Mountain Natural Resources

Discussion Paper
Series No. MNR 99/1

Methods in Applied Ethnobotany
Lessons from the Field

Ajaya Rastogi

International Centre for Integrated Mountain Development
Kathmandu, Nepal
1999

ISSN 1024 - 7556

Methods in Applied Ethnobotany

Lessons from the Field

Ajaya Rastogi

MNR Series No. 99/1

Ajaya Rastogi was a professional staff member of ICIMOD. An ethnobotanist, he has worked on nature conservation issues since 1968. He currently works in the eastern Himalayan region providing inputs to government and non-government agencies working in the area of biological diversity assessment, monitoring, and conservation.

International Centre for Integrated Mountain Development
Kathmandu, Nepal

August 1999

ISSN 1024 - 7556

Published by

International Centre for Integrated Mountain Development
G.P.O. Box 3226
Kathmandu, Nepal

Typesetting at ICIMOD Publications' Unit

Preface

Part of the mandate of the Mountain Natural Resources' Division of ICIMOD is to examine how people interact with their environment and the use they make of the resources it provides.

The current paper is a result of the applied ethnobotany project that began in 1995 as a joint undertaking between ICIMOD and UNESCO and implemented within the broad framework of the People and Plants' Initiative with a view to promoting institutional capabilities and improving the skills of young botanists for integrated conservation and development research.

The project held training workshops at national and subregional levels and published proceedings and synthesis reports on the use of medicinal plants and traditional resource management systems in the Hindu Kush-Himalayas.

The Mountain Natural Resources' Division is publishing the current paper in its discussion paper series in order to share the knowledge gained with those interested in ethnobotany and those who are considering its value in mountain natural resource management.

We appreciate the funds provided by UNESCO through the trust fund established by DANIDA. From MNR ICIMOD, Mr. Ajaya Rastogi, has performed an exemplary job in putting the paper together in its present form.

Abstract

An applied ethnobotany project was launched in July 1995 in the Hindu Kush-Himalayan region as a joint operation of UNESCO and ICIMOD (International Centre for Integrated Mountain Development). This project, which ended in September 1998, was implemented within the larger framework of the People and Plants' Initiative. The aim of the project, which had a duration of three years, was to build up capacities of and capabilities in institutions, improve the skills of young ethnobotanists, and bring ethnobotany into the mainstream in integrated conservation and development research. The programme was funded by UNESCO with trust funds provided by DANIDA. The countries involved were India, Pakistan, Bangladesh, Nepal, Bhutan, and China.

The principal activities of the programme were training workshops at national and subregional levels; publication of proceedings from these to be used as resource materials; a programme of small grants for young ethnobotanists from the region; and production of synthesis reports on methods and approaches. In addition, a synthesis report on lessons learned from the case studies on the use of medicinal plants and a synthesis report on lessons learned from case studies on traditional resource management systems in the Hindu Kush-Himalayas were also produced.

The diversity of themes and subjects; academic backgrounds and capabilities of the researchers; and the biologically, culturally, and geographically varied sites for research resulted in the use of a variety of methods. This experience has been summarised in one section of this paper. There is an overall gradual convergence in the approach to community-based research and, therefore, another section briefly describes some of the most frequently used methods in order to share information on methods of applied ethnobotany. The last section contains information on recent developments in ethical guidelines for ethnoboiological research and information on the important issue of the protection of intellectual property rights of local communities.

Acronyms and Abbreviations

ASOMPS	Asian Symposium on Medicinal Plants