

The use of medicinal plants for primary health care has several advantages and should be encouraged. In many parts of the Himalayas, there are no doctors. In interior areas, especially during rains and snow fall, allopathic drugs invariably arrive after their expiry date. It would be better, in such circumstances, to use herbal medicines chosen with care, supplied with a guarantee of quality, and prescribed by local practitioners whom the patients have trust in. The availability of locally grown drugs, their relatively low cost and minimum side effects are important factors in providing primary health care. The neglect of medicinal plants coupled with deforestation and the subsequently reduced availability of herbals portends a significant attrition in the quality of life.

Many medicinal plants can be cultivated on marginal, remote and degraded lands with low monetary inputs. All efforts should be made to carry out intensive, in-depth studies on selected medicinal plants in collaboration with local farmers to determine optimum environmental requirements for sustainable production.

At present, there are no well-organized marketing and systems for medicinal plant raw materials. No reliable data are available regarding total demands of each raw material, the prevailing prices and localized availability, in the country. There is no direct linkage between collecting, marketing and processing agencies. Hence, prices of herbals vary in a cyclical and unpredictable manner.

Many people of the Himalayas depend on forests for their sustenance. Medicinal plants are both a source of income and affordable health care remedies. The fluctuation in prices of medicinal plants directly affects the economy of these people. Systematic marketing and trade of medicinal plants can improve socio-economic conditions of specific areas. If appropriate arrangements are made supplies of raw material from wild sources will rapidly increase necessitating due attention being paid to cultivation to avoid exploitation (Singh and Ghosh, 1993).

The demand for medicinal plants by industry and for export is soaring. To meet export needs, cultivation of selected species is the only alternative to collecting plants from the wild. Once production systems are in place, it will be possible to consider breeding of improved cultivars adapted to different agro-ecological regions so that production can be matched to availability of infrastructure.

4.0 Private Investment

In India, a liberalization policy since 1991 promotes private sector investment to assist growth in the economy. Nonetheless, in order to stimulate international investment in R & D oriented industries like pharmaceuticals, it is necessary to provide adequate protection to intellectual property rights. The Indian pharmaceutical industry seems to be taking concrete steps in this regard. The trigger in this case is two-fold: (a) the increasing competition from international drug companies who are taking new initiatives to invest in India, and (b) the anticipated adoption of the product patent by India as a part of our

by India as a part of our accepting Trade-Related Intellectual Rights (TRIPS). The Indian Patent Act of 1970 which permitted only process patents and not product patents, actually triggered the growth of the Indian pharmaceutical industry, but discouraged foreign investment.

As a part of the TRIPS, the pharmaceutical industry will have the right to patent products as well as processes throughout the world including India. Indian pharmaceutical companies are well aware of this inevitable change in the scenario and are responding.

Whether it is an Indian-owned company or an international drug company operating in India, the advantages and scope for undertaking R&D in the country are significant. Firstly, there is the cost advantage. Major costs in R&D are in the infrastructure and in the scientists. Most infrastructure facilities are much cheaper in India than in developed countries. Indian scientists of international calibre are available at comparatively cheaper costs. The costs of carrying out clinical trials will also be much lower in India. Also, there are added advantages of access to a large and growing domestic market.

A third major factor which makes R&D more relevant in India is that many of the diseases prevalent here (e.g. tuberculosis, hepatitis, skin diseases etc.) are not comparable in the West. That makes it worthwhile to do research on many tropical diseases for the whole global market from a base in India. Currently, brain-related disorders account for the highest percentage of populations hospitalized the world over and synthetic drugs have only provided partial answers. Traditional systems with their greater emphasis on the social and psychological context of disease need to be drawn upon further.

There is a tendency for the traditional practitioners of Indian systems of medicine–Ayurveda, Siddha and Unani–to provide prescriptions in the form of manufactured products rather than making up their own prescriptions. As a result, about 7,000 pharmacies have started manufacturing drugs utilizing medicinal plants. The success of Himalaya Drug Company Limited and Dabur (India) Limited shows that there is real opportunity in this area and this can only be enhanced and extended through R&D work of international quality.

5.0 National Aspects

Besides the Central Government, several State Governments and some pharmaceutical companies have started their own research and development units related to cultivation of medicinal plants. With the increasing awareness of the limitations of allopathic system, the awakening of pride in the national systems of medicine, and demand for medicinal plants in Europe and North America, Indian systems of medicine are expected to grow rapidly.

To accelerate progress, the Government of India has established a new department for the Indian System of Medicine and Homeopathy. A Central Council of Ayurveda has been fully strengthened. Pharmacopoeial standards of most important plants are being laid down. National laboratories, Universities and other institutions have started collaborative work with R&D Corporations. Departments of various Ministries and NGOs are all joining hands to conserve, cultivate, collect, process and market medicinal plants.

As a nation, what we need most of all is generation of additional employment for about 30 million people per annum for the next several decades. Apart from the continuing increase in the population at the rate of nearly 20 million per annum, we will have to provide for the inevitable shift of people from agriculture (including shifting cultivation) to manufacturing industries and services. Today, nearly 90% of the Himalayan population (compared to 70% in the country) is dependent on agriculture, forestry, horticulture and animal husbandry as compared to less than 10% in the case of developed countries. In order to reduce the dependence on land, we have to create jobs, including in pharmaceutical companies; otherwise we will have a massive number of landless labour and acute social tensions. This is not merely an economic need but also a social and ecological need of the country. Lack of employment and income in a country with no social safety net can only lead people to extreme despair on an increasing scale.

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Resource Management in Mountain Development Through Farm Forestry in Nepal

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1.0 Introduction

Nepal's forestry, especially in the hilly and mountainous regions, is becoming unsustainable. More than half of the current fuelwood harvest exceeds replacement growth in the forests and is threatening the source for future supply. Although the source for the future is diminishing, the energy needs of the population are increasing rapidly. In 1992/93, 68% of primary energy supply came from fuelwood, 15% from agricultural residues, 8% from animal dung, and the balance from commercial products. These proportions are not expected to change much in the near future (MPSC 1988).

Another important resource obtained from the forest by a large section of the population is plant biomass for animal fodder and bedding materials. After use, it is mixed with animal dung and converted to compost which is the major source of plant nutrients in the hill farming systems of Nepal. Trees and shrubs either growing naturally in the forests and/or raised and maintained by the farmers within their farm forestry systems include bamboos and other grasses primarily for the purpose of supplying green foliage or fodder to animals.

Within the last 13 years, almost 15% of the forests of the Tarai or plains (which also contain 30% of the most accessible and fast growing

forests in Nepal) has disappeared. Forest depletion is rapid in the hills. Recent surveys indicate that only 15% of forests have over 70% crown cover; and only 1% has significant regeneration. In the hills and mountains, the loss of forest cover is about one percent per annum.

Total fuelwood consumption for 1992-93 was estimated at about 11 million tons. This, due to population increase, had reached 11.5 million tons in 1994-95. The amount of timber harvested annually is around 2.8 million m^3, worth $ 200 millions at current prices.

The sustainable fuelwood production capacity of Nepal under prevailing conditions is estimated at 7.5 m tons. However, the production figure for 1994-95 was only 4.3 m tons.

The consequences of unsustainable exploitation of forest resources will be disastrous for the livelihoods of 90% of Nepal's population who live in rural areas. The ever rising demand for fuelwood, fodder and construction timber to meet the needs of the growing population, is causing severe environmental degradation in Nepal (Mahat 1987). This degradation is of serious concern for the long term stability of the fragile ecosystems of the Himalayas.

The landscape is characterized by elaborate crop and livestock farming systems where food plants, trees, shrubs, grassy vegetation and domesticated animals interact to generate a complex mix of primary and secondary production processes to fulfil the basic needs of the people. These systems are threatened by i) a high ratio of population to cultivated land; ii) the high rate of both human (2.6% pa) and livestock population growth (1.0% pa); and iii) the shrinking supply of food, fodder, fuelwood (Wyatt-Smith 1982).

In the mountain areas, these pressures have caused rapid deforestation and clearing of steep slopes for cultivation. Resultant soil erosion rates are currently estimated at roughly 300 million tons per year; roughly 20 tons/ha/year. The result is constant decline in agricultural productivity which is causing widespread poverty.

2.0 Options for Solutions

The root cause of most of the problems associated with environmental degradation is rapid increase in human and animal population (2.6 and 1.0% per annum respectively). The government's failure to

control both the human and animal populations can be partly held responsible.

Nonetheless, the Master Plan for the forestry sector, in response to social needs, has outlined six major programmes in Nepal. They are:

- Community and Private Forestry
- National and Leasehold Forestry
- Conservation of Ecosystems and Genetic Resources
- Soil Conservation and Watershed Management
- Wood Based Industries
- Medicinal and Aromatic Plants and other Minor Forest Products.

The largest of these programmes is the community and private forestry with a declared government policy to "develop and manage forest resources through the active participation of individuals and communities to meet their basic needs". The private forestry programme refers to the management of trees on private land to produce small timber, animal fodder, fuelwood, poles, and other subsistence goods and services as well as to provide some marketable produce. They include trees in small woodlots or trees integrated with agricultural crops in agro-forestry cropping. Growing more trees on farmlands has a high national priority for three reasons:

a. it can significantly augment forest resources reducing the pressure on forest lands;
b. It will help check soil erosion and lead to sound watershed management; and
c. planting on private land has demonstrated social benefits, greater self-sufficiency and improved income generation through small scale industrial activities.

Although private forestry is an important programme for the overall development of the forestry sector in Nepal, the projects so far undertaken by the government have been limited to free distribution of seedlings from Department nurseries. The TU/IDRC Farm Forestry Project has taken a major initiative to develop farm forestry technologies in Nepal with emphasis on the development of appropriate agroforestry systems and the establishment of on-farm woodlots to benefit rural people.

3.0 Potential Benefits of Farm Forestry Technologies

Farm forestry activities are important in all the three agro-ecological zones of Nepal i.e. Tarai, Inner Tarai and Mid-hills. However, the most important ecological and economic impacts from such activities will be in the hills and mountains, because the climates, topographies and social and economic situations in these areas are all favourable for private tree-growing and community forestry. Such activities can transform the management of old, traditional, private forests and the growing of trees on field bunds or in small blocks on degraded lands and in flood-affected areas in river plains.

The project has sponsored tree plantings on both private farm lands and wastelands, especially in flood plains, and rehabilitation of degraded lands has resulted in significant increase in food production. Even in existing agricultural fields, introducing trees has not caused any significant decrease in food production.

Both in the Tarai and the Mid-hills, the majority of the farmers require seedlings of multipurpose trees such as *Dalbergia sissoo* to start tree farming. The demand also includes species like *Eucalyptus camaldulensis, Leucaena leucocephala, Melia azederach, Ceiba pentandra* and *Acacia catechu.* Once farmers become familiar with these species in farm forestry, they recognize that *Leucaena leucocephala* and *Melia azederach* are the preferred species for leaf fodder; *Eucalyptus camaldulensis* for small poles; *Ceiba pentandra* for its fibre; and *Acacia catechu* for wood. *Acacia auriculiformis* and *Cassia siamea* are preferred in areas with large numbers of stray cattle.

On a limited basis, afforestation of agricultural and flood plains of Nepal has begun with project support and increasing interest shown in it is due to:

a. Lack of irrigation facilities for annual crops, leading to low agricultural yields and limited options;
b. low production on marginal agricultural land (e.g. only 200 kg of corn/ha);
c. less intensive management is required to grow trees as an intercrop or alternative crop; and

d. the profitability of tree based farming systems since there is a growing market for forestry products.

There was no standing forest in the project areas. For this study, three potential species for private planting were considered as they were the only species for which existing data and experience were available: *Dalbergia sissoo, Eucalyptus* and *Populus.* However, other important species are *Acacia catechu, Bombax ceiba, Tectona grandis,* bamboo species, and *Ceiba pentandra,* among others were also included. It is also recognized that farmers may interplant a variety of tree and woody species with different rotations depending on the local site and soil conditions, as well as local demand for specific wood products.

4.0 Technologies Investigated

4.1 Plant Species Selected

A series of species trials involving over fifty species were conducted in the three regions of central and western Nepal. Based on the survival and growth rates of plants, species have been identified as potential for farm forestry plantations (Table 1).

Table 1. Tree species with potential for farm planting in different sites

Tarai	Inner Tarai	Mid-hills
Eucalyptus camaldulensis	*Melia azedarach*	*Prunus cerasoides*
Leucaena leucocephala	*Eucalyptus camaldulensis*	*Ficus semicordata*
Dalbergia sissoo	*Dalbergia sissoo*	*Leucaena leucocephala*
Ceiba pentandra	*Ficus semicordata*	*Lysesteria formosa*
Acacia catechu	*Leucaena leucocephala*	*Albizia chinensis*
Melia azedarach	*Morus alba*	*Erythrina indica*
Albizia chinensis	*Ficus roxburghii*	*Artocarpus lakoocha*
Ficus semicordata	*Ficus semicordata*	*Dalbergia sissoo*

Bauhinia variegata	*Cassia siamea*	*Ficus semicordata*
Dalbergia latifolia	*Acacia catechu*	*Bauhinia vare igata*
Anthocephalus cadamba	*Acacia auriculiformis*	*Eucalyptus camalduensis*
Cassia siamea	*Albizia lebbek*	*Melia azedarach*
Bamboo, Rattan and Medicinal Plants	Bamboo, Rattan and Medicinal Plants	Bamboo and Medicinal Plants

4.2 Simple Propagation Techniques

In order to develop simple propagation techniques for the most promising species which are appropriate to small farms, five different methods of propagation were tried involving thirty different tree species.

Raising seedlings in plastic bags of root-shoot cuttings was promising with most species tested. Eighteen species can be successfully propagated by stem cuttings:

Bassia butyracea, Bauhinia purpurea, Boehmeria rugulosa, Buddleia asiatica, Bridelia retusa, Ceiba pentandra, Dalbergia sissoo, Erythrina indica, Ficus cunia, F. hispida, F. lacor, F. nemoralis, F. glaberrima, F. roxburghii, Garuga pinnata, Grewia latifolia, Premna integrifolia, P. victorata and Bamboos.

Preparation of cutting materials, planting and aftercare methods have been standardized and simple, ready-to-follow instruction booklets have been prepared and published for extension.

Bamboos also can be propagated by a range of techniques in Nepal: *Dendrocalamus hamiltonii* through culm cuttings and offset/rhizomes (also seed can be used); *D. strictus* through offset/rhizomes (or seed); *Bambusa balcooa* through macroproliteration and *B. nutans* through culm cuttings (Banik 1995). Rattans are amenable to seed propagation and techniques are being developed for medicinal plants (see other papers in this volume).

4.3 Social Fencing

After years of experience, the project concluded that the most effective method to protect the planted trees and seedlings is to convince the local people of the benefits of farm-forestry. Once the local people are convinced of the benefits, they themselves ensure that the planted trees are protected.

4.4 Development of Planting Models

Five models were introduced according to the site availability and preferences of the farmers:

- Block plantations
- Roadside, canalside, riverside plantations
- Field bund and pond bund plantations
- Homestead plantations
- Mixed plantations

The concept behind all the models is to obtain fuelwood, fodder, small poles and green manure. By concentrating on unused lands in the beginning, the project could demonstrate to the farmers that they are not risking any reduction in crop yields by introducing trees in their farming systems. The project also encouraged the farmers to try out a number of species in their plantations so that they could themselves make a choice of potential species for future reforestation.

A large number of farmers in more than twenty Village Development Committees (VDCs) have undertaken tree planting activities, adopting one or more models depending upon the availability of sites. The number is rising each year.

4.5 Improved Agroforestry Practices

Agroforestry trials emphasizing tree/crop interactions have been conducted both in the hills and plains. Mixed cropping of trees and crops has a big potential in farm forestry as the majority of farms in Nepal are small. Agroforestry models developed by the project in various forms as per farmers' needs were promoted through extension.

A large number of tree-crop combinations have also been tested using tree and crop species preferred by the farmers, and appropriate designs and practices perfected for extension.

In some designs, the project encouraged tree rows with multiple use species to produce fodder, fruit, fuelwood and small poles. These tree rows were popular with small farmers who had to obtain a number of products. A combination of timber or fruit species, *Eucalyptus* for small poles, and *Leucaena* for fodder was preferred.

For those farmers who are reluctant to intercrop trees and crops in the field, trees are planted along farm boundaries. This design has

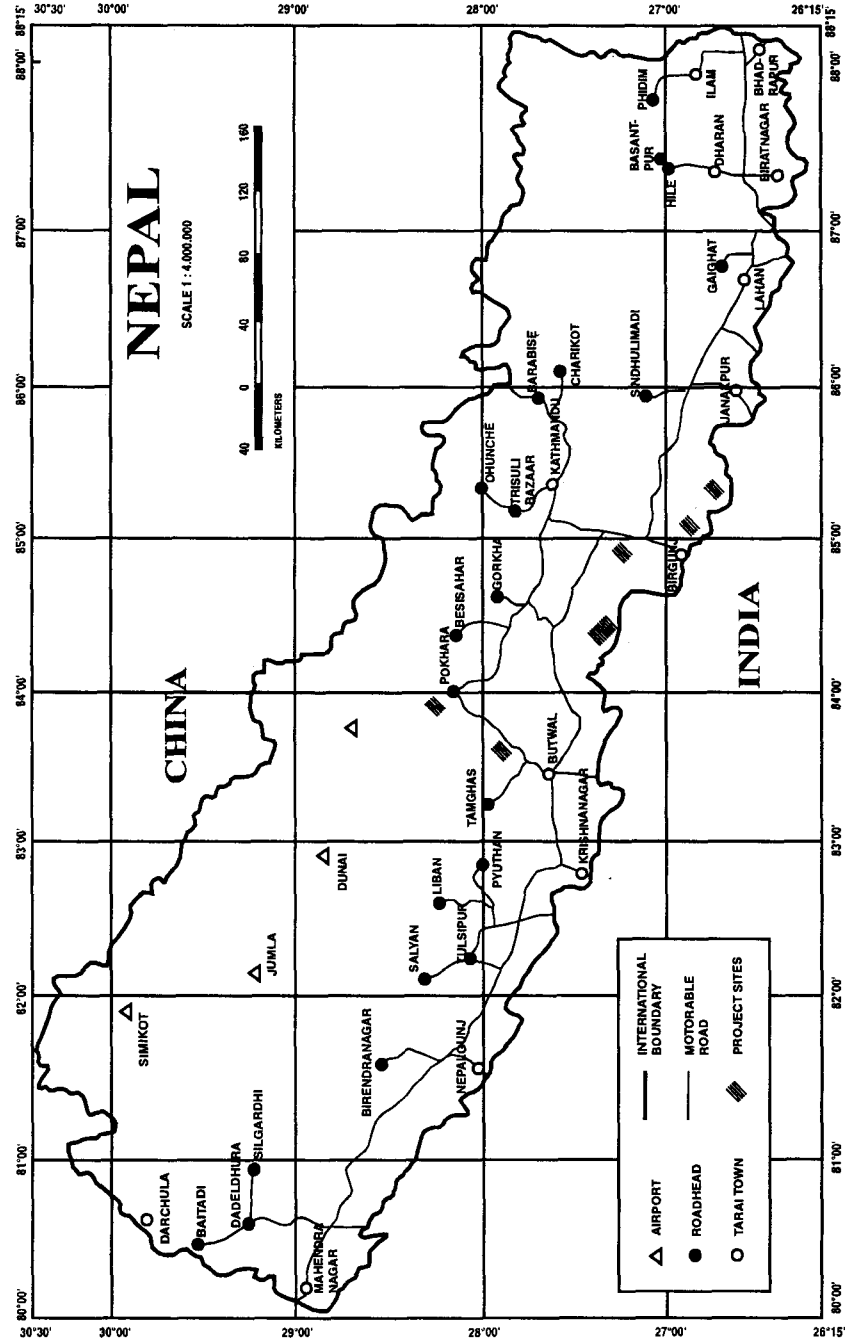

Figure 1. Map of Nepal showing project activity sites

become popular amongst rice farmers. We estimate roughly 3-5% of the upland cultivated areas which at present are used for growing crops unsuitable for such areas. These can be changed to intercropping with appropriate tree and crop combinations.

4.6 Specific Applications for River Affected and River Damaged Areas

There are around 3,00,000 ha of river damaged or river affected areas in Nepal. The project focussed its attention on this to develop appropriate technologies to reclaim the area for the benefit of farmers whose land had been lost. Experiments were conducted along four river sites, two in the Tarai, one each in the Mid-hills and Inner Tarai (Figure 1, page 138). This enabled researchers to verify results obtained in research stations during previous years. The following were undertaken:

4.6.1 Evaluation of tree species for riverside planting

Nine species were evaluated for survival, annual rate of growth, biomass yield, and farmers' acceptance: *Dalbergia sissoo, Acacia catechu, Ceiba pentandra, Melia azedarach, Albizia chinensis, Leucaena leucocephala* and *Eucalyptus camaldulensis* have been found to be promising species.

4.6.2 Fodder tree block plantation

Seven fodder tree species selected on the basis of their superior performance by a US-AID-funded Fodder Tree Management Project were planted in the flood affected areas. On the basis of the height growth, *Ficus semicordata* (9.2 m) *Melia azedarach* (5.7 m) *Ficus clavata* (4.3 m) and *Litsea monopetala* (4.0 m) were found to be superior after four years of evaluation. *Artocarpus lakoocha, Bassia butyracea* and *Grewia latifolia* were poor performers and therefore were not included. Fodder tree blocks were established in the institutional lands.

4.6.3 Intercropping studies

Intercropping techniques developed by the project were introduced in the area and compared with existing cropping systems.

Farmers have modified the traditionally practised mixed cropping and have adopted intercropping with line sowing. Wide spacing available for crop growing allows the use of bullock power. The cropping duration also increased in this system. Many traditional but low yielding crops like rice and maize were replaced by better yielding crops and fruits in demonstration plots. There has been a gradual switch by the farmers. Millets, sweet potato and lentil are some of the crops introduced. Banana is extensively grown now as an intercrop, because of its high returns. A tree-sugarcane intercropping system has been improved by adding a number of cashcrops like lentil, mustard and radish in the system. Such annual crops have provided the farmers with extra income before sugarcane is harvested.

4.6.4 Alley farming

The species were selected so that they provided farmers with a mix of subsistence and commercial products. Tree rows consisted of *Dalbergia sissoo* (timber) *Eucalyptus camaldulensis* (small pole) and *Leucaena leucocephala* (fodder + fuel). The intercrops were sesame, sorghum, lentil, linseed and mung bean. Oats were also intercropped where there was additional need for forage.

4.6.5 Silvipastoral systems

Different forages were introduced in tree plantations and silvipastoral systems. The best results were obtained when seeds of lab bean (15%); *Leucaena leucocephala* (30%); and Kudju grass (55%) were broadcasted in standing plantations of one year-old sissoo with spacing of 2 x 4 m. An average yield of 27 tons of green forage was obtained from one hectare. *Brachiaria mutica, Brachiaria decumbens* and *Setaria* have also given good forage yields. Bamboos have also been included in the systems developed.

4.6.6 Improving existing rangelands

Public grazing lands are the main source of animal feed in most villages in the Mid-hills. The project failed in its bid to improve these due to tremendous human and animal pressure. A controlled cut and

carry system introduced by the project in Syangja district has been successful because farmers completely controlled the stray grazing and changed to stall feeding. About 270 tons of forage yield was harvested over a period of six months from three hectares of land. The system of stall feeding has been introduced in the project areas and this is expected to improve the conditions of the community grazing areas.

4.6.7 Study on time of planting

In most river-affected areas, normal tree-planting time of July is not suitable, because flash floods destroy the new plantations. Tree-planting during the end of monsoon season i.e. September was found to be more suitable.

5.0 Lessons Learned

The results of the project work suggests that people in and around the project sites are better off now than they were when the project started. There is an increased supply of basic goods and services such as fodder, fuelwood, and compost manure. There has also been a rise in production of essential food grains either due to better crop selection and improved cropping practices or due to additional areas being brought under cultivation using improved technologies/ implements introduced by the project. Table 2 provides one such example:

Table 2. Impact of project activities in Andhi Khola (Syangja district, midhills)

Item	Baseline Survey 1993	Present 1995
Education (Literacy %)	76.3	79.6
Land holding (ha)		
Domestic animals (Goats, cattle, buffaloes), no.	180	223
Fuelwood used (t/y)	0.76	1.25

Wheat yield	2.2 t/ha	3.6
Maize yield	1.7 t/ha	2.4
Millet yield	0.8 t/ha	2.8
Rice yield	4.2 t/ha	3.4
Trees in river-affected areas (no.)	8,462	40,445

Also, there has been a steep increase in land value from US$1000/ha before the project started to US$ 5000/ha mainly due to reclamation measures adopted by the project.

The Project has successfully demonstrated that it is essential for scientists from agriculture, forestry and social science disciplines to work together to develop suitable technologies for villagers. The project has also emphasized the importance of scientists and farmers working together to develop, test, verify and extend technologies by conducting research activities in farmers' fields. This culture of 'working together' developed through the project enables the development of appropriate technologies with a sound scientific and socio-economic grounding for the benefit of the people.

Interestingly, the villagers who were initially reluctant to get involved in the activities have become the most vocal supporters of the project after seeing its benefits. The farmer-to-farmer approach adopted by the project to extend farm forestry technology has benefitted the newcomers immensely, because they have felt that the best way of learning is by doing it themselves. The project has included study tours to bring the farmers to observe benefits derived by fellow farmers from their farm forestry activities. The project has also allocated special sessions in each training programme to allow interaction between potential farm foresters and project beneficiaries so that the know-how can be shared.

The success or failure of farm forestry depends to a large extent on the ability of the researcher or extension agent to understand the role of women and children in the farming system. Women play an important roles in planting, protection and management of trees; therefore, it is essential to get their opinions in such decisions. Children were found performing various activities with great enthusiasm which must be capitalized to bring successful bearing on farm forestry. Tree-

planting in Nepal coincides with the main paddy cultivation time when most adults are busy in rice fields. Children have their summer holidays during the planting season and can get involved in tree plantations devoting more time than their parents. More importantly, involving children in environmental work helps to prepare environmentally conscious human resources for the future.

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Bamboo Production, Use and Trade in Eastern Nepal: A Case Study

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1.0 Introduction

Bamboo-based economic activities are an intrinsic part of both the rural and urban socio-economic life of Nepal. The rural economy is highly dependent on bamboo resources. Entire culms are used as rafters, pillars, and fence posts; they are split into sections, crushed into panels or split for further use; or are woven and then used. The importance of bamboos in the predominantly agricultural economy of Nepal is well-recognized. Bamboo and bamboo products are in great demand by farmers, artisans and rural as well as urban enterprises.

Bamboo-based local enterprises, especially in the mountain areas, are an important source of employment to both the rural and urban workforce. It is estimated that more than 100,000 mandays of workforce is currently employed in this sector. Out of the estimated 12% contribution to the national GDP by the forestry sector, the contribution of bamboo is 1-2% (Karki 1995), although no proper accounting has been carried out. However, the low contribution is mainly due to lack of processing at the production sites and/or rural areas where factor costs are relatively low and most of the products are consumed to meet subsistence needs.

Most of the bamboo products such as mats, baskets, household accessories, and implements are manufactured by the local people

and sold in local markets. The marketing is strictly local/regional in nature. The national market, although strong, does not receive products from all the regions due to lack of transportation and well established marketing. The only item which captures value-added is furniture for which a national/international market is slowly emerging with demands for different types of household furniture; and high/medium end market-targeted handicraft products are also in demand. Due to an abundance of human resources and rich, indigenous craftsmanship, Nepal could gain comparative advantage, provided the workforce could be trained in improving their skills and if enterprises could be developed for processing and marketing.

2.0 Bamboo Resources

Bamboos are native to all the three major ecological zones : Tarai, Mid-hills, and Mountains of Nepal. However, diversity is more concentrated in the eastern half of the country (from Annapurna to Kanchenjungha range of the Himalayan mountains). The species abundance is directly related to the rainfall amount and distribution with areas receiving widely distributed, higher rainfall such as Pokhara and Illam, regions having the largest number of species.

One characteristic of bamboos in Nepal is that tropical bamboos found in Southeast Asia as well as the temperate bamboos found in Tibet and Bhutan occur (Stapleton 1990).

Many bamboos are semi-domesticated. They form major agroforestry crops widely planted on farms and vacant land in the vicinity of settlements. There are a large number of bamboo farms, with an area of 1.25-2.5 ha each in size, in the eastern Tarai. Natural stands are mixed with deciduous subtropical forest vegetation in the lowlands. However, the natural stands are suffering from uncontrolled exploitation, lack of any type of management, lack of plantation development schemes to lessen pressure on them, and unsustainable harvesting. In terms of utilization, weaving is the most popular as 70% of the farmers grow bamboo on their farms and around homesteads. About 66% of the bamboos are grown for commercial purposes and an equal percentage of growers are interested in expanding bamboo farming (Shreshta 1994).

Table 1 summarizes the most important species and their uses in Nepal. There have been no systematic attempts to match provenances with end use or ecology; many species are used for the same purposes, often in the same order of importance.

Table 1. Major bamboo species of Nepal and their traditional uses

S. No.	Local Name	Scientific Name	Major Uses
1.	Dhanu Bans	*Bambusa balcoa*	scaffolding, storage bins, fencing roofing etc.
2.	Tama/Choya Bans	*B. hamiltonii*	bamboo shoots, weaving materials etc.
3.	Tharu Bans	*B. tulda*	basketeries, scafolding, low quality woven products
4.	Mal Bans	*B. nutans*	construction including bridges
5.	Malingo Bans	*Arundinaeea maling*	basket and furniture making
6.	Kante Bans	*B. bambos*	construction of buildings
7.	Kalo/Balu Bans	*Dendrocalamus hookerii*	weaving, construction, fodder
8.	Kath/Lathi Bans	*D. strictus*	sticks and constructions
9.	Nigalo Bans	*Drepanostachyum* sp.	construction, mats, weaving, fodder, and sticks
10.	Phosre Bans	*Dendrocalamus* sp.	weaving and fodder
11.	Ringal Bans	*Thamnocalamus* sp.	weaving and fodder
12.	Leyas/Murali	*Ampelocalamus patellans*	flute and weaving
13.	Koraincho Bans	*Oxytenanthera* sp.	fencing, construction, weaving
14.	Chigar Bans	*Thamnocalamus* sp.	food for black beer and pheasants
15.	Dhungre Bans	*Dendrocalamus giganteus*	construction, weaving, container, weaving

(Ref. Stapleton 1994; other data from authors)

3.0 The Case Study

Although the case study was conducted in east Nepal it did not specifically address mountain areas. Nonetheless, it is presented here

since the findings provide pointers to development needs in other areas. It highlights policy constraints which are common, and also causes of exploitation of the resource base.

Table 2. Villages studied and their characteristics

District	Village	No. of households	Population
Siraha	Kushaha Lakshminia	1476	8266
Udaypur	Hadiya	1273	3023
Saptari	Bhangaha	1768	9812

Table 3. Demographics of the districts (1995)

	SIRAHA	SAPTARI	UDAYPUR
Population	454,038	420,041	178,122
Male	234,789	215,393	89,760
Female	219,249	204,648	88,362
Household size	5.6	5.55	4.2
Total Households	81,078	76,683	42,410
Literacy (%)	32.6	34.3	24.5
Av. Size of:			
Land holding (ha)	2.45	1.98	2.34
Landlessness (households)	4403	4531	1023

In each village development committee (VDC), 60 households were surveyed using multi-stage sampling methods ensuring that the households were growing bamboo for both consumption and sale. Interviews using questionnaires were carried out of all the major actors of the bamboo production to the consumption chain, and secondary information was tapped as far as possible.

3.1 Results

The study results are divided into five key areas and each has been related to the resources-end-use spectrum.

In the study areas, major players in the bamboo-based activities were: private growers, forest user groups; local enterprises, outside enterprises, farmers, operational castes, craftspeople, local traders, Indian traders, urban businessmen, NGOs, and government officials.

The typical feature of the bamboo resources of the study area is that the bulk of it is in the hands of private growers and harvesters. The utilization is based on traditional practices, and to support agriculture. The harvesting is generally carried out by contract labourers which leads to waste and unsustainable growth. The processing is rudimentary and trading generally involves monopoly by a few wholesalers. The end-users have scant idea of the resource situation and their decisions are determined by convenience and price. Tables 4, 5 and 6 provide more information.

Table 4. Size of bamboo holding in the case study villages

Farm Size	No. of households Sampled	Av. bamboo holding (ha)	No. of clumps	No. of culms
< 0.65 ha	63	0.07	14	486.
0.65-2.00	57	0.15	32	1,280
2.00-4.00	47	0.35	69	2,898
> 4.00	12	0.76	143	5,720
Total	178	0.22	258	10,384

4.0 Using the Study for Development Options

The description of the economy of different village-based enterprises as shown below (Table 7), indicates the comparative advantage bamboo-based enterprises enjoy in the area. Bamboo-based activities provide various options for development.

Table 5. Production and consumption of bamboo culms in the sampled villages

Village of culms)	Production (no. culms/household	Annual yield culms/year	domestice use culms/year	Sale
Siraha	30,571	510	168	342
Saptari	40,403	673	316	357
Udaypur	18,153	313	131	182
Study Area	89,153	501	205	296

Note : A total of 178 bamboo growing households were sampled

Table 6. Bamboo prices in the study districts

District	Type of bamboo	Price (Rs.) Farm-gate	Retail Price (Rs.) (US$1 = Rs 56.00) E.Nepal	Kathmandu*	India
Siraha	Weaving Bamboo	30 (30.0)	60 (60.0)	100 (100)	96 (96.0)
	Construction	25 (27.8)	55 (61.1)	90 (100)	88 (98.0)
	Bamboo	40 (36.4)	70 (63.6)	110 (100)	102 (92.7)
	Scaffolding Stick Bamboo	12 (24.0)	30 (60.0)	50 (100)	48 (96.0)
Saptari	Weaving Bamboo	35 (31.8)	65 (59.1)	110 (100)	104 (94.6)
	Construction	28 (29.5)	58 (61.1)	95 (100)	93 (7.9)
	Bamboo	43 (35.8)	75 (62.5)	120 (100)	120 (100)
	Scaffolding Stick Bamboo	13 (26.0)	30 (60.0)	50 (100)	48 (96.0)
Udaypur	Weaving Bamboo	25 (27.8)	55 (61.1)	90 (100)	88 (97.8)
	Construction	22 (27.5)	55 (62.5)	80 (100)	80 (100)
	Bamboo	36 (32.7)	67 (60.9)	110 (100)	107 (92.3)
	Scaffolding Stick Bamboo	10 (25.0)	23 (57.5)	40 (100)	37 (92.5)

Local Names	Scientific Name	Use for
Chao/Gharaiya Bans	*Bambusa tulda*	Weaving
Ban/Banaiya/Tama Bans	*Dendrocalamus hamiltonii*	Stick/Pole
Harout/Bansin Bans	*Bambusa balcooa*	General Construction
Mal bans	*Bambusa nutans*	Scaffolding/Building

* Used as 100 p.c. to calculate price differences.

Table 7. Range of economic options, opportunities and constraints for the rural residents of Siraha, Saptari and Udaypur districts

Opportunities	Constraints
Bamboo and other NTFP extraction Good opportunities exist. The market for bamboo, (and medicinal plants) is excellent especially across the international border to India. Availability of merchant middlemen and petty agents (and networks of smugglers) and access to markets in India is relatively easy. Urban markets within Nepal are also gradually developing.	Government rules, regulations and restrictions are many; the permit system requires some attention.
Farming, Farm ownership Most common activity. Many market opportunities and good infrastructure (transport) and technical and financial services are available.	Requires access to land (of sufficient size), infrastructure (irrigation), labour force and capital. Land can be acquired through inheritance or through forest conservation, both of which are difficult options.
Tenant Farming Very common option among small landless farmers with long standing tenant - owner relationship is often inherited. Recent legislation provides rights to acquire some portion of the land they cultivate.	Needs interested land owners to rent out the land. The tenant needs sufficient land, some capital and foresight to benefit from his farming.
Small-Scale Rural Enterprises. Recent liberalisation of the economy has made it easy to set up small rural enterprises. Good markets exist for most of the products, specially based on forest products. Some technical and financial assistance is available.	Requires appropriate property, capital and collateral to invest, also technical knowledge and skills are needed which are rather difficult for the poor and less powerful.

Employment in Local Labour Market	
Employment opportunities are increasing in local industries, business and development projects. However, labour is in over-supply and a fairly large number go outside the region to Kathmandu and India to work at seasonal labour.	Opportunitites are decreasing in local agricultural sector; unskilled industrial jobs have long hours, low pay, hazardous conditions, and are risky. The seasonal migration is highly disruptive to family systems and risky.
Govt. and Public Sectors	
Many agencies and offices exist in the area.	Requires education, training, and personal connections.

Small-scale Enterprise Option

The option is suitable to the traditional craftsmen and the landless households who can use the traditional skills and abundant labour at their disposal to initiate small local enterprises. Generally, small capital to buy the necessary accessories and raw materials are required. In fact, lack of capital and appropriate market information are the most serious hurdles these family-based enterprises face. The government's role is critical here since it can offer small loans through group collateral schemes, provide training for skill improvement, and help link disadvantaged producers to the markets. There is the strong involvement of ethnic communities in bamboo crafts as can be seen from Table 8.

5.0 Policy and Institutional Issues

Although bamboo culms and bamboo products are exempt from any forest product regulations, the various government excise and police checkposts do charge nominal taxes. There are additional taxes from exporting raw bamboos. Export of handicrafts are freely allowed from the study area. Forest Sector Policy of 1989 states that forest resources of Nepal will be managed and utilized so as to give priority to the products that can best contribute to the basic needs of the people. However, the specific issues faced by the growers and entrepreneurs of the study area are described as follows:

- There is a lack of clear-cut government policy and suitable marketing infrastructure of any organized nature in the study area;

Table 8. Number of families of different ethnic groups engaged in bamboo works in some key bamboo craft villages

District	Ethnic Groups	Number of Families
SIRAHA		
Bathnaha	Malik Dom	6
Lahan Gudi	Sarki, Dusad, Magar, Gurung	45
Lahan Bhadaiya	Sarki, Dusad, Magar, Gurung	32
Harouth	Sahani, Malaha	118
Khapate Danda	Sarki, Kami	12
	Sub-total	213
SAPTARI		
Pansera	Dom	7
Sitapur	Dom	4
Thelia Byangri	Magar, Sarki	20
Bakdhuwa Basantpur	Magar, Rai	27
Basaha	Magar	20
	Sub-total	78
UDAYPUR		
Hadiya	Tharu, Sarki, Magar	8
Jogidaha	Kshetri, Sarki	18
Gaighat	Gurung, Rai, Sarki, Magar	32
	Sub-total	58
	Total	349

Note : These are the figures only from the major craft villages. In the study area, the total households exclusively engaged in bamboo work is estimated to be around 1,000.

- Gatherers/producers currently lack good information on:
  - * the extent of the resource and its sustainable, harvestable yield on an annual basis;
  - * the range of potential products from the resources and their potential usages;
  - * potential markets and marketing techniques;
  - * competitors, their strengths and weaknesses;

  * their own strengths and weaknesses compared to their competitors; and
  * how to get to the markets they have identified.
- There is a lack of market information.
- There is a lack of well thought-out, marketing strategies focused on bamboo products alone. Organizations such as production and marketing cooperatives, as well as NGOs, have potentials to provide small-scale enterprises with greater strength and more competitive economies of scale against larger competitors.

Producers also need to know what to do with marketing information. In this respect, training and capacity-building is important. Extension services are critical elements in developing marketing capabilities. Enterprises also need advice and training in entrepreneurial skills. In these areas, local NGOs can provide vital support to small scale producers. Government officials also need to have more familiarity with the market forces affecting the communities they work with, and policy makers need an understanding of these basics in order to know which policies create a conducive business environment for sustainable NTFP exploitation. Deal-making is a skill required by producers and producer groups involved in marketing their products, yet government enterprise promotion programmes often overlook it.

Even broader is the need for development of entrepreneurial skills for producers entering the complex market system. The potential entrepreneurs, especially from the private sector, lack skills not only in locating raw materials, but also lack knowledge on technology. The lack of technological innovation is making it increasingly difficult for producers to compete with substitutes or to raise productivity to a level where prices could remain competitive.

6.0 New Directions

Under the existing forest policy and recently enacted Forest Regulations (1995) of Nepal, management of a large part of the national forests is being handed over to the Forest User Groups. Similarly, degraded lands are being leased to private individuals or enterprises for reforestation and utilization. However, the government is unable to

meet the administrative, institutional, and technical support needed to successfully and timely implement the recently enacted policy reforms and institutional mechanisms. There is an inadequate pool of technical manpower to effectively implement new, some of them radical, programmes in forestry. For example, some of the new strategies included in the new forest policy are: reduction in fuelwood consumption by effective demand management, increased supply of fuelwood and fodder by involving user groups, private individuals and enterprises in private forestry; effective strategies for conservation of ecosystems and genetic resources; public education in conservation; improved pasture and livestock management; provision of livelihood to poor and landless people in forestry; improvement of the institutional framework; priority ranking of development programs and adherence to priorities; and encouraging active participation of the people and NGOs in forest development and protection.

Under this broad ranging scenario, the strategies need to be planned to maximize the utilization of NTFPs such as bamboo by adopting the following approaches:

* The government should provide a strong leadership and financial support to the bamboo-based enterprises;
* Private sector should be encouraged to invest in large-scale bamboo plantations and processing activities;
* Coordination among the different public and private agencies involved in the collection and processing of bamboo products should be enhanced;
* The private sector needs to take full advantage of the current policy provision of leasehold and private forestry to invest in the area of plantation establishment of better planting materials of bamboo;
* Trained manpower is needed to improve the harvesting, processing, utilization of bamboo;
* Good marketing infrastructure and a reliable information system should be developed;
* Technology transfer from neighbouring countries such as India is vital to develop an improved production systems and in-country processing facilities;

* As the primary producers/harvesters are forced to operate from a limited bargaining position, there is a need to organize them in groups such as production co-operatives to participate in the bamboo trade from a position of strength;
* Skill-oriented training courses need to be conducted, for instance, by the Institute of Forestry and Department of Forest Training Division.

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Rattan in Nepal

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1.0 Background

Nepal is one of the poorest countries in the world. It has a total area of 14.7 million ha and population of about 20 million. Although the area is small, it is rich in floral and faunal biodiversity, because of its diverse land configuration and high altitudinal ranges (i.e. 75 m to 8,848 m a msl). Geographically, Nepal is divided into five regions: Tarai, Siwalik (foot hills), Mid-hills, High hills and High Himalayas.

The Tarai is the flat land along the foot hills which is rich in sal forest and other mixed ever/semi-evergreen and riverine forest vegetation. This is the area where rattan used to be found in large quantities. Due to population pressure, severe habitat destruction and unmanaged harvesting of rattan, it has decreased and is now found in a very limited scale. Although rattan found in Nepal is not of too good quality, its diverse ecological conditions may allow the introduction of good quality rattan to meet growing demands. In this paper, the existing condition of rattan resources and the prospects for their development are described.

Although rattan is one of the native plant species of Nepal, it's conservation has been altogether neglected. There is no detailed documentation of ecological conditions and conservation status in the country. Biological, social, environmental, economical characteristics are unknown. There are no legal prescriptions governing harvesting, conservation, and utilization practices.

2.0 The Rattan Resource

Because of the lack of detailed research, there are few data reported from within the country. With the help of secondary information collected from various publications two genera and six species of rattan are reported in Nepal (Table 1).

Table 1. Rattan species of Nepal

Local Name	Scientific Name
Pani Bet	*Calamus tenuis*
Dangre Bet	*Calamus leptospadix*
Gauri bet	*Calamus acanthospathus*
Phakre bet	*Calamus latifolius*
Tokri bet	*Calamus erectus*
Himali bet	*Plectocomia himalayana*

According to a preliminary survey done by Chaudhary and Paudel, (1994), there are four important useful species of *Calamus* recorded (Table 2 and Fig.1) in Nepal.

Table 2. Distribution of major species

Scientific Name	Distribution
Calamus latifolius	Tarai and Inner Tarai region,common in moist sal deciduous forest of foot hills
Calamus tenuis	Tarai and Inner Tarai regions: in swampy areas of Sunsari, Nawalparasi, Bardiya, Kailali, Kanchanpur districts
Calamus leptospadix	Mid-hills region i.e. Kaski, Tanahu, Syangja Sankhuwasabha districts
Calamus acanthospathus	Eastern Tarai i.e. Jhapa, Morang

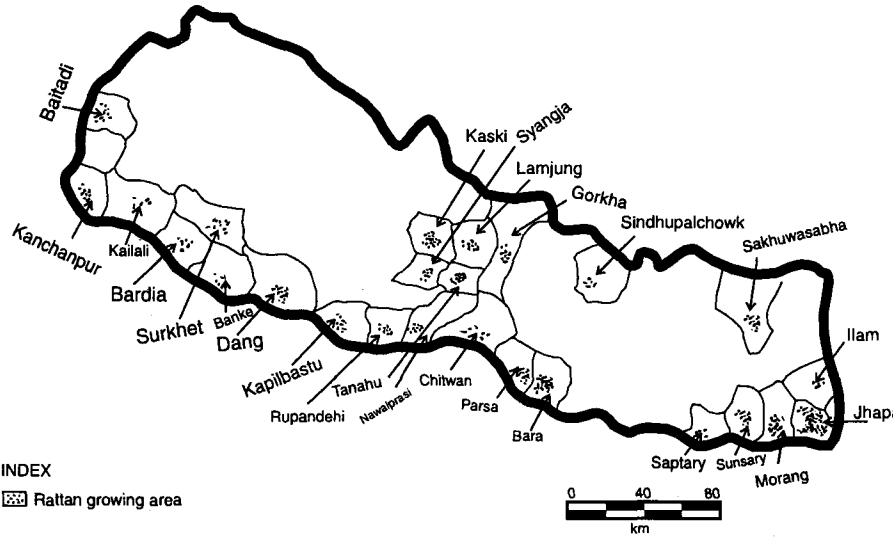

Figure 1: Map showing rattan distribution in Nepal

All the above listed species are found in pockets of NE India also. *C. erectus* has no economic potential, but the four useful species of Nepal are also utilized widely in India. *C. latifolius* is rarely used commercially but is used for making baskets, rattan seats and furniture; *C. tenuis* is the most popular rattan and is used for many purposes. *C. leptospadix* has thin culms of little utility and *C. aconthospatus* is one of the best cane-producing species (Sultan 1993).

Plectocomia himalayana is, however, used in China in the Himalayan area. This appears to be a species common to India, Nepal and China (Chen Sanyan *et al.* 1993). Also, *Calamus erectus* occurs in the Mid-hills of Nepal up to 3,000 m, but less attention has been paid to study its taxonomy and ecology.

As far as quantity of the stems is concerned, the actual status of rattan in Nepal has not been studied yet. The study of preliminary survey data suggests that the acreage and the growing stock of rattan are decreasing. In the past, the quantity of Nepalese rattan was good, especially in the eastern and western districts, but due to pressure on natural habitats caused by increasing human population, the quality has also gone down considerably. According to a recent

report by IUCN, three species of rattans–*C. leptospadix, C. latifolius* and *C. acanthospathus*–are listed as threatened. However, due to the lack of any intervention, people are freely harvesting not only to meet their genuine needs, but also for selling in the local markets. Naturally, its availability is decreasing due to lack of any management systems.

At present, rattan is found sparsely and with very low population sizes throughout the lower altitudes of Nepal except for some areas of the western region like Bardiya, Kailali and Kanchanpur districts where *C. tenuis* is still found in large quantities.

The estimated area of rattan habitat in these districts are as follows:

S.No.	District	Key Sites	Estmd. Area (ha)
1.	Bardiya	Rajapur, Tribhuwan Nagar Jamunia, B. National Park	700
2.	Kailai	Seti, Tikapur	275
3.	Kanchanpur	Suklaphanta NP	150
4.	Surkhet	Dhanbot	50

3.0 Rattan Farming

Large scale rattan farming by individuals in Nepal is almost unknown. However, in the eastern Tarai region, some attempts have been made to cultivate rattan on marginal lands. It was propagated once in the Madhumalla Nursery in Morang district. About 15 years ago, a farmer of Sunsari district had cultivated rattan in a small scale, but due to lack of marketing knowledge, he destroyed it after a few years. Some farmers of Kaski district have also cultivated rattan on their marginal lands which are used to meet their domestic needs.

Rural people use rattan especially for household crafts such as weaving baskets, mats, margins of winnow baskets etc. They use rattan stems and leaves to make partition walls of house, walking sticks, carrying baskets etc. In central Nepal, mature and long sized rattan are used as a rope to drag heavy logs.

Besides its local uses, it also has great cultural value. A native ethnic group called Tharus have been found to be using rattan sticks in performing different religious rituals. They believe that a rattan stick is holy and no evil spirits or witches can come near it. Some witch doctors (Jhankri) use a rattan stick while going to religious functions. There is also a belief that keeping rattan sticks at home scares away snakes. Rattans have been protected well in the religious areas (within the compound of temples) like in Kalika temple of Solukhumbu district, Dhorbarahi temple of Tanahu district and Barahi temple of Syangja district where people cannot harvest it because of its cultural value.

4.0 Marketing

There are about 50 rattan processors recorded in Nepal, out of which more than 40% are in the capital city of Kathmandu, because of its high demand by the urban middle and upper class consumers. Hotel and restaurants are other big markets for rattan furniture. Nepal has also exported some furniture to western countries. Mostly, the rattan processors are confined to eastern and central Nepal due to their locations falling in trade route from India which is mostly through eastern Nepal. However, all are small scale processors employing 2-8 employees each. Initial cost of establishment was found to be US$1,000-8,000 which yields an average annual profit of 10 to 30% depending on quantity sold and demand trend in the market, price of raw materials, taxes and business margins charged by middlemen etc.

4.1 Source of Rattan Canes

Although rattans are found growing in degraded sites throughout the Tarai region of the country, they are not being commercially exploited. The possible reasons are: (i) sufficient quantity is not available, (ii) rattan area is not well assessed, (iii) inaccessibility to roadheads and markets (iv) lower quality as compared to Indian rattan and (v) traders' preference to import from India.

It was estimated that more than 90% of total requirement/consumption of cane in Nepal is being supplied from India, especially from the North-east. Also more than 50% of harvested rattan from

western Nepal is exported to India through contractors and middlemen.

4.2 Demand and Supply

The demand and supply of rattan are not well quantified. But it can be safely said that the required quantity of rattan is not being supplied and some of the processors have to wait a long time to get the supply, because it comes from India, mostly through illegal means, therefore taking a longer time to pass through the international border.

The demand for rattan furniture is increasing in Nepal as it is comparatively less expensive than wood-based items. Cane furniture is light in weight and easy to handle. Although the current market of rattan furniture is confined to urban areas only, the future of rattan marketing in Nepal is bright.

5.0 Enhancing the Use of Rattan

Research is needed to enhance the use of rattan, and at the same time conserve the resource better. This requires concerted actions:

* National inventory of rattan.
* Taxonomic identification of all the rattan species
* Study of marketing constraints and opportunities
* Quality classification of identified species
* Preparation of appropriate management guidelines
* Refinement of propagation methods and provenance trails for species introduction
* Special focus on mountain rattans.

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Medicinal and Aromatic Plants of Nepal

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1.0 Introduction

Nepal extends along the great Himalayan range south-eastward from 81°15′ to 88°10′E longitude for some 800 km, it has an area of 147, 181 km^2 and the altitude ranges from 60 to 8,848 m. With the widest altitudinal range in the world within a narrow width of about 150-200 km, Nepal has at least 75 distinct vegetation types and a rich flora, estimated to comprise about 7,000 species of higher plants.

Nepal's flora is transitional between the flora of the west Himalayas and the east Himalayas with many Sino-Japanese elements. It has plants representative of Tibet through its many northern frontiers, especially in the trans-Himalayan regions. Numerous plant representatives of the Indo-Gangetic plains are also found in its tropical and sub-tropical regions.

Species diversity in Nepal can be well illustrated by the fact that over 1,000 species of the Himalayan plants have been originally discovered and described from the Nepalese flora among which more than 250 are endemic to the country (Bajracharya *et al.* 1988; Joshi and Joshi 1991).

The flora of Nepal contains about 1,000 economic plant species (14% of the vascular plants of the country). These include 440 species of wild food plants, 71 species of fibre-yielding plants, 50 species used as fishpoison, 30 species of wild spices, and over 100 species of fodder-yielding trees. The list of Nepalese medicinal plants exceeds 700 species comprising about 10% of the known vascular

plant species of the country (Malla and Shakya 1984). Among these, about 100 species of medicinal and aromatic herbs are currently exploited for commercial purposes (Malla *et al.* 1993).

2.0 Uses of Wild Medicinal Plants

Every year, ten to fifteen thousand tons of crude medicinal herbs are collected from forest lands and pastures, and much of this harvest is traded to foreign countries. The trade in crude medicinal herbs is an important source of livelihood and cash income to the rural people, and is estimated in the order of US$10 million. In certain areas, non-timber forest products (NTFPs), including medicinal and aromatic plants, provide up to 50 percent of a family's income (Edwards, 1996).

Regarding data on quantities of medicinal and aromatic plants and other non-timber forest products harvested from the wild, the Departments of Forests and of Customs have the details. However, the record keeping systems for NTFPs are neither consistent nor systematic, and the harvested and exported quantities far exceed the quantities recorded.

A study on the available records reveals that 3,448 t of NTFPs were collected in the fiscal year 1989/90, 6,217 t in 1990/91, 3,372 t in 1991/92, 5,679 t in 1992/93 and 5,679 t in 1993/94. The revenue earned by the Department of Forests during those fiscal years was US$0.4 million, US$0.3 m, US$0.19 m, US$0.38 m, US$0.53 m.

Concerning exports of NTFPs, 509 t were exported in the fiscal year 1989/90, 9,510 t in 1990/91, 13,581 t in 1991/92 and 4,018 t in 1992/93. The custom duty collected was US$0.25 million, US$0.75 m, US$1.03 m and US$0.73 m respectively. Between 97 and 99.6% of the exports were to India.

To understand more about the harvesting, use, and exports of medicinal plants, the present investigator surveyed 12 major herb trading centres of the country (Ilam, Basantpur, Hile, Dharan, Gaighat, Lahan, Hetauda, Butwal, Bahadurganj, Ghorai, Chhinchu and Nepalganj in 1993 (Malla *et al.* 1993) and recorded was the annual harvests and quantity traded was equivalent to 4,383 t of major herbs belonging to 37 wild plant species.

Some 525 t of crude herbs involving 5 species of higher plants (*Gaultheria fragrantissimia*; 200 t; *Zanthoxylum armatum*: 100 t; *Nardostachys grandiflora*: 80 t; *Cinnamomum glaucescens*: 70 t; and

Rhododendron anthopogon: 15 t) and species of lichen (*Parmelia* sp., *Usnea* sp. etc. 60 t) are processed annually by private sector in Nepal (Rajbhandary and Bajracharya 1994).

2.1 Processing and Sales

Regarding local industrial and commercial uses, Herbs Production and Processing Company, the HPPCL, a government-owned herb enterprise, purchased about 1,308 t of crude medicinal herbs during 1981 to 1993, the highest volume purchased being 426 t in 1989/90 (HPPCL, 1993). The HPPCL processed the material to produce herbal extracts, resinoids and essential oils. Income was obtained from domestic selling, through sales to India and from exports elsewhere (Rajbhandary and Bajracharya 1994).

Singhadurbar Vaidyakhana, a government-owned, ayurvedic drug manufacturing company, manufactures and sells ayurvedic medicines using local medicinal plant resources. The company also supplies ayurvedic medicines worth Rs.2 million per year to the 165 ayurvedic hospitals and dispensaries scattered throughout the country.

Gorkha Ayurved Company, a private ayurvedic drug manufacturing company utilized 37 t of crude medicinal herbs during the fiscal year 1994/95. These herbs belonged to 24 species of medicinal plants. At present, the company is manufacturing some 26 types of ayurvedic drugs and preparations, the majority of which are exported to foreign countries, notably France and Germany.

Humla Oil Pvt. Ltd., owned and operated by Humla Conservation and Development Association (HCDA), a local NGO with community participation, is said to use about 30 t of jatamansi (*Nardostachys grandiflora*) roots to extract essential oil using its locally installed distillation unit in its first year of establishment 1994-95.

Natural Products Industries, a private herb-processing enterprise located at Kapilvastu district, reported selling products worth Rs.12 million within 8 months of its operation in 1992 (Malla *et al.* 1993). The industry produced intermediaries for industrial uses and export involving wild plant species.

Many of the renowned private ayurvedic drug manufacturing institutions notably Piyushvarsiya Ausadhalaya, Shree Krishna Ausadhalaya, Arogya Bhawan Works, and others, and ayurvedic medical practition-

ers are also using huge quantities of wild medicinal plant species.

In addition to these industries, some 30 private entrepreneurs in 12 districts (Dhanusha, Dolakha, Dolpa, Humla, Jhapa, Jumla, Kapilbastu, Kathmandu,Lalitpur, Morang, Ramechhap and Solukhumbu) are involved in herb-processing and producing extracts for industrial uses.

Tables 1-5 provide information on some important commercially harvested medicinal plants in Nepal.

Table 1. *Nardostachys grandiflora* (Jatamansi, Bhulte, Balchad)

Fiscal year	Quantity collected (Ton)	Development Regions	Number of districts Involved
1987/88	64.35	E, C, W, MW	9
1988/89	111.00	E, C, W, MW, FW	14
1989/90	118.10	E, C, W, MW	9
1990/91	70.40	C, W, MW, FW	10
1991/92	203.30	E, C, W, MW	14
1992/93	113.30	E, C, W, MW, FW	19
1993/94	260.00	C, W, MW	14
Total	940.45		

Source : Department of Forest, HMG/Nepal, 1995

Table 2. *Picrorhiza scrophulariiflora* (Kutki, Katuki)

Fiscal year	Quantity collected (Ton)	Development Regions	Number of districts Involved
1987/88	24.90	E, C, MW	11
1988/89	25.80	E, C, W, MW, FW	14
1989/90	31.40	E, C, W, MW	13
1990/91	30.70	E, C, W, MW, FW	19
1991/92	116.40	E, C, W, MW, FW	26
1992/93	46.20	E, C, W, MW, FW	21
1993/94	25.30	E, C, W, MW, FW	23
Total	300.70		

Source : Department of Forest, HMG/Nepal, 1995

Table 3. *Swertia chirata* (Roxb. ex Fleming) Karsten (Chiraito)

Fiscal year	Quantity collected (Ton)	Development Regions	Number of districts Involved
1987/88	159.50	E, C, W, MW	15
1988/89	131.80	E, C, W, MW,	18
1989/90	165.10	E, C, W, MW	18
1990/91	85.60	E, C, W, MW, FW	19
1991/92	159.30	E, C, W, MW, FW	27
1992/93	200.80	E, C, W, MW, FW	36
1993/94	304.60	E, C, W, MW, FW	35
Total	1,206.70		

Source : Department of Forest, HMG/Nepal, 1995

Table 4. *Zanthoxylum armatum* (Timur)

Fiscal year	Quantity collected (Ton)	Development Regions	Number of districts Involved
1987/88	227.10	E, C, W, MW	9
1988/89	182.90	E, C, W, MW,	11
1989/90	320.20	E, C, W, MW	9
1990/91	371.80	E, C, W, MW, FW	12
1991/92	305.40	E, C, W, MW, FW	12
1992/93	296.90	E, C, W, MW, FW	16
1993/94	260.30	E, C, W, MW, FW	9
Total	1,964.60		

Source : Department of Forest, HMG/Nepal, 1995

2.2 Local Use

Apart from commercial and industrial uses, the majority of the local population use wild plants in a variety of ways, additional uses being for food, fodder, fuel, and a variety of domestic articles. They are also used for dyes, tannin, fibres, gums, resins, and agricultural and hunting tools and weapons. Some species are also used in religious ceremonies.

Modern health services, in Nepal, like in most other developing countries, due to the shortage of trained manpower and facilities, have not been provided to the greater part of the rural areas of the country where the majority of the population lives (Bhattarai 1989). What is available to this sector of the population is their own indigenous home herbal remedies. In Nepal, folk herbal remedies have been used and appreciated by the people since pre-historic times (Bhattarai 1992). About 85% of the rural population are said to use these remedies (Dani 1986). Traditional herbal remedies, therefore, play an inevitable role in the health services of the rural Nepalese populations (Bhattarai 1992).

Table 5. *Cinnamomum tamala*

Fiscal year	Quantity collected (Ton)	Development Regions	Number of districts Involved
1987/88	11.50 (L)	E, C, W, MW	18
	149.60 (B)	E, C, W, MW	17
1988/89	17.00 (L)	E, C, W, MW, FW	10
	63.90 (B)	E, C, W, MW, FW	18
1989/90	13.10 (L)	E, C, W, MW, FW	7
	90.80 (B)	E, C, W, FW	24
1990/91	31.20 (L)	E, C, W, MW, FW	10
	251.10 (B)	E, C, W, FW	23
1991/92	248.10 (L)	E, C, W, MW, FW	15
	141.10 (B)	E, C, W, MW, FW	33
1992/93	101.70 (L)	E, C, W, MW, FW	14
	361.90 (B)	E, C, W, MW, FW	33
1993/94	259.30 (L)	E, C, W, MW, FW	9
	240.10 (B)	EW, MW, FW	25
Total	1,964.60		

Source : Department of Forest, HMG/Nepal, 1995

3.0 Threats to the Medicinal Plants Resource Base

In Nepal, as in most other developing countries, wild plant resources are critical to hundreds of thousands of rural people as sources of nutrition, health care, raw materials and cash income. The interaction between the people and plant resources has emerged as a critical factor in sustaining the region. At the same time, as 14% of the land (including most suitable habitats for different species of medicinal plants) has been brought under protection, the pressure on other forests and pastures have increased beyond the carrying capacities of the ecosystems.

Indiscriminate collecting, not in accordance with any regulatory procedure or recognized management practices, has threatened the survival of some species and reduced the quality of many medicinal herbs. In Nepal, adequate conservation measures have not yet been thought of. Wild plant resources, especially NTFPs, are regarded as free commodities to be collected from nature and resource poor people are coming to believe "if I do not pick what I can today, someone else will get it tomorrow". As a consequence, raw materials are over-harvested when, for example, immature plants, roots, tubers, rhizomes, and bark are taken or excess pruning is done. As a result, even protected areas like national parks are facing the problem of indiscriminate collecting of plant resources (Yonzon 1993).

These trends and attitudes have led to a cycle of impoverishment in which the local people increasingly lose control over the management of their resources. They have also degraded the country's medicinal plant resources and gradually exploited species are becoming more difficult to find in a given locality where they once flourished. Thus, the once abundant availability of the commercially harvested high-altitude herbs supplying underground parts (roots and rhizomes) e.g. *Picrorhiza scrophulariiflora, Nardostachys grandiflora, Rheum australe, Dactylorhiza hatagirea, Aconitum spicatum, Aconitum palmatum, Aconitum heterophyllum, Podophyllum hexandrum, Fritillaria cirrhosa,* etc., have declined drastically in recent years. The supplies of midland and low altitude herbs like *Dioscorea deltoidea, Valeriana jatamansi, Asparagus racemosus, Rubia cordifolia, Brachycorythis obcordata,* etc., and many epiphytic orchids, notably *Dendrobium macraei,* have declined considerably. Tropical and sub-tropical plants like *Acacia*

concinna and *Mucuna pruriens* have become rare in many localities and *Rauwolfia serpentina* and *Alstonia scholaris* have already approached extinction in most areas of the country.

The districts facing over harvesting of particular plants are Sankhuwasabha and Taplejung (*Swertia chirayita* and other allied species like *S. angustifolia* and *S. racemosa*), Sindhuli and Udaypur (*Cinnamomum tamala*), Makawanpur and Chitwan (*Dendrobium macraei*), Jumla and Dolpa (*Nardostachys grandiflora* and *Picrorhiza scrophulariiflora*), and almost all the southern districts of the country (*Asparagus racemosus, Mucuna pruriens* and *Acacia concinna*).

4.0 Research and Development Activities

In Nepal, there are very few agencies carrying out R & D activities on wild medicinal plants. Regarding the cultivation and/or domestication of wild medicinal and aromatic plants, the Department of Plant Resources (DPR) initiated efforts and conducted experimental cultivation of some medicinal and aromatic plants in its nine herbal farms (Hetauda, Dhankuta, Tarahara, Daman, Tistung, Manichur, Shivapuri, Khaptad and Tamagadi) situated at different altitudes and climatic zones of the country, but no considerable research findings have been published so far. Currently only Tistung and Hetauda herbal farms are functioning under the Department. However, DPR's work on ethnobotanical studies in some parts of the country and phytochemical screening and pharmacological study of some medicinal and aromatic plants are noteworthy.

HPPCL is presently conducting commercial as well as trial cultivation of some medicinal and aromatic plants in its various herbal farms notably, Tarahara, Tamagadi and Belbari.

Some academic institutes under the Tribhuvan University, namely, the Institute of Science and Technology, Institute of Forestry, Research Centre for Applied Science and Technology (RECAST), as well as other organizations like Agriculture Research Centres at Pakhribas and Lumle are also involved in the various aspects of research in medicinal and aromatic plants.

Some private laboratories like Research Laboratory for Agriculture and Biotechnology (RLAAB) are also involved actively in various aspects of medicinal plant research and development.

For the promotion and advancement of science and technology in the country Royal Nepal Academy of Science and Technology (RONAST), established in 1982, has been launching specific research programmes under its Natural Product Research Program (NRRP).

There are some well equipped institutions such as Royal Drugs Limited, Department of Drug Administration, Central Food Research Laboratory, Bureau of Standards, etc., that have the capacity to conduct advanced research on medicinal and aromatic plants providing ample opportunities to enhance commercialization of the products. However, the analytical laboratories of these institutions are largely engaged in the evaluation of industrial products. As a consequence, various industries, including the pharmaceutical industries, are bound to depend on foreign markets for the supply of plant-based raw materials.

The Biodiversity Program Unit of the Asian Network for Small Scale Bioresources (ANSAB), has focused its activities on assisting communities and development practitioners to sustainably utilize NTFPs while conserving the ecosystems. Currently some 18 research projects on various aspects of development, management and sustainable use of wild plant resources including medicinal and aromatic plants are being undertaken in different parts of the country. Likewise, some 10 institutions have been provided with various types of technical assistance to conduct study and to promote conservation, management and local level value addition on various NTFPs including medicinal and aromatic plants.

In the Nepalese context, although considerable research activities are being carried out by various organizations and individuals, a serious lack of specific information and mechanism for dissemination of available information has been urgently experienced. However, the recently initiated Nepal NTFP Network, assisted by ANSAB, is a forum for individuals and institutions to obtain, study and compare research findings, as well as to disseminate information for the advancement of understanding of the importance of development and management of biological diversity and the sustainable utilization of the benefits and result from wild plant resources. At present some 400 NTFP-related researchers and research organizations are directly attached with the network.

5.0 Discussion

Although there is considerable evidence of over-harvesting of medicinal plants in Nepal, quantitative analyses of the effects of extraction on natural populations are lacking. Without such analyses, it is impossible to assess the effect of harvesting on depletion of resources in natural communities or to design appropriate conservation and management plans.

Another complication arises from the fact that the scientific identity of some medicinal plants that are being regularly collected, used and traded, such as Bompo, Sugandhapatta, Dhawa, Tigedi, Kawala, Hiunkhamar, Kaldana, Mujoseda, Tairi, Sankhadurlabha, Halik, Rishimarka, Amphi, and others are still unknown.

A systematic identification process of such plants and a study on ecology, distribution, and availability are recommended.

The improper and excessive exploitation of medicinal plant resources including immature plants, leading to habitat destruction and posing a threat to biodiversity is undoubtedly due to the direct outcome of ignorance, poverty and shortage of off-farm employment opportunities, compelling the rural people to continue activities that help them survive in the present, but which will cause severe problems in the future.

Wild medicinal plants and different products thereof, properly harvested, managed, processed and marketed, can play a strategic role in the conservation of biodiversity as well as in the economic development of the region. Recognizing that important decisions on biodiversity conservation and utilization are made at the local level, there is a need for direct involvement and a flow of benefits at this level. Community training and capacity building are a necessary prerequisite for any local biodiversity conservation programme. Community-based approaches should be initiated involving *ex situ* measures like ethnobotanical gardens, home gardens and commercial cultivation, and a network of green health nurseries should be established according to local needs.

Under natural conditions, medicinal plants can be managed along with wood and other NTFPs in an integrated manner, thereby increasing overall productivity. Controlled and regulated exploitation of wild

medicinal plants is fully compatible with the ecological and conservation functions of the forest and pastures. Most of the wild medicinal plants can also be grown as pure or mixed crops under agroforestry systems.

The large number of community owned forests spread throughout the country could be considered as potential sites for *ex situ* conservation as well as large scale production of commercial and industrial (as well as traditionally utilized medicinal plants for subsistence use) products. This would provide economic benefits to the communities.

Finally, if the medicinal plants of the Himalayas are to continue to serve the needs of the people without being reduced to a dangerously unstable resource base, it has to be considered in the perspective of sound ecological management that also has economic benefits to local people. Sustainable development and biodiversity conservation must be firmly linked if Nepal is to meet the needs and improve the quality of life of its present and future generations.

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Status of Commercialization of Medicinal and Aromatic Plants in Nepal

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1.0 Introduction

Since ancient times, ayurvedic physicians (Vaidyas) have incorporated natural medicinal products in traditional ayurvedic formulations. The bulk of these medicinal substances are derived from the indigenous flora. It is sad however, that many of the natural herbs having medicinal/aromatic properties have been indiscriminately collected for export to India and other overseas markets. For most of the valuable plants, this is the case. Of the 700 species of medicinal plants (HMG/IUCN 1988), over 200 species are also aromatic (Adhikary 1989). Natural resource policy makers and programme planners are becoming increasingly aware of their extensive subsistence and commercial use throughout the country, and that emerging markets worldwide hold potential for development. While promotion of Nepal's botanical resources can and should complement the objectives of rural development and sustainable forest management, several important issues must be considered (Hammett 1993; Malla *et al.* 1993).

The trade in medicinal and aromatic plants (MAPs) is ancient and supports large numbers of poor rural collectors, porters and traders. Even today these poor people do not fully receive what they deserve.

Little research has been carried out beyond the identification of the major species and products. Far less is known about species ecology, conservation status, role in village life and end uses. Opportunities for development of the trade at both national and international

levels, and measures of the economic and social benefits that might accrue, remain to be assessed.

2.0 Present Status

Most of the naturally occurring MAPs grow in the wild, especially at high altitudes. They are sold to middlemen and to local traders, and then to wholesalers who export the MAPs to other countries.

About 90% of the total value of trade is exported in the crude form and only 10% of the total volume is processed in the country to form extracts, essential oils, and resinoids; these reach India, France, Germany, Spain, Belgium, Australia and Pakistan.

Various attempts have been carried out to establish herbal farms in different ecological regions. These attempts focus on domestication and development of agro-technologies for some economically important species. Processing technologies were initiated through the establishment of the Department of Medicinal Plants (now the Department of Plant Resources) in 1961.

Commercial cultivation, processing and marketing was initiated after the establishment of Herbs Production and Processing Co. Ltd. (HPPCL) as a public sector company in 1981.

The following are other institutions/organizations involved in R&D and utilization of MAPs:

* Natural Products Research Laboratory, Royal Nepal Academy for Science & Technology (RONAST)
* Research Centre for Applied Science and Technology, Tribhuvan University, Kathmandu
* Singh Darbar Vaidyakhana Vikash Samitee, Kathmandu
* Gorkha Ayurved Company (P) Ltd., Gorkha
* Royal Drugs Ltd., Kathmandu
* Natural Products Industries Pvt. Ltd., Kapilbastu
* Himalayan Ginger Co. Pvt. Ltd., Khairenitar, Gorkha
* Balganga Ayurvedic Pharmaceuticals (Pvt.) Ltd., Rupandehi

With a view to better management of the forests, His Majesty's Government of Nepal introduced a Community Forestry Development

Programme. Under this programme, certain forest areas have been handed over to local rural communities where user groups manage and utilize the natural resources present in the forest. In such areas, only members of the local user groups are entitled to harvest the non-timber forest products (including MAPs) and outsiders are not eligible for such activities.

The Department of Forests, under the Ministry of Forests and Soil Conservation, is the legal authority that oversees the harvesting of naturally occurring medicinal and aromatic plants. Its activities and responsibilities include the collection of royalties on harvested items and regular monitoring of the indigenous flora. Illegal collection/ harvesting or export of timber or non-timber forest products is punishable according to existing laws. As a result of indiscriminate collecting for swift monetary gains, some valuable species of medicinal plants are facing the threat of extinction. Endangered species, whose collection has been officially prohibited, include *Dactylorhiza hatagirea* (Panchaunle) and *Cordyceps sinensis* (Yarsagumba). Seven additional species can only be exported after processing within the country. These include (a) *Nardostachys grandiflora*, Lichen spp. (*Parmelia nepalensis, Usnea* spp., *Ramalina* spp.), (c) *Valeriana jatamansi* (d) *Cinnamomum glaucescens* (Sugandha kokila), (e) *Rauwolfia serpentina*, (f) *Taxus wallichiana*, (g) *Abies spectabilis* (Talispatra). These are some of the relevant measures taken by the Government to protect important indigenous species.

Other indirect methods of protecting natural ecosystems include the establishment of national parks and wildlife reserves, which occupy a significant proportion of total land area (14%). Although this measure may not be supported by all, because the rural population of the vicinity appears to be deprived of potential economic benefit, the positive impacts of such a measure far outweigh the negative ones. The most significant impact is the protection of gene pools.

3.0 Scope

The current global resurgence in the consumption of 'green' products, especially drugs, flavours and fragrances of natural origin, has spin-off on the scope of the utilization of natural flora as well as on some introduced exotic species. The vital question here is to tackle

the situation in such a way that long-term benefits may be enjoyed without any harm to the fragile Himalayan ecosystems.

The nation's dependence on a few selective commodities, namely woollen carpets and ready-made garments, necessitates diversification of its export sector. Utilization of indigenous plants and cultivation of exotic species yielding essential oils for export are good alternatives, because, besides helping to generate valuable foreign currency, such industries would generate much-needed employment and income-generating opportunities in the villages and towns. The activities would supplement the nation's overall development drive as there would be a diffusion of relevant agro-processing technology even to remote rural areas.

Questions may arise as to the availability of sufficient land for cultivation of aromatic or essential oil-bearing plants as the country requires land for vital cereal crops. Available data indicate that only 18% of the country's area falls under agricultural land (7th Plan, Nepal, as cited in Shreshta *et al.* 1994). Land with inferior soil could effectively be put to use for cultivation of medicinal and aromatic plants.

The entry of multinational companies e.g., Unilever (Nepal Lever Ltd.) and large foreign firms such as Dabur (Nepal Pvt. Ltd.) has paved the way for rapid expansion of this sector. The essential oils produced by local rural communities, private sector processing units, and public sector processing companies could be used for the local manufacture of products such as soaps, detergents, and cosmetics, besides their application locally and abroad in the manufacture of paints, pharmaceuticals, food flavours, and fragrances.

4.0 Present Market Structure

The marketing of crude herbs (medicinal and aromatic) is quite complex. At present, HPPCL has bilateral contracts, renewable annually, with the village/rural processor. The company tends to shield the local processor from the uncertainties and fluctuations in the international markets with regard to prices. In the case of raw materials, however, local and regional price fluctuations seriously affect the income of the village collector, who is at the mercy of the middlemen or village trader.

Essential oils from Nepal have been well-received in regional and European markets. The conventional oils such as Palmarosa, Citronella, Lemongrass, Tagetes have a growing demand from foreign customers. The case is similar with certain newly introduced unconventional items like Oil of *Rhododendron anthopogon*. Oils like Jatamansi oil and Xanthoxylum oil require greater effort for successful export.

5.0 Herb Production and Processing Company Limited

In its different herbal farms and under several extension programmes, HPPCL has been successful in covering an area of 340 ha for commercial cultivation of essential oil-bearing plants. Table 1 shows the quantities of resinoids and essential oils produced by HPPCL in the past four fiscal years (1991/92 to 1994/95) and four months of 1995/96.

HPPCL has pioneered the commercial cultivation of several exotic species of aromatic, or essential oil-bearing, plants such as *Cymbopogon martinii* (Palmarosa), *Cymbopogon winterianus* (Citronella), *Matricaria chamomilla* (German chamomile), *Ocimum basilicum* (French basil). *Tagetes minuta*, a naturalized species growing as a weed in the hill regions, has also been cultivated commercially. Table 2 illustrates the present status of commercial cultivation of different aromatic plants in HPPCL's farms and in its extension programme.

5.1 Socio-economic Benefits

Processing by steam distillation of naturally occurring species, e.g. *Gaultheria fragrantissima* (middle hills), *Rhododendron anthopogon* (alpine region), *Nardostachys grandiflora* (subalpine and alpine regions), and *Artemisia* species (middle hills), has been facilitated by the establishment of distillation units for operation by the local people. Alternative income generation for these communities has thus been realized. Another benefit is the awareness, seen in the communities, of the need to conserve the biological diversity and to protect the rich but fragile Himalayan environment.

Table 1. Quantity in tons of resinoids and essential oils produced by HPPCL for 5 years

Resinoids & Essential Oils	1991/92	1992/93	1993/94	1994/95	1995/96 4 months
Resinoids					
Lichen	0.74	0.41	-	-	-
Valerian	0.51	-	-	-	-
Essential Oils					
Citronella	1.62	5.18	5.340	4.800	4.50
Palmarosa	2.06	1.08	0.720	1.470	1.54
Lemongrass	0.61	1.33	1.040	1.220	0.79
Mentha	0.47	1.14	0.750	0.700	0.10
Sugandha kokila	-	-	0.740	0.560	-
Jatamansi	-	0.23	0.630	0.400	0.16
Tagetes	-	0.04	0.030	0.020	-
Wintergreen	0.13	0.69	0.700	0.550	0.46
Matricaria	-	0.02	0.009	0.016	0.07
Xanthoxylum	0.19	0.45	-	-	-
Turpentine*	23.78	11.10	19.02	12.30	50.08
Anthopogon	-	-	0.06	0.01	0.68

Note: *in kilolitres, Source : HPPCL

Table 2. Present status of commercial cultivation of different aromatic plants under HPPCL's herbal farms

S.No.	Aromatic Plant	Tamagadhi (ha)	Tarahara (ha)	Belbari (ha)	Total (ha)
1	Palmarosa (*Cymbopogon martinii)*	54.80	5.50	2.00	61.00
2	Citronella (*C. winterianus*)	62.39	4.00	30.00	87.00
3	Lemongrass (*C. flexuosus*)	29.63	0.70	3.00	54.00
4	Japanese mint (*Mentha arvensis*)	2.11	-	1.00	10.00
5	Wild marigold (*Tagetes minuta*)	1.00	-	-	5.00
6	German chamomile (*Matricaria chamomilla*)	24.00	-	-	5.00
7	French basil (*Ocimum basilicum*)	13.00	-	1.00	5.00
		186.93	10.20	37.00	234.13
	(In the private sector)	(Bara)	(Nepal gunj)	(Tikapur)	Total
1	Palmarosa	17.94	30.00	14.00	51.45
	No. of farmers	35	60	10	-
2	Citronella	1.56	10.00	-	27.7
	No. of farmers	5	12	-	-
3	Lemongrass	3.59	1.5	-	3.59
	No. of farmers	16	1.00	-	
4	Japanese mint	12.46	3.00	10.00	16.9
	No. of farmers	67	2	20	-
5	German chamomille	1.57	340.00	330.75	-
	No. of farmers	5			
	Total area (ha)	37.12	44.50	24.00	105.62
	No. of farmers	112	75	31	213

Source : HPPCL

Table 3. Quantity of collection of MAPs (ton)

S. No.	Scientific Name	Local Name	89/90	90/91	91/92	92/93	93/94
1	*Acorus calamus*	Bojho	8.00	13.00	18.00	12.00	6.00
2	*Acacia concinna*	Sikakai	20.00	3.00	15.00	19.00	14.00
3	*Aconitum heterophyllum*	Atis	2.00	1.00	24.00	9.00	4.00
4	*Asparagus racemosus*	Satawari	71.00	56.00	40.00	197.00	52.00
5	*Bergenia ciliata*	Pashanved	20.00	49.00	41.00	56.00	15.00
6	*Cinnamomum tamala*	Tejpat	17.00	13.00	31.00	248.00	102.00
7	*Cinnamomum zeylanicum*	Dalchini	59.00	81.00	246.00	134.00	265.00
8	*Dioscorea deltoidea*	Bhyakur	2.00	5.00	20.00	7.00	8.00
9	*Elaeocarpus sphaericus*	Rudrakshya	84.00	31.00	84.00	47.00	46.00
10	*Lycopodium clavatum*	Nagbeli	6.00	7.00	11.00	14.00	5.00
11	Lichen sp.	Jhyao	17.00		14.00	56.00	62.00
12	*Nardostachys grandiflora*	Jatamansi	111.00	118.00	70.00	203.00	113.00
13	*Picrorhiza scrophulariiflora*	Kutki	26.00	5.00	31.00	66.00	46.00
14	*Paris polyphylla*	Satuwa			3.00	4.00	7.00
15	*Rubia cordifolia*	Majitho	6.00	52.00	39.00	53.00	53.00
16	*Rheum emodi*	Padamchal	3.00	22.00	13.00	442.00	163.00
17	*Swertia chirata*	Chiraito	131.00	165.00	86.00	159.00	201.00
18	*Sapindus mukorossi*	Rittha	364.00	159.00	664.00	357.00	873.00
19	*Valeriana jatamansi*	Sugandha wal	7.00	9.00	8.00	9.00	153.00
20	*Zanthoxylum armatum*	Timur	183.00	320.00	372.00	305.00	297.00
	Total		1137.00	1109.00	1830.00	2397.00	2475.00

Source : Department of Forests

Table 4. Royalty collected from MAPs (NRs. in '000) (1US$=NRs. 56.50)

S. No.	Scientific Name	Local Name	89/90	90/91	91/92	92/93	93/94
1	*Acorus calamus*	Bojho	11.00	19.00	27.00	17.00	9.00
2	*Acacia concinna*	Sikakai	29.00	5.00	21.00	28.00	20.00
3	*Aconitum heterophyllum*	Atis	6.00	4.00	70.00	2800	11.00
4	*Asparagus racemosus*	Satawari	104.00	82.00	58.00	288.00	75.00
5	*Bergenia ciliata*	Pashanved	45.00	115.00	96.00	131.00	34.00
6	*Cinnamomum tamala*	Tejpat	15.00	11.00	27.00	213.00	87.00
7	*Cinnamomum zeylanicum*	Dalchini	130.00	176.00	536.00	291.00	578.00
8	*Dioscorea deltoidea*	Bhyakur	7.00	16.00	57.00	21.00	22.00
9	*Elaeocarpus sphaericus*	Rudrakshya	246.00	89.00	246.00	137.00	134.00
10	*Lycopodium clavatum*	Nagbeli	73.00	84.00	127.00	163.00	58.00
11	Lichens	Jhyao	170.00		142.00	565.00	519.00
12	*Nardostachys grandiflora*	Jatamansi	777.00	827.00	493.00	1423.00	793.00
13	*Picrorhiza scrophulariiflora*	Kutki	111.00	20.00	132.00	287.00	200.00
14	*Paris polyphylla*	Satuwa			4.00	6.00	11.00
15	*Rubia cordifolia*	Majitho	7.00	60.00	45.00	61.00	61.00
16	*Rheum emodi*	Padamchal	6.00	45.00	26.00	896.00	133.00
17	*Swertia chirata*	Chiraito	285.00	360.00	187.00	347.00	438.00
18	*Sapindus mukorossi*	Rittha	262.00	14.00	478.00	357.00	628.00
19	*Valeriana jatamansi*	Sugandh awal	48.00	65.00	56.00	62.00	1074.00
20	*Zanthoxylum armatum*	Timur	640.00	1121.00	1301.00	1069.00	1039.0
	Total		2972.00	3113.00	4129.00	6390.00	6122.00

Source : Department of Forests

Table 5. Some medicinal and aromatic plants with market potential

Name of Plant	Part of the Plant	Habitat	Product	Availability		Market		
				Cult	Nat	Lo	Re	Gl
Aconitum spp.	Root extract	Temperate	Total		N	+	+	+
Acorus calamus	Rhizome Crude drug	Sub-tropical/ temperate	Essential oil	C	N	+	+ +	+
Aloe vera	Leaf juice	Sub-tropical	Aloin	C	N	+	+ +	+ +
Amomum subulatum	Fruits	Temperate	Essential oil	C	N	+	+ +	+ +
Artemisia spp.	Whole plant	Temperate	Essential oil		N	+	+	+ +
Atropa belladonna	Leaf and roots	Temperate	Total alkaloids	C		+	+ +	+ +
Berberis aristata	Root, stem, bark	Temperate	Berberine		N		+ +	+ +
Centella asiatica	Whole plant	Sub-tropical	Asicatic-oside		N		+ +	+ +
Cymbopogon flexuosus	Grass	Tropical/ Sub-tropical	Essential oil, geraniol	C		+	+ +	+ +
Cymbopogon martinii	Grass	Tropical/ Sub-tropical	Essential oil, geraniol	C			+	+ +
Cymbopogon winterianus	Grass	Tropical/ Sub-tropical	Essential oil	C		+	+ +	+ +
Emblica officinalis	Fruits	Sub-tropical	Extract, crude	C	N	+ +	+ +	+
Ephedra gerardiana	Whole plant	Temperate	Ephe-drine		N	+	+ +	+ +
Gaultheria fragrantissima	Leaves	Temperate	Essential oil		N	+	+	+ +
Juniperus indica	Berries	Alpine, sub-alpine	Essential oil		N	+	+	+ +

Lycopodium clavatum	Spores (powder)	Temperate	Lycopod-ium		N		+	+ +
Mentha arvensis	WholePlant	Sub-tropical	Essential oil	C		+	+ +	+ +
Nardostachys grandiflora	Rhizome	Alpine and sub-alpine	Essential oil, crude drug		N	+	+ +	+
Ocimum basilicum	Flowering tops	Sub-topical temperate	Turpentine oil and rosin	C			+	+ +
Pinus roxburghii	Resin	Sub-tropical/ temperate	Turpentine oil and rosin	C	N	+	+ +	+
Podophyllum hexandrum	Tubers	Temperate	Podophy-llun, podophyll ot oxin		N	+	+	+
Rheum australe	Roots	Temperate	Total extract		N	+	+ +	+ +
Swertia chirata	Whole Plant	Temperate	Total extract crude drug	C	N	+	+ +	+ +
Taxus wallichiana	Leaves	Temperate	Extract (resin)		N		+	+ +
Valeriana jatamansi	Roots, rhizomes	Temperate	Essential oil oleoresin	C	N	+	+ +	+ +
Zingiber officinale	Rhizomes	Sub-tropical/ temperate	Essential oil oleoresin	C		+	+	+ +

Note:
Cult, C: Cultivated
Nat, N: Natural distribution
Lo.: Local
Re.: Regional
G.: Global

Additional income generation has been realized through the practice of contract farming in the Tarai. More than 160 farmers are engaged as contract farmers and an area of 85.73 ha is under aromatic

crops in the Tamagadhi farm under this scheme. The average annual income per farmer is Rs.12,575 per 0.5 ha.

Alternative cropping patterns have also been utilized. Under agroforestry implemented by HPPCL, small and landless farmers are involved in agroforestry practices in Bansgadhi, Bardia District, and Tamagadhi, Bara district. Tree species such as *Dalbergia sissoo, Populus* spp. and aromatic plants such as *Cymbopogon martinii, C. winterianus* and *C. flezuosus* are intercropped.

In the mountainous areas, the rural collectors and the processors have a symbiotic relationship. The rural enterprise enables the collectors to get a better price for the MAPs, because of the guaranteed prices from a local processor and the collector who benefit mutually. The collectors learn the proper harvesting techniques as well as the appropriate methods of post-harvest treatment. Thus, a sustainable two-way mechanism is established (Rawal 1995).

5.2 Considerations for Regeneration and Sustainable Utilization of MAPs

Successful trials in the hilly region on *Tagetes glandulifera*, (syn. *T. minuta*), *Matricaria chamomilla, Ocimum basilicum* and *Trichosanthes palmata* have shown these species to be suitable for commercial cultivation. Valuable high-altitude crops such as *Nardostachys grandiflora, Juniperus indica*, and *Rhododendron anthopogon* need to be studied extensively and their cultivation initiated on a scientific and commercially viable basis if sustainable gains are desired from their high-value essential oils. *Rhododendron anthopogon* is particularly attractive because of the sweet, faintly-balsamic odour of the essential oil distilled from the leaves of this perennial alpine shrub. It has been well-received in the European market.

In the Mid-hills range, which is home to many valuable MAPs, naturally available species such as Wintergreen (*Gaultheria frangrantissima*), Timur (*Xanthoxylum armatum*), Valerian (*Valeriana jatamansi*), Chirata (*Swertia chirata*), and *Asparagus racemosus* require further studies on commercially viable methods of domestication. The Department of Plant Resources has successfully carried this out for *Cinnamomum glaucescens* (Sugandha kokila), a tree from mid-western Nepal, prized for its aromatic berries.

Such challenges require appropriate national policies on management of the natural resources. The relevant Government agencies need to work with a greater degree of co-operation and co-ordination. The Department of Forests, which is, at the moment, chiefly restricted to collection of revenue (royalty) from collected herbs, could play a significant role in the management of non-timber forest products, including MAPs. There is also room for improvement in the method of determining royalty on collected herbs. Tables 3 and 4 depict the quantity of collected herbs in tons and the royalty earned by the Government respectively.

International donor agencies, the private sector, and international and national NGOs could also be actively involved in the conservation, cultivation and utilization of the valuable natural resources so that long-term, sustainable benefits are derived for the good of the country as a whole.

Attracting foreign investment could be a means of introducing expensive but appropriate technology into the country and sharing external expertise with local skills for mutual benefit. Table 5 shows MAPs with market potential.

6.0 Constraints

Some major constraints are listed below:

a. Improper harvesting or harvesting of immature plants
b. Improper post-harvest treatment of collected medicinal and aromatic plants or their parts (drying, storage, etc.)
c. Adulteration of collected items
d. Difficulties in processing in remote areas and transportation of the essential oil-bearing species or their parts to the nearest processing sites.
e. Incomplete information or inadequate knowledge of the composition of the derived products (essential oils, oleoresins, resinoids, pharmacologically active constituents) leading to domination by the customer
f. Problems relating to access to favourable markets resulting from above-mentioned constraints or lack of up-to-date market infor-

mation and inability to visit clients or interact closely with them due to financial constraints

g. Difficulties encountered in relation to securing best-quality, high-yielding genotypes or varieties of planting materials in the case of cultivated species.

h. Lack of environment-friendly technologies in the case of local processing in the hilly and mountainous regions (e.g., use of fuelwood)

i. Increasing demand for products produced through organic cultivation and environment-friendly products.

7.0 Recommendations to Ease Constraints

i. National priority should be given to medicinal plants. A separate policy should be formulated to encompass medicinal and aromatic plants;

ii. Adequate research should be conducted with the specific aim of solving socio-economic and technological constraints;

iii. The collecting and harvesting, of medicinal and aromatic plants from naturally regenerating forest should be streamlined and monitored for effective control on indiscriminate collection;

iv. The Department of Forests should take a leading role in the regeneration of medicinal plants. Plantations should be developed in the appropriate ecological zones for replenishing the growing stocks;

v. It is desirable to formulate an integrated resource development plan for effective and sustainable management of medicinal and aromatic plants;

vi. There is the urgent need to develop agrotechnology for domestication of naturally occurring medicinal and aromatic plants, especially those species exploited heavily;

vii. Special protection should be provided to forest areas where the danger of depletion of MAPs is high;

viii. Collectors need to be trained on proper post-harvest techniques (drying, storage) in order to minimize wastage and unnecessary losses;

ix. Adequate research should be directed towards effective and sustainable utilization of MAPs, i.e., their phytochemistry and potential pharmacological properties should be investigated so that they could be utilized for the production of pharmaceuticals or cosmetics for domestic use or export;

x. Alternative fuels should be tapped and the use of fuelwood in the hills should be discouraged. Micro-hydro electricity generation units, solar power, wind power should be developed and utilized.

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Medicinal Plants, Markets and Margins: Implications for Development in Nepal Himalaya

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1.0 Introduction

Income generation and off-farm employment in rural areas are becoming integral parts of Nepal's development policy as seen in the Eighth five-year plan and the new industrial policy. A large number of medicinal and aromatic products (MAPs)[1] are widely believed to hold a potential for contributing to poverty alleviation, economic growth and, occasionally, improved natural resource management, and these commercial MAPs are receiving increasing attention (e.g. Aryal 1993; Olsen 1994; Pradhan and Maharajan 1994; Yadav and Stoian 1995; Sharma 1995; Edwards 1996).

Nonetheless, there is currently a paucity of studies on MAPs in all main areas, from resource base assessment to final consumption patterns. This lack of information has led to a number of assumptions about MAP utilization and the involved actors. Two of the most common assumptions among development workers and government officials are: (i) that MAP markets are imperfect allowing unscrupulous

[1]Medicinal and aromatic products are here defined as *all products of biological origin derived from forest or any land under similar use, including pastures, used by the medicinal and aromatic industries in India.* Included are products such as mushrooms and minerals . These products are all traded along the same channels.

middlemen, usually road head traders, to exploit collectors; and (ii) that the public sector can contribute positively to the development of MAP markets by direct interventions (e.g. through establishment of parastatals; Sheak 1994).

This paper attempts, on the basis of two years field work in central Nepal, to provide some relevant insights into the structure and functioning of the MAP markets in central Nepal[2]. Marketing margins and price data are analyzed. It is observed that although the MAP market is imperfect, it is functioning. It is argued that the current market reality does not call for direct government intervention, but rather the provision of public goods such as MAP market price collection and dissemination.

2.0 Study Area and Methods

Fieldwork[3] was undertaken in the period of February 1994 to December 1995 in central Nepal in Gorkha District (27°15′-28°45′N latitude and 84°27′-84°58′E longitude, Figure 1, page 205). The district has an area of 3,642 km^2 and is bounded by China Tibet in the north, in the east by Dhading, in the west by Lamjung and in the south by Tanahu and Chitwan districts. The district is a land of extremes:on the 80 km stretch from the Trisuli river in the south to the peak of Manaslu in the north there is an elevation gradient of almost 8,000 m. The huge variations in topography and climate and the fact that Gorkha District lies at the meeting point between the western and eastern Himalayan floristic regions (Singh and Singh 1987) have resulted in a high level of biodiversity. This is reflected in the large number of commercial MAP yielding species found.

There is no system for public collection and dissemination of MAP market prices or other relevant statistics in Nepal. All data

[2] Issues relating to the resource base, e.g. levels of annual sustainable yields for economically important species are beyond the scope of this paper.

[3]The work presented in this paper is part of a research project undertaken by the Unit of Forestry/RVAU with the aim of investigating how, if possible, to increase rural incomes through non-timber forest product utilization.

required for analysis must be gathered in the field. Price data were collected through monthly interviews in the September 1994 to August 1995 trading season. Seven wholesalers[4] participated; three road head traders and four Tarai wholesalers[4] are estimated to cover 63% of trade from the district at first point of sale and at least 80% of trade from the district at the point of sale to India. Interviews with a number of Indian wholesalers and processors were undertaken and monthly prices collected from two Delhi wholesalers. Further information was collected by conducting approximately 400 interviews with other traders, government officials, collectors, farmers, etc.

It is believed that the results of the investigation outlined in this paper are valid for the rest of central Nepal particularly the Western (except Mustang District) and Central Development Regions.

3.0 Medicinal and Aromatic Products Traded

Collection of MAPs is an important income-generating activity contributing significantly to household budgets in the northern and middle parts of the district. It is not uncommon to find more than 50% of households in a village to be involved in collection and sale of MAPs. Two early sources mention commercial MAPs from Gorkha District (Kimura and Akabori 1956; Dobremez and Jest 1976) and interviews in the district indicate that the trade in some locations is hundreds of years old. In spite of this, very little is known about the trade; thus, conclusions, intended for use in development work, are often drawn from insufficient data (e.g. Amatya and Amatya 1995).

3.1 Products and Volumes Traded

An overview of the main, traded MAPs harvested in the wild in Gorkha District in the study period is provided in Table 1. It is derived from interviews with all buyers at first point of sale.

The six most important plant species collected in the wild (*chiraita,*

[4] Tarai wholesalers is a term covering wholesalers based in the Tarai and Kathmandu. They are further characterized by buying mainly from roadhead traders and selling mainly to buyers in India.

jatamansi, panchaunle, kutki, nirmashi, and *padamchal*) constituted more than 70% of the collector value of the trade. These six species were selected for detailed analysis in the following sections. One of the species, *panchaunle*, is currently banned from collection and trade; it did, however, contribute significantly to rural incomes in the 1994-95 trading season (12% of total value of trade to rural collectors).

4.0 Structure and Function of the Map Markets

The structure of the market refers to the categories of business of those who take over ownership of the MAPs along the marketing chain. The function of the market refers to the value adding activities performed in the marketing chain.

4.1 Marketing Chains

Figure 2 (p. 206) presents an overview of the trade in MAPs collected in the wild in Gorkha District. The number of village traders in the district is low since most collectors, usually at time of annual festivals, prefer to market the collected products themselves. There are approximately 10 road head traders (the number varies from year to year), but there is usually only one road head trader in a single location. The retail business, limited to, for instance, eight retailers in Kathmandu, is likewise not an important component in the marketing chain (when considering amounts and values). The typical marketing chain for MAPs from Gorkha District is: thousands of collectors sell their products to the road head traders who concentrate the small sales into large lots sold to 4-6 Tarai wholesalers. These sell the products to Indian wholesalers who sell to processors and retailers in India or re-export the products to third countries. In general, the wholesalers only perform the functions of storage and transport: they do not advance cash, grade the material or undertake processing. However, cash advances to collectors, village traders and road head traders are provided elsewhere in Nepal (Edwards 1993).

In general, with respect to grading there is only one form and quality of a given product (though minor variations are common, e.g., thin bark of daalchini is preferred to thick bark and fetch 1-2 NRs more per kg). *Jatamansi*, one of the main products from the district, is traded

in two distinct qualities: the large (from the south side of the Himalayas) and small (from Tibet and the inner valleys) varieties (Figure 2).

More than 98% of the trade in MAPs from Gorkha District passes to India through a small number of Tarai wholesalers. Almost none of the products is processed in Nepal and only a fraction are traded through retailers (also unprocessed).

5.0 Marketing Costs and Margins

Sales of products from collectors to road head traders take place at the *collector price*. Sale from road head traders to Tarai wholesalers is termed the *road head wholesale price*; sale from Tarai wholesalers to Delhi wholesalers is the *Delhi wholesale price*. Collector prices were cross-checked in collector interviews; road head wholesale prices are estimated to be maximum prices (as the Tarai wholesalers knew the research also included India); and Delhi wholesale prices are believed to be minimum prices (assuming the Delhi wholesaler speculated in later purchases from the interviewer).

Using the collected prices and estimates of costs, the marketing margins for the six main species were calculated (details of the calculations for *chiraita* are given in Table 2). Three different calculations were made for each species: (i) using the prices during the one year period from September 1994 to August 1995; (ii) using the prices during the main trading season from October 1994 to March 1995; and (iii) using an average of the two maximum sale prices offered (in Delhi and the Tarai) during the one year period.

An overview of the margins in the main trading season for the six main species collected in the wild is presented in Table 3. The assumptions about road head wholesale prices and Delhi wholesale prices mentioned above means that road head trader margins are maximum margins and Tarai wholesaler margins are minimum margins.

The collectors' margins range from 37-62%; this is less than the average of 61% reported from Eastern Nepal by Edwards (1996). However, Edwards' calculations were based on very limited data; using data from a whole trading season may result in a different picture.

The average prices offered during the one year period and the main season will only allow a road head trader to survive; no substantial profits can be made. In order to secure a satisfactory return (or, in the

case of *jatamansi* and *padamchal*, simply to make any profit at all) the road head trader has to speculate and take advantage of the optimum prices in the Tarai during a year (taking the example of *chiraita* in Table 2 this can increase the road head traders' net margin from NRs.2.1–13.4 per kg). This is inherently difficult and may be the major reason why there are so few road head traders: the low net margins and the high risks involved do not attract many new traders and make survival difficult. Many (past and present) road head traders complained that they were not able to make profits on all species, but were forced to buy all the products collectors brought as the collectors might otherwise sell elsewhere or not return the following year. The low returns make it essential that road head traders buy air-dry products; any excess weight loss can easily result in a negative net margin.

The situation is different for the Tarai wholesalers. They may also substantially increase their income by speculating on the Indian wholesale market (from NRs.12.0/kg to NRs.34.9/kg, Table 2), but they are certain of a high net margin even when selling at the average prices. This is true for all species.

The issue of Tarai wholesalers' storage costs is still a relatively grey area. It appears that they keep detailed records of each road head trader's store and only buy at the latest possible moment. Thus, they make maximum use of the road head traders' stores and reduce the need for storage facilities in the Tarai significantly as well as decrease the need for working capital and the risk of storage losses. Thus, it appears that the Tarai wholesalers receive a higher net margin than road head traders while simultaneously taking lower risks.

6.0 Price Data Analysis

All prices pertain to the same quality and form of products. Prices were analyzed by looking at seasonal movements for Tarai wholesale prices and by calculating inter-market price correlations (Delhi, Tarai wholesalers and three main road heads).

6.1 Seasonal Price Analysis

The monthly wholesale prices offered by Tarai wholesalers for three of the main species are presented in Table 4.

Price movements as expected for agricultural crops (high pre-harvest price and low post-harvest price) were not found. Small price increases were observed for *chiraita* and *jatamansi* while *kutki* prices rose significantly. The latter rise was due to a very high increase in demand in India (reflecting increased demand in China). Comparing the development of *kutki* prices with net margins is very illustrative. While price changes in India are transmitted to road head traders in Nepal, it seems that Tarai traders can control the flow of price information and effectively utilize this to their advantage: their net margins for *kutki* are very high while the road head traders' net margins remain low.

6.2 Inter-market Price Correlations

Market integration was investigated by correlation of wholesale prices among pairs of markets (three main road heads, Tarai wholesalers and Delhi), Table 5.

Table 1: Estimates[1] of amounts (kg) and values (Nr) of traded main medicinal and aromatic products harvested in Gorkha District, central Nepal, September 1994 to August 1995

Scientific name[2]	Product	Nepali name	Traded amount	Average collector	Collector value	Percent of total	Accumulated percentage
Swertia chirayita (Roxb. ex Fleming) Karsten	whole plant	*chiraita*[3]	34450	49.98	1721811	20.8	20.8
Nardostachys grandiflora DC.	rhizomes	*jatamansi*	39270	39.45	1549202	18.7	39.5
Dactylorhiza hatagirea (D. Don)Soo	tubers	*panchaunle*	2130	421.95	989754	12.0	51.5
Picrorhiza scrophulariiflora Pennell	roots	*kutki*	10270	58.50	600795	7.3	58.8
Aconitum orochryseum Stapf.	tubers	*nirmashi*	1510	341.39	515499	6.2	65.0
Rheum australe D. Don	roots	*padamchal*	32060	15.81	506869	6.1	71.1
Other species			102740		2392661		
	Total		222430		8276591		

[1]Based on amounts and prices at the first point of sale obtained by: (i) monthly interviews with mainbuyers; and (ii) interviews with lesser buyers
[2]Names according to Koba *et al.* (1994)
[3]This product is known as *tite* in Gorkha District

Table 2. Average marketing margins for jatamansi, kutki and chiraita from Gorkha District

	Jatamansi Sep94-Aug95	Jatamansi Oct94-Mar95	Jatamansi two highest prices	% of Delhi Wholesale price (Oct-Mar prices)	Kutki Sept94-95	Kutki Oct 94-Mar95	Kutki Two highest prices	% of Delhi wholesale Sept94-95 (Oct-Mar prices)	Chiraita Oct 94-Mar95	Chiraita Two highest	Chiraita wholesale prices	% of Delhi (Oct-Mar prices)
Collectors												
Delhi wholesale price[1]	92.40	93.87	104.00		166.34	154.00	200.00		92.75	95.73	120.00	
Collector price[2]	46.03	46.95	46.95		56.73	58.50	58.50		48.23	49.98	49.98	
Road head traders												
Road head wholesale price[3]	56.51	55.44	65.31	59.06	75.09	68.44	97.50	44.44	64.33	65.73	78.44	68.66
Collector price	46.03	46.95	46.95	50.02	56.73	58.50	58.50	37.99	48.23	49.98	49.58	52.21
Road head traders' gross margin	10.48	8.49	18.36	9.04	18.36	9.94	39.00	6.45	16.10	15.75	28.46	16.45
Storage[4], space	0.45	0.45	0.45	0.48	0.45	0.45	0.45	0.29	0.45	0.45	0.45	0.47
interest charge	1.30	1.32	1.32	1.41	1.60	1.65	1.65	1.07	1.36	1.41	1.41	1.47
weight losses	5.65	5.54	6.53	5.91	1.50	1.37	1.95	0.89	6.43	6.57	7.84	6.87
Transport[5] (incl. handling)	1.20	1.20	1.20	1.28	1.20	1.20	1.20	0.78	1.80	1.80	1.80	1.88
losses	0.57	0.55	0.65	0.59	0.00	0.00	0.00	0.00	0.64	0.66	0.78	0.69
Royalties[6]	7.00	7.00	7.00	7.46	4.38	4.38	4.38	2.84	2.18	2.18	2.18	2.28
Rent-seeking[7]	0.60	0.60	0.60	0.64	0.60	0.60	0.60	0.39	0.60	0.60	0.60	0.63
Road head traders' net margin	-6.28	-8.18	0.60	-8.72	8.63	0.29	28.77	0.19	2.63	2.08	13.39	2.17
Tarai wholesalers												
Delhi wholesale price	92.40	93.87	104.00	100.00	166.34	154.00	200.00	100.00	92.75	95.73	120.00	100.00
Road head wholesale price	56.51	55.44	55.44	59.06	75.09	68.44	68.44	44.44	64.33	65.73	65.73	68.66
Tarai wholesalers' gross margin	35.89	38.43	48.56	40.94	91.25	85.56	131.56	55.56	28.42	30.00	54.27	31.34
Storage[8]	5.86	5.92	6.43	6.31	3.16	2.95	3.41	1.91	5.99	6.16	7.37	6.43
Transport[9], costs	6.67	6.67	6.67	7.10	6.67	6.67	6.67	4.33	10.00	10.00	10.00	10.45
losses	0.92	0.94	1.04	1.00	0.00	0.00	0.00	0.00	0.93	0.96	1.20	1.00
Custom duties[10]	0.53	0.53	0.53	0.56	0.60	0.60	0.60	0.39	0.45	0.45	0.45	0.47
Rent-seeking	0.40	0.40	0.40	0.43	0.40	0.40	0.40	0.26	0.40	0.40	0.40	0.42
Tarai wholesalers' net margin	21.51	23.98	33.50	25.55	80.41	74.95	120.49	48.67	10.65	12.04	34.85	12.57

[1] Market prices collected through interviews with two wholesalers in Old Delhi. [2] The average of prices collected monthly at the three main road head sale points. [3] The average of prices collected monthly at four largest Tarai wholesalers (item delivered in the Tarai). [4] Road head traders' cost of storage is calculated as: (i) storage space is one store costing 1,500 Nr/month, storage space is needed all year, 40,000 kg is stored during the year and all species are stored the same amount of time; (ii) interest charge on working capital tied up in one kg of a species is calculated asuming a monthly interest rate of 1.4% (approximately 18% p.a.) and an average storage time of two months (e.g. per kg of jatamansi in the main season: $46.95 \times 1.014^2 - 46.95 = 1.32$ Nr/kg); and (iii) weight losses are based on the assumptions that jatamansi and chiraita lose 10% and all other species 2%. [5] Road head traders' transport costs (between road head and the Tarai) are estimated per truck to: rent of truck 2,500 Nr. handling, loading and unloading 600 Nr. driver's pay 500 Nr. Capacity per truck is estimated at : 2,000 kg chiraita, 3,000 kg jatamansi/kutki, padamchal 10,000 kg. Costs for nirmashi and panchaunle are equalled to jatamansi. Transport losses occur for jatamansi and chiraita, the losses are estimated to be 1%. [6] The royalty rates used were in force till April 3rd 1995. [7] Rent-seeking by forest and police personnel; estimates based on interviews. [8] The Tarai wholesalers' storage cost for space is estimated equal to road head traders', interest charges are based on a monthly interest rate of 1.4% and an average storage time of one month; weight losses are estimated to be half of the road head traders' losses. [9] Transport costs are calculated using the same truck capacity as for road head traders; the cost for renting a truck Tarai-Delhi is 20,000 Nr. (including loading, unloading and driver's pay; the price varies from 15,000 to 22,000 Nr). Transport losses are assumed equal to those of road head traders. [10] Custom duties are those for the fiscal year 1994-95: 1,5% of the species specific border rate (this duty decreased to 0,5% in the fiscal year 1995-96)

Table 3. Marketing margins for main MAP species from Gorkha District, central Nepal, October 1994 to March 1995.

Species	Collector net margin	Road head trader gross margin	Road head trader net margin	Terai wholesaler gross margin	Terai wholesaler net margin
Chiraita	52.2[1]	16.5	2.2	31.3	12.5
Jatamansi	50.0	9.0	-8.7	40.9	25.6
Panchaunle	62.3	14.0	10.4	23.7	20.5
Kutki	38.0	6.5	0.2	55.6	48.7
Nirmashi	36.8	17.8	15.1	45.4	42.8
Padamchal	40.5	10.0	-1.0	49.6	39.0

[1]Percentage of Delhi wholesale price in main trading season (October 1994 to March 1995)

Table 4. Monthly Tarai wholesale prices[1] (Nr/kg) of three main species from Gorkha District, September 1994 to August 1995

Species	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Range
Chiraita													
Mean	50.0	59.4	63.8	65.6	68.8	69.4	67.5	63.8	66.3	64.5	62.5	70.6	20.6
Standard deviation	6.1	1.3	4.8	16.1	13.6	10.5	11.9	13.2	10.3	514.2	15.0	10.5	
Jatamansi													18.1
Mean	45.0	50.0	51.3	57.0	59.5	55.0	59.9	58.6	58.8	60.0	70.0	63.1	
Standard deviation	5.8	0.0	2.5	4.8	1.0	4.1	7.2	7.6	4.8	7.1	9.1	6.3	
Kutki													
Mean	46.9	52.5	53.8	64.4	71.9	77.5	90.6	89.4	85.0	88.0	88.8	92.5	45.6
Standard deviation	8.0	2.9	4.8	13.9	9.7	24.0	14.8	11.6	4.1	8.1	4.8	6.5	

[1]The prices are not adjusted for inflation

Table 5. Correlation of wholesale prices among pairs of markets (three road heads, Terai and Delhi), October 1994 to March 1995

Correlation coefficient	Proportion of total coefficients by species					
	Chiraita	*Jatamansi*	*Panchaunle*	*Kutki*	*Nirmashi*	*Padamchal*
0.90+	0.00	0.00	0.03	0.10	0.07	0.00
0.80 - 0.89	0.00	0.00	0.10	0.10	0.03	0.00
0.70 - 0.79	0.07	0.10	0.03	0.14	0.07	0.00
0.60 - 0.69	0.03	0.10	0.07	0.00	0.00	0.00
0.50 - 0.59	0.07	0.00	0.00	0.10	0.00	0.17
0.40 - 0.49	0.03	0.03	0.07	0.10	0.03	0.00
0.30 - 0.39	0.07	0.03	0.10	0.10	0.10	0.14
0.20 - 0.29	0.07	0.03	0.03	0.17	0.03	0.10
0.10 - 0.19	0.03	0.07	0.07	0.03	0.17	0.07
0.00 - 0.09	0.14	0.00	0.10	0.03	0.07	0.03
< 0	0.48	0.62	0.38	0.10	0.41	0.48
Total	1.00	1.00	1.00	1.00	1.00	1.00
Number of markets	5	5	5	5	5	5
Number of pairs	29	29	29	29	29	29
First quartile	0.30-0.39	0.30-0.30	0.40-0.49	0.70-0.79	0.30-0.39	0.30-0.39

Price movements are generally not identical among the markets. Only in the case of *kutki* is there any resemblance of market integration. In general, however, the correlation coefficients between Tarai wholesalers and Delhi wholesalers are the highest. The poor lack of integration between road heads indicates that collectors could benefit from knowing the prices in several road heads before they decided where to sell.

7.0 Discussion

The analysis indicates that the MAP market is imperfect: there is very limited market information and poor market integration. A small number of Tarai wholesalers have sole access to price information on the wholesale markets in India and are able to translate their superior knowledge into market power by determining the prices paid to road head traders and, thus, to collectors. Their control of price information is further enhanced as there seems to be a lack of communication between road head traders.

Table 6. Marketing margins for Chiraita from Gorkha District, 1994-95 (all prices in Nr/kg)

	Chitraita Sep 94 - Aug 95	*Chitraita* Oct 94 - Mar 95	*Chitraita* Two highest prices	% of Delhi Wholesale price (Oct-Mar prices)
Collectors				
Delhi wholesale price[1]	92.8	95.7	120.0	
Collector price[2]	48.2	50.0	50.0	
Road head trader				
Road head wholesale price[3]	64.3	65.7	78.4	68.7
Collector price	48.2	50.0	50.0	52.2
Road head traders' gross margin	16.1	15.8	28.5	16.5
Costs[4]	13.5	13.7	15.1	14.3
Road head traders' net margin	2.6	2.1	13.4	2.2
Tarai wholesalers				
Delhi wholesale price	92.8	95.7	120.0	100.0
Road head wholesale price	64.3	65.7	65.7	68.7
Tarai wholesalers' gross margin	28.4	30.0	54.3	31.3
Costs[5]	17.8	18.0	19.4	18.8
Tarai wholesalers' net margin	10.6	12.0	34.9	12.5

[1]Market prices collected through interviews with two wholesalers in Old Delhi, India
[2]The average of prices collected monthly at the three main road head sale points
[3]The average of prices collected monthly at four largest Tarai wholesalers (item delivered in the Tarai)
[4]Costs include storage, royalties and rent-seeking
[5]Costs include storage, transport, custom duty and rent-seeking

It is uncertain how Tarai wholesalers control price information. The analysis of Tarai wholesale prices in Table 4 indicates that there are some variations in prices offered around a low average price. It does not seem that Tarai wholesalers reach a price by actively agreeing on a common price, but rather that there is simply no need to pay higher prices. This may be termed a "passive oligopsony" motivated by the knowledge that there are sufficient supplies for all to exist and operate with high margins. Raising prices significantly would immediately be discovered by the other members of the passive oligopsony and would thus not be in the long term interest of the individual Tarai wholesaler.

The high marketing margins obtained by the Tarai wholesalers begs the question: why are there not more Tarai wholesalers? Part of

the explanation may be that entry into the trade is difficult for new participants: (i) the capital requirement to buy stocks is very large (several million NR); (ii) the period of apprenticeship is probably quite long. Road head traders estimate that at least six months, i.e. one trading season, is required to learn about the products (according to Edwards (1996) approximately 100 species are exported from Nepal); and (iii) the cost of establishing a network of buyers in India is possibly high (see below). Furthermore, the scale of the trade with MAPs is not well known and the Tarai wholesalers (many of whom are also engaged in other activities) may have been able to conceal the profitability of the trade. Keeping the trade as little known as possible and hiding the large profits involved would be necessary to maintain the passive oligopsony.

Competition in the MAP markets is not only limited by the control of price information exercised by the Tarai wholesalers: the collectors' range of choice at the initial point of sale is limited as there is usually only one road head trader in each location. If the collector finds the price unacceptable, he may spend up to several days to reach another road head trader; the bargaining position of the collector is therefore very limited (apart from the fact that the road head traders do not have a net margin that allows them to offer higher prices to the collectors). As mentioned above, the number of road head traders is limited by the low net margins and the high risks involved. The situation is further exacerbated as road head traders find it difficult to obtain credit to finance short-run inventories (e.g. they can not obtain bank loans in MAP stocks). This limits their possibilities for: (i) increasing purchases in favourable trading seasons; and (ii) speculating in price increases by delaying sales.

Road head traders could significantly increase their income by selling directly in India; indeed, some road head traders have already tried this but unsuccessfully. A number of factors have limited their success: (i) the road head traders' lack of a network means they have to rent storage space and sell through commission agents charging 5% of final value of transaction; (ii) as they are unable to sell their products before arrival they often have to accept low prices; and (iii) some have lost all their products during transport (theft). Thus, it seems that high costs are involved in starting up sales in India. These costs, combined with a lack of knowledge of the general level of prices in

India, seem sufficient to deter road head traders from establishing direct sales to India.

7.1 Implications for Development

Although the MAP market is imperfect, it is important to keep in mind that the market is actually functioning and has done so for hundreds of years. Given the negative experiences elsewhere with direct government intervention, such as the nationalization of non-timber forest product commodities in India and its adverse effect on collector income (Chambers *et al.* 1989), such initiatives should be avoided in Nepal. Nor does the market situation in central Nepal call for such interventions. Rather, the government should be concerned with the provision of public goods.

Much could be achieved by establishing *a system for public dissemination of market prices* for MAPs. Price information should be gathered in the main wholesale markets in India (at least Delhi, Kanpur and Calcutta) and at the main road heads in Nepal (see map in Edwards 1996). Information should be disseminated by radio to collectors (even the most remote village has at least one radio) and road head traders. At the same time the number of Tarai wholesalers should be increased. This can be done by encouraging and helping road head traders to establish direct sales to India and by publishing the profitability of MAP export to India. This would all serve to increase competition and, ultimately, to increase the collectors' margins.

Investment in *physical infrastructure* should also be pursued, e.g. improvement of trails in northern Gorkha, both primary and tertiary trails leading to collection areas in highland pastures, would serve to decrease transportation time and would therefore increase the average daily income from MAP collection. This approach would improve average daily income even at constant (and possibly falling) collector prices.

Research is also badly needed. To mention a few issues: MAP resource base assessment techniques, the impact of harvesting on plant communities, integration of MAPs into community forestry, and the marketing chain beyond the Indian wholesale markets.

The royalty system should be reviewed: the royalty rates have no relation to current market prices and the recent increase in royalty

rates will severely hurt road head traders by lowering their marketing margins even further. If the objective of the royalty system is to generate government revenues, it should consider discarding the system and replacing it with an *export tax* levied at the border. This would have the following advantages: (i) removing a cost from the road head trader and placing it on the Tarai wholesalers; combined with improved information and more competition the Tarai wholesaler would not be able to pass on the cost to the road head trader (thereby increasing the road head traders' net margin and increasing competition); (ii) decreased possibilities for forest and police personnel to extract rents from traders and collectors; and (iii) tax collection at border points should be easier to monitor and control and would thus provide better statistics on the trade. However, replacing the royalty system may be difficult as it seems a part of a system of political control and patron-client relationship (Olsen 1996).

Species banned from collection and trade (including export in unprocessed form) currently contribute more than a third of the total value of the trade of collectors. There is an urgent need to review current ban on collection and trade. All bans should be justified, e.g. why is the collection and trade of yarsagumba (a product consisting of a dead caterpillar and a fungus that has spread its spores) prohibited? Ban on export of products in their unprocessed form would lead to income losses in all parts of the marketing chain if enforced while no domestic market exists.

Given the current distribution of profits among collectors, road head traders and Tarai wholesalers, there is nothing to be gained by organizing farmers to market their products directly to Tarai wholesalers, i.e. by-passing road head traders. Non-governmental organizations and others interested in improving rural incomes from MAP utilization should pursue other possibilities (e.g. collectors can benefit from knowing the prices at several road heads before they decide where to sell).

8.0 Conclusion

The current methods of MAP market in central Nepal are inadequate. This is due to competition among road head traders and Tarai wholesalers, and is caused mainly by Tarai wholesalers who are able

to control the flow of price information from India. By being able to act as a passive oligopsony, they limit competition and secure high net margins. Secondary causes of market imperfections are: (i) difficult entry into trade at the Tarai wholesaler level; and (ii) road head traders' difficulties in obtaining credit to finance short-run inventories.

It is necessary to increase competition in the market by increasing the number of road head traders and Tarai wholesalers. The key to this is improved information. The focus should be on provision of public goods. Priorities should be a system for public dissemination of market prices, research and investment in physical infrastructure. Establishing credit facilities and reviewing the royalty system (including banks on collection and trade), and possibly replacing it with an export tax, is also important.

The findings suggest a need for reviewing significant components of the proposed US$80 million "Medicinal and aromatic plants and other minor forest products" programme detailed in the Master Plan for the Forestry Sector, Nepal.

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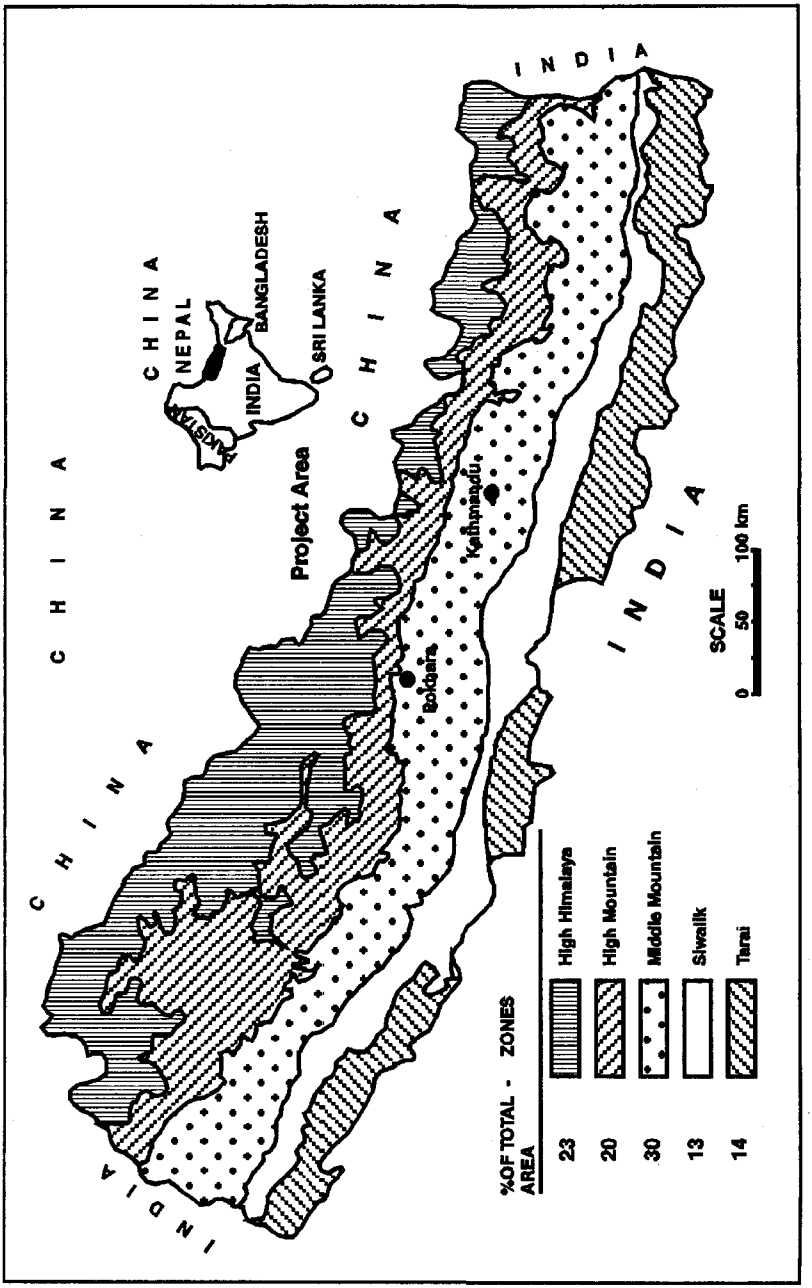

Figure 1: Gorkha District in central Nepal

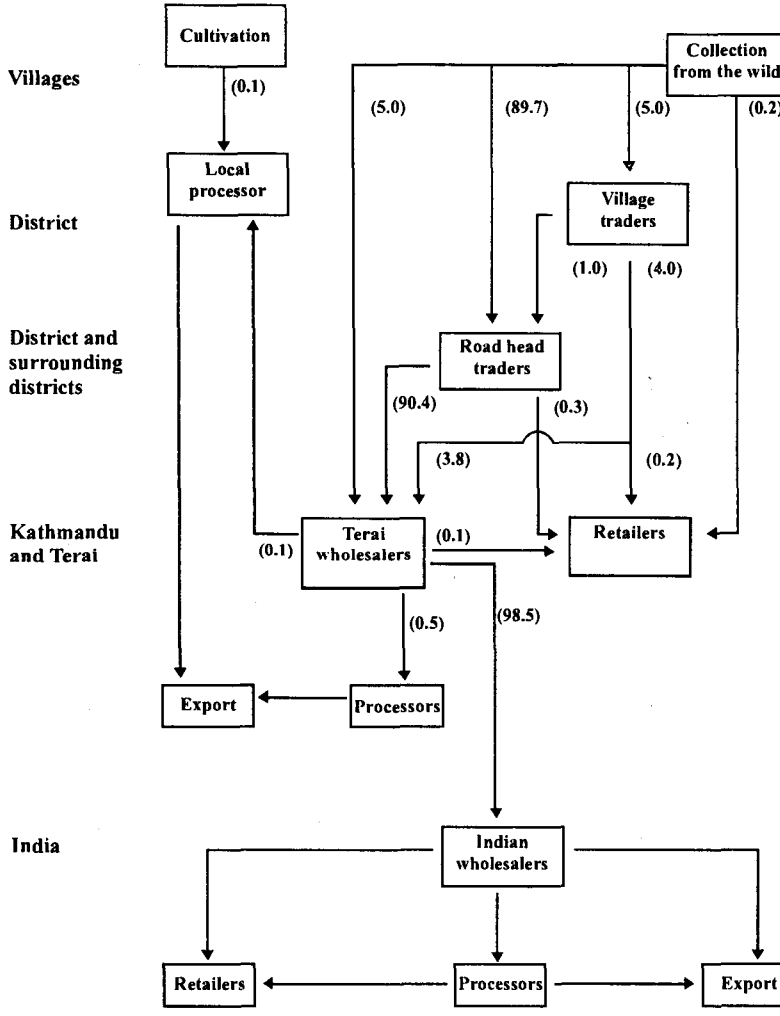

Figure 2 : Marketing chain for medicinal and aromatic plant products from Gorkha District, central Nepal, 1994-95

Medicinal Plants of Pakistan

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1.0 Introduction

Geographically, Pakistan is situated between 23° 28′N and 61° 77′E comprising of an area of 796,096 km^2. The northern areas of Pakistan contain high mountain ranges including Karakuram and Hindu Kush. Administratively, Pakistan is divided into four provinces; there are also some federally administrative areas.

The northern areas are considered to be a centre of diversity for many plant species. The ancient trade route from China to West Asia passed through this region resulting in the introduction of many crop, fruit and medicinal plant species which have been cultivated for many centuries.

The excavations at Mohanjo Daro and Harappa had revealed that many crops like wheat, barley, rice, cotton and sesame were cultivated during ancient times in Pakistan.

The Flora of Pakistan comprises more than 6,000 vascular plant species and approximately 1,500 species have been used for medicinal purposes in one way or the other and 30 are known to be used in traditional medicine (FAO 1993). More than 400 species of medicinal plants are reported from the mountain regions. There are cultivated as well as wild medicinal plants in Pakistan.

2.0 Cultivated Medicinal Plants

There are many crop plants which are cultivated for their medicinal values and other uses. These include ispaghol (*Plantago ovata*), minit (*Mentha piperita*), basil (*Ocimum basilicum*), linseed (*Linum*

usitatissimum), *Dioscorea* spp., sesame (*Sesamum indicum*), turmeric (*Curcuma domestica*), ginger (*Zingiber officinale*). The major uses and medicinal properties are as follows :

Table 1. Cultivated medicinal plants and their properties

Species	Uses
Plantago ovata	Seeds are cooling, diuretic, demulcent; used in inflammatory conditions of mucous membrane, chronic dysentery, diarrhoea and constipation. Plants contain mucilage. Seed contain holoside planteose.
Mentha piperita	Leaves used as carminative, stimulant, stomachic, used for allayingnausea, sickness, vomiting and as infant cordial. Essential oil from plant is carminative, stimulant and antiseptic.
Mentha spicata	It is considered a stimulant, antiseptic, and carminative. Leaves are used in fever and bronchitis, decocition is given in apthae as a lotion.
Ocimum basilicum	Leaves are used to cure spasmodic laryngitis. Flowers are stimulant, carminative, demulcent, and diuretic. Seeds are used in chronic diarrhoea, dysentery and gonorrhoea. Plants yields essential oil. Commonly cultivated in gardens.
Mirabilis jalapa	For curing boils, abcesses, healing wounds. Plants contain alkaloid trigonelline. Cultivated and sometimes escapes. *Linum usitatissum* Flower is cardiac and nervine tonic. Bark and leaves are used in gonorrhoea. Seeds for gout and rheumatic swellings. Oil is used in cosmetics. Cultivated in most of the areas.
Dioscorea bulbifera	Tubers used in dysentery, piles, syphills *D. deltoida* and also applied for ulcers. Tubers contain poisonous glucoside. Found in foothill zone up to 2,000 m.
Sesamum indicum	Leaves as demulcent in infantile cholera, diarrhoea, dysentery; seeds are tonic, diuretic and lactagogue. Cultivated in plains and foothills.

Ricinus communis	Seed and seed oil is purgative, seeds are counter irritant, used in scorpion stings and as a fish poison. It is cultivated as well as an escape.
Allium sativum	Bulb is carminative, aphrodisiac, expectorant, stimulant. Juice is used as ear drop in earache. It is cultivated every where. Wild garlic is found at high altitudes.
Coriandrum sativum	Seeds are chewed to stop foul breath. It is carminative, diuretic, tonic, stimulant, stomachic, refrigerant aromatic, antibilius. It is cultivated in all parts of the country.
Curcuma domestica	The flower paste is used in gonorrhoea, and skin disease. The rhizome is carminative, stimulant and applied extremely to wounds for healing. It is cultivated in many parts.
Zingiber officinale	Used in colic, dyspepsia, rheumatism piles, vomiting, nausea. Introduced 20-30 years ago.

3.0 Medicinal Plants of Mountain Areas

The main wild medicinal plants of the mountain regions are listed below.

Table 2: Wild medicinal plants of mountain regions

Species	Uses
Abutilon theophrasti	Found in Kashmir and northern areas. Seeds are laxative, and demulcent. Bark astringent, and diuretic.
Acer cappadocium	Common in Murree hills. Leaves are irritant, and bark is astringent.
Aconitum heterophyllum	It is common in Chitral, Swat, Hazara and Murree. Root is antiperiodic, aphrodisiac, astringent, tonic, used in diarrhoea
Actaea spicata	Found at 2,400-4,000 m. The root is a nerve sedative, emetic and purgative.
Adiantum venustum	It is abundant in forests upto 4,000 m. Frond is tonic, resolvent, expectorant, diuretic, and used as a plaster.
Adonis aestivalis	It is found up to 2,000 m. Plant is used as a cardiac stimulant, and diuretic. Flowers are laxative.

Albizia chinensis	Found in Sub-Himalayan tract. Infusion of the bark used as a lotion for cuts, scabies and skin diseases.
Apium graveolens	N.W. Himalayas and foot hills. Seeds are stimulant, cordial tonic, carminative, diuretic, used in bronchitis, asthma, fever and spleen diseases.
Astragalus strobiferus	Himalaya from 2,500-4,000 m. The gum is a substitute for tragacanth.
Atropa acuminata	Up to 2,900 m. Roots and leaved are narcotic, sedative, diuretic.
Azadirachta indica	Cultivated and wild in many areas. Skin diseases, insecticides. Fruit is purgative and used for intestinal worms.
Bauhinia variegata	Cultivated as well as wild. Bark is anthelmintic tonic, astringent, useful in skin diseases; dried bulbs are used in dysentery.
Berberis pachyacantha	Common above 200 m. Diuretic, relief of heat, thirst and nausea.
Bergenia himalaica	Murree hills and other high altitudes. Root contains gallic acid, tannic acid, mucilage, wax; used in fever, diarrhoea, applied to boils.
Bunium persicum	Gilgit, Baltistan, Skardu, Astor. Fruits carminative, lactogogue, stomachic.
Bupleurum falcatum	1,000-3,000 m. Contains saponin. For liver troubles.
Caesalpinia decapetala	Sub-Himalayan tract. Laxative, applied to burns. Roots purgative.
Calamintha vulgaris	From 1-4,000 m. Plant is astringent, carminative and heart tonic.
Callicarpa macrophylla	Sub-Himalayan tract. For rheumatic joints. Oil from root is aromatic and stomachic.
Carduus edelbergii	1,200-3,000 m. Leaves are used to curdle milk. Flowers are febrifuge: Seeds contain oil.
Carpesium abrotanoides	1,600-3,500 m. Seeds are laxative, bacchic. All parts are diuretic, and anthelmintic.
Cedrus deodara	Common from 1,500-3,000 m. Wood is carminative, useful in fever. Plant contains gum, essential oil, needles contain ascorbic acid.
Cichorium intybus	Common from 1,000-3,000 m.
Dactylorrhiza hatagirea	Above 2,400 m. Tubers yield salop and reputed as expectorant, aphro-disiac and nervine tonic.

Daphne oleoides	Tran-Indus, Hazara, Kaghan, Chitral. Infusion of leaves is given in gonorrhoea and applied to abscesses. Root is purgative.
Datura spp.	*D. innoxia*, *D. metel* and *D. stramonim* are reported. Plants contain alkaloids: daturine, hyoscyamine, atropine etc.
Dioscorea spp.	*D. bulbifera* and *D. deltoida* are reported from foot hills up to 2,000 m. Tubers used in dysentery, piles, syphilis etc.
Diospyros lotus	Wild at high altitudes. Seeds are sedative.
Ephedra gerardiana	Northern areas and Baluchistan.
Equisetum arvense	At high altitudes. The herb is diuretic, haemostatic, used in dropsy, gravel in kidney. Plant ash is used to stop stomach acidity.
Flacourtia indica	Sub-Himalayan zone. Gum is used for cholera. Fruit juice is used in jaundice and enlarged spleen.
Geranium spp.	Six species with medicinal importance are reported from Himalayan region. These have many medicinal properties.
Hedera nepalensis	It is common in Murree hills. Plant contains arsenic acid, leaves contains saponin. It is stimulant, cathartic and diaphoretic.
Hyoscyamus niger	Wild in Kashmir and NWFP. Leaves are narcotic, sedative, anodyne.
Hyssopus officinalis	Kashmir and up to 3,000 m. The infusion of the plant is used in asthma and cough. The leaves are stimulant and carminative.
Lamium album	Root is astringent and used as resolvent and vulnerary.
Lonicera semenovii	In dry areas of the Himalayas up to 4,000 m. Leaves and flowers are considered as a remedy for veneral diseases.
Lycopus europaeus	Kurram, Gilgit, Chitral, Swat etc. Plant is used as a colling medicine.
Lyonia ovalifolia	Common in the Himalayas. Leaves and buds are used to hill insects.
Marrubium vulgare	Kurram, Swat, Chitral. Plant is carminative, expectorant, diuretic.
Melilotus officinalis	Chitral, Gilgit, Baltistan. It is carminative, aromatic, emollient.
Morus alba	Cultivated and wild. The bark is purgative and vermifuge.

Myricaria germanica	Common along streams in Chitral, Kurram and gilgit. Decoction is used in jaundice.
Nepeta cataria	Common in Kurram, Ziarat, Gilgit. Leaves are chewed to relieve toothache.
Olea spp.	*O. ferruginea* and *O. glandulifera* are abundant in the Himalayas. Bark and leaves are astringent and antiperiodic.
Onosoma hispidum *Onosma bracteatum*	Common in Swat, Kaghan, Kurram and Baluchistan. Flowers as cordial and stimulant in rheumatism and palpitation of heart. Root is purgative.
Origanum vulgare *Origanum majorana*	Swat, Gilgit, Kalam. Plant contains essential oil (0.4-0.5%) containing thymol (50%)
Osmunda spp.	*Osmunda claytoniana* and *O. regalis* (ferns) above 2,600 m. The plant is tonic and styptic.
Papaver spp.	Five species of *Papaver* with medicinal and narcotic properties are reported
Physochlaina praealta	Gilgit and Baltistan. Leaves applied to boils to reduce swelling. It contains hyoscyamine and hyoscine.
Picris hieracioides	Common at 1,700-4,000 m altitude. Leaves used as febrifuge.
Podophyllum emodii	Occurs in Kurram, Swat, Chitral, Hazara at 2,500-3,000 m. Rhizome and roots are hepatic-stimulant, cholagogue, purgative.
Polygonum spp.	Nine *Polygonum* species occur in Northern areas. These contains essential oils and used as astringents, and for insect and snake bites.
Potentilla spp.	Seven species with medicinal importance are reported. Roots are tonic, febrifuge and astringent.
Prangos pabularia	Reported from Chitral, Swat and Kurram. Roots are used to cure itching, it also diuretic, carminative, stimulant.
Quercus incana	Trans-Indus, 1,000-3,000 m. It is astringent and diuretic.
Rhamnus spp.	Three *Rhamnus* species are reported from Kurram, Chitral, Dir etc. Fruits are purgative, emetic and used in spleen disorders.
Ribes nigrum	Chitral, Gilgit, Baltistan, 2,600-5,000 m. Leaves are diuretic, refrigerant, fruits are laxative and cooling. Buds contain essential oil.
Rosa brunonii	Chitral, Swat, Hazara, Gilgit, Kurram used in skin and eye diseases.

Rubia cordifolia	Dir, Chitral, Gilgit, Swat. Root is astringent and tonic. Stem used for snake bite.
Rubus ulmifolius	Reported from Kurram, Chitral, Lower Gilgit. Plant is astringent.
Rumex spp.	Three species are reported from Himalayan region. These are used in cutaneous disorders.
Salvia moorcroftiana	Found in Dir, Chitral, Hazara, Swat etc. Leaves are used for guinea-worm, itches; seeds are emetic.
Sambucus wightiana	Common from 1,800-3,200 m. Leaves are diuretic, expectorant, diaphoretic, purgative.
Silene vulgaris	Common at 600-3,900 m. Plants are emollient.
Skimmia laureola	Common from 2,400-3,500 m. Leaves are used in small pox, plant contains essential oil.
Solanum indicum	Sub-Himalayan tract. Root is expectorant, carminative, useful in cough asthma, toothache, fever.
Solidago virgaurea	Common in temperate and low alpine zone. Herb is antiseptic, diuretic and carminative.
Sophora mollis	Sub-Himalayan tract up to 2,000 m. used as vermicide.
Syzygium cumini	Sub-Himalayan tract. Seeds are used in diabetes. Fruits are useful in bilious diarrhoea, as a stomachic etc.
Taxus wallichiana	2,000-3,500 m. Leaves are used in bronchitis, hiccough and asthma.
Trifolium pratense	Chitral, Swat, Hazxara 1,300-3,000 m. Dried flowers expectorant, and antiseptic.
Urtica dioica	Common in waste places from 1,300-3,000 m. Decoction of plant is astringent, anthelmintic and diuretic. Plant contains lecithin.
Valeriana jatamansi	Hazara, Kurram, Chitral, Swat. Roots are aromatic, carminative, useful in cholera.
Verbascum thapsus	Dir, Gilgit, Swat, Chitral. Seeds are aphrodisiac and narcotic. Herb is used in pulmonary complaints.
Viola album	1,000-3,000 m. used for diseases of ear, wounds, tumours and in enlargement of spleen.
Vitex spp.	Four species are reported. used as tonics, vermifuges, for rheumatism etc.
Woodfordia fruitcosa	Sub-Himalayan zone. Dried flowers are astringent, used in liver complaints etc.
Xanthium strumarium	Chitral, Swat, Gilgit, Baltistan. Plant is sedative, emollient, diuretic and strong diaphoretic.

In Pakistan, a number of plants having medicinal importance provide major sources which are used commercially for the extraction of medicines. From the highland areas, *Ephedra gerardiana* provides the raw material for the preparation of ephedrine hydrochloride which is a bronchial dilator and used in the treatment of asthma and coughs.

However, the rest of the mountainous species have not been commercialized.

4.0 Germplasm Status of Medicinal Plants

No systematic efforts so far have been made to collect and preserve the germplasm of medicinal plants. However, the Forest Department, Pakistan Council of Scientific & Industrial Research and Plant Genetic Resources Institute of Pakistan/ Agricultural Research Council maintain some medicinal plants either in the gene bank or as living collections in the field. Hamdard University, Karachi has also started to maintain and utilize medicinal plants. However, the germplasm of medicinal plants maintained at the Plant Genetic Resources Institute does not include mountain species.

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A Note on Bamboo in Pakistan

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Bamboos are of limited diversity in Pakistan. The following are the most important :

1. *Arundinaria falcata* in the NW Himalayas at 1,200-2,000 m. It occurs in the undergrowth in forests of oak, firs and mixed trees, usually on northern slopes or in ravines. It is part of a wider gene pool through the Himalayas. It is used for making baskets, mats and pipes.
2. *Bambusa bambos.* It is rare in the Ravi river eastward. It is absent in the hills. This species is extensively used for construction.
3. *B. multiplex* in the plains of Punjab is a hedge bamboo, as in India; originally introduced from China. It has the potential to reach 2,000 m.
4. *Dendrocalamus strictus.* In Punjab and Kashmir. It is found also in mixed vegetation on Marghalla hills surrounding Islamabad. It is used for construction and a variety of purposes. This forms part of a gene pool extending across Hindustan and usually growing below 1,200 m. In Pakistan, the resources are shrinking.

Historically, after the splitting of Pakistan in 1971, the Forest Department and also progressive farmers introduced bamboos from India, Bangladesh and elsewhere, and plantations were established in Punjab. However, postharvesting and processing was poor and prices fell after 1980 so most plantations were uprooted.

There is a need to assess the existing diversity, introduce additional productive forms and conserve representative stands.

Medicinal Plants, Bamboo and Rattan in Mountain Development of Thailand

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1.0 The Plant Resources

Mountain areas have the potential to become major sources of medicinal plants (Table 1) and rehabilitation of degraded mountain areas can be tied to bamboo production, processing and marketing. Suitable species of bamboo are shown in Table 2. These have all been used in rehabilitation of denuded slopes.

Of the major indigenous rattans, *Calamus caesius, C. ornatus, C. scipionum, Daemonorops sabut, Korthalsia flagellaris* and *K. rigida* are largely associated with lowlands. *C. palustris* can grow up to about 900 m elevation.

Thailand's research interests on rattan started from the late 1960s with the development of plantations of *C. caesius* and later *C. manan.* Other cultivation trials have been initiated in several regions of the country.

Calamus siamensis, related to the species complex *C. viminalis* and locally used for mats and baskets through Indo-China, Malaysia and Indonesia, tends to be a lowland species, but has some potential in hilly areas for shoot production and is acceptable to commercial concerns. *Calamus erinaceus* of the complex of species belonging to

the section of the *Calamus* genus. *Podocephalus*, which can grow to reasonably high elevations, is currently untapped for its use in agroforestry. *C. blumei* also native to Thailand is a clustering climber reaching 800 m, as is *C. densiflorus* up to 600 m. *C. diepenhorstii, C. insignis, C. luridus* and *C. oxleyanus* are minor species used for ties and basketry and occur in hilly forests of Thailand. There are additional lowland species which are also minor in terms of uses.

Researchers in Thailand have not specifically studied the rattans of the higher altitudes.

Table 1. List of important medicinal plants of Thailand

Scientific name	Common name
Amomum krervanh	Camphor seed, Siam cardamum
Calophyllum inophyllum	Alexandrian laurel, larvel wood
Carthamus tinctorius	Safflower
Cassia angustifolia	India senna
Costus speciosus	Malaya ginger
Derris elliptica	Tuba root, Derris
Dioscorea spp.	Yams
Diospyros mollis	Ebony tree
Gloriosa superba	Climbing lily
Hydnocarpus anthelminticus	
Rauwolfia serpentina	
Stemona tuberosa	
Strychnos nux-vomica	Snake wood
Croton longissimum	Plao Noi

Table 2. Bamboo in mountain area development

Species	Performance rating	Altitude(m)
NATIVE BAMBOOS		
Bambusa bambos	5	up to 1,000
Bambusa burmanica	5	
Dendrocalamus asper	5	up to 1,500
Dendrocalamus hamiltonii	5	
Dendrocalamus strictus	5	up to 1,200

Thyrsostachys siamensis	5	up to 500
EXOTIC BAMBOOS		
Bambusa oldhamii	5	
Dendrocalamus latiflorus	5	
Phyllostachy makinoi	5	
Phyllostachys lithophila		
Bambusa beecheyana var. *pubescens*	3	
Bambusa dolicochlada	3	
Bambusa vulgaris var. *striata*	3	
Phyllostachys bambusoides	1	
Phyllostachys pubescens 2 types	1 - 3	

5 = high 1 = low

2.0 The Mountain Environment and Development

Thailand borders hill areas of Myanmar and Laos and N. Thailand shares biodiversity with these areas and adjacent areas of China. Although it is not part of the Hindu Kush-Himalaya, the hill areas of Thailand have many similarities with hill areas of that region.

In particular, similar socio-economic and environmental problems are encountered: deforestation, exploitation and exhaustion of land and marginalized tribal people.

Especially in such areas, people depend on medicinal plants for their health care.

3.0 Future Needs

In general, research and development work in Thailand has not focussed specifically on the three groups of plants in the highlands, except for use of bamboo in ecosystem rehabilitation.

Many technologies developed in neighbouring countries are likely to be directly applicable in Thailand.

WORKING GROUP DISCUSSION AND RECOMMENDATIONS

Three working groups were constituted under three different themes. Each Working Group (WG) was given an outline to structure their discussions. The theme, salient features of the discussion, and the recommended activities are summarized below:

Working Group # 1

THEME: CONSERVATION AND SUSTAINABLE MANAGEMENT OF RESOURCES

Chairman: *Dr. Ramanatha Rao*
Rapporteur: *Dr. Madhav B. Karki*

Goal:

Prioritization of bamboo, rattan and medicinal plants (MP) species for improved conservation and development activities. The prioritization should be based on the concept of ecological zonation as described below:

Zone 1: < 1,500 m
Zone 2: 1,501-2,500 m
Zone 3: 2,501-4,000 m
Zone 4: > 4,000 m

Objectives:

Information Gathering: To synthesize, evaluate, disseminate and identify gaps. Information collected to include taxonomy (gene pools) and inter and intraspecific variation within and among the targeted (priority) species;

Ethnobiological Studies: To study, document, validate, and apply extraction systems, indigenous knowledge and skills;

Resource Assessment: To classify, assess, and quantify resources of the priority species; patterns of population variation; causes and consequences of resource depletion; distribution, and prepare a list of threatened species (need to be coordinated among the countries involved) with emphasis on actions required to protect the biodiversity;

Biodiversity Conservation: To plan conservation of the B&R/MP species with emphasis on *in situ* (community based) conservation in relation to economic development of the communities and ecological rehabilitation of the areas concerned; *ex situ* conservation is to be linked with enhancement of production;

Development Strategy: To develop management systems for bamboo and rattans (pure stand and agroforestry crops); in the case of medicinal plants, to develop management system in natural conditions by integrating traditional/indigenous systems wherever possible; and

Germplasm Exchange: To promote germplasm enhancement and exchange through regional cooperation;

Current Gaps, Constraints, and Opportunities

In-country capacity enhancement in human resource development, information management, and R&D infrastructure and facilities development;

- Networking and sharing of information and expertise among participating institutions;

- Conducting training courses and technology transfer in various aspects of conservation and sustainable management of B&R and MP resources;

- Exchange of scientists and researchers between the organizations is strongly recommended to facilitate the training and technology transfer; and

- Encourage institutions to assist the weaker partners in the region in different aspects of conservation and management.

Suggested Strategies for Identification of Priority Species:

Each plant will be prioritized as given below:

- Bamboo: Use INBAR criteria for the lower altitude bamboos and develop suitable criteria for high altitude bamboos;

- Rattans: include Himalayan regions as a distinct area in selection of priority species;

- Medicinal and Aromatic Plants: Develop criteria to select priority species.

Recommended Activities:

- Collation, storage, retrieval, analysis, and dissemination of existing information to the targeted end-users;

- Selectively and pro-actively filling up the gaps in information, quality, and media of dissemination;

- Assess the existing ethnobiological information and if necessary generate new information through suitable investigations;

- Integration of ethnobiological information collected/generated and validated in the conservation, development, and utilization strategies;

- Resource inventory and assessment using standard methods; use of GIS may be explored wherever possible to improve the utilization of the information collected;

- Genetic resource (species and genetic diversity) assessment and evaluation by specialized institutions and sharing of information and technology;

- Survey and assessment of the extent of resource depletion and its impact on genetic erosion as well as socio-economic impoverishment;

- Inventory of threatened species in different countries of the region with suggestions to regulate trade and marketing factors; simultaneously develop strategies for their conservation;

- Study current *in situ* conservation/management practices in the region;

- Develop appropriate sustainable conservation strategies/ technologies which will assist in the economic development of the communities and also in the ecological rehabilitation of the ares;

- Select elite germplasm for *ex situ* conservation, develop/refine *ex situ* conservation techniques (based on traditional practices), refine propagation techniques and popularize them to assist enhanced production;

- Develop management/operation plans for bamboo, rattan, and medicinal plants based on the principle of sustainable conservation and commercialization for both natural and on-farm stands integrating traditional/indigenous knowledge and skills;

- Demonstrate and implement management systems developed with full participation of all the stakeholders;

- Initiate exchange/sharing of appropriate germplasms among the partner countries/institutions and carry out selection, evaluation and test plantations;

Working Group # 2

THEME: INTEGRATED PROJECT DEVELOPMENT APPROACHES

Chairman: *Dr. D.N. Tiwari*
Rapporteur: *Dr. Vineeta Hoon*

Goal

Integrated development of bamboo, rattan and medicinal plants in Himalayan region for the conservation and sustainable utilization of the NTFPs for the benefit of the people.

Specific Objectives:

1. To systematically inventory the resources and record their indigenous and commercial uses;

2. To conduct national and regional policy analysis and study the legal framework;

3. To evaluate existing production, processing and utilization practices in different places for further improvement;

4. To identify needs and opportunities in terms of infrastructure, technology, training, trade and marketing;

5. To disseminate information at all levels especially to the small scale producers and gatherers;

Recommended Activities

- Integrate resource assessment and socio-economic studies;
- Compare resource survey results to identify the sustainable systems for application;
- Review existing national and international policies and programme;
- Analyze policy frameworks, identify constraints and suggest solutions;
- Review existing management and utilization practices;
- Analyze and suggest improved management techniques including methods of reproduction including genetic improvement, processing and utilization;
- Identify needs and opportunities in terms of infrastructure, technology especially training in trade and marketing;
- Establish communication between all the different partners (scientists, producers and gatherers, rural communities and government agencies);
- Assess impacts of existing institutions and programmes;
- Match needs and opportunities;
- Disseminate research findings through networking;
- Prepare manuals, audio-visual aids and other extension materials in relevant languages; and
- Establish on site demonstration and training facilities;

Working Group # 3

THEME: MICROENTERPRISE DEVELOPMENT

Chairman: Mr. R.B. Rawal
Rapporteur: Mr. Bhishma Hoon

Objectives

1. To empower local people to manage their resources; and
2. To generate sustainable income in an equitable manner.

Main Gaps and Constraints by Different Aspects:

Resource Base

A. Heterogenous resource distribution/community composition
B. Erratic availability/supply of raw materials
C. Lack of sustainability in annual yield
D. Poor quality of natural resource management
E. Lack of strategy for cultivation and domestication of NTFPs
F. Seasonality, irregularity in quantity and1 lack of uniformity in quality of supplies

Resource Management

A. Lack of Skills
B. Lack of Training facilities

Utilization Technology

A. Lack of suitable equipment and mechanization
B. Not matching the scale of operation
C. Large number of products
D. Lack of capacity for technology transfer

Marketing Facilities

A. Lack of marketing infrastructure and information;
B. Lack of marketing skills

Policy and Institutional Framework

A. Inconsistent and repressive national policies
B. Lack of regional/international coordination and collaboration

Socio-economics Issues

A. Un-uniform distribution of benefits
B. NTFP crops competing with other agricultural crops and/or land uses
C. Unavailability of suitable labour force

Main Strategies Proposed

A. Create market infrastructure and information systems
B. Transfer appropriate technology to the target group of producers
C. Tie-up raw material supply with marketing, trading and processing units
D. Build community based institutions based on indigenous structures and value systems
E. Incorporate indigenous technologies and ideas with more scientific methods
F. Practice a sound financial management of the firm/production unit/household.

Recommended Activities:

1. Develop market information system including a network of market intelligence;

2. Develop community-based resource management systems based on indigenous knowledge and technical skills; and
3. Share micro-enterprise experiences and refine them to develop models for diverse socio-economic conditions and resource regimes;

The Pokhara Declaration

Recognizing that:

1. Over 120 million people in the Himalayan region rely on plant products mostly extracted from the wild, and over 450 million people are inter-related in this economic downstream;
2. Non-timber forest resources, including bamboos, rattans and medicinal plants, are most important in this region; they are invaluable to the livelihoods;
3. The region is ecologically complex, diverse and fragile; it is heavily degraded and rapidly becoming impoverished in biological diversity;
4. Many existing production systems are equally fragile and threatened resulting in grave threats to the livelihoods of millions of disadvantaged people;
5. Degradation is increasing due to increasing populations, indiscriminate harvesting, over-grazing, soil erosion, open-cast mining, shifting cultivation, and other environmentally unsound developmental activities;

Noting that:

1. There is lack of knowledge regarding collection and utilization of bamboos, rattans and medicinal plants in the region, and that the research capabilities and interests vary widely between the different countries of the region;
2. Where information does exist, it is inadequate, uncritical, and often not easily accessible to researchers, farming communities, governments and development agencies, resulting in many inadequate or restrictive policies and regulations;

3. There is a lack of information on demand and supply situation, market intelligence, and the actual operation of local/regional/national/international trade in these commodities; and
4. There is a lack of attention towards developing appropriate technologies which will enhance, on the one hand, sustainable production systems for the benefit of the local people and, on the other, conserve the resource base, protect essential watersheds and reduce soil erosion;

The Workshop participants resolved that:

1. There is an urgent need to conduct integrated, innovative and collaborative research to obtain the information required to solve the constraints and problems noted above;
2. There is an urgent need to seek people's participation at the grassroots level, thereby making them full partners in the research and development work;
3. Such research should be strategically focused to improve conservation, cultivation, production, sustainable management, utilization and marketing of a limited number of priority species to begin with;
4. There is an urgent need for interdisciplinary cooperation, networking and information dissemination in the region; and
5. The results of such research should have measurable and sustainably beneficial impact on economically disadvantaged people, and lead to sustainable development initiatives at all levels.

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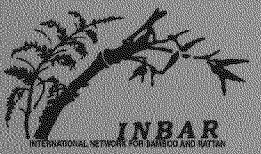

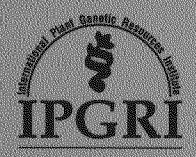

A three day workshop on the role of bamboo, rattan and medicinal plants in mountain development was jointly organised by International Network for Bamboo and Rattan (INBAR), International Plant Genetic Resources Institute (IPGRI), International Centre for Integrated Mountain Development (ICIMOD) and IDRC Medicinal Plants Network (IMPN). The Institute of Forestry (IOF), Pokhara, hosted the Workshop.

Thirty participants comprising policy makers, administrators, researchers and donors from eight countries and four international organisations attended the Workshop. The focus was on wiser use of non-timber forest resources in mountain development and the accent was on collaborative efforts.

The workshop theme was based on the fact that resource poor farmers of the Hindu Kush Himalayan region have been using bamboo, rattan and medicinal plants since time immemorial to meet their livelihood needs. These keystone commodities are especially appropriate for the low-input and low-technology situation prevailing in the mountain regions.

The proceedings of the Workshop include two inception papers, five thematic papers and fifteen country reports. The Workshop output is given as Working Group recommendations and the Pokhara Declaration. This publication will be useful to resource managers, mountain development planners, development workers, policy makers and researchers, especially in the Himalayan region.

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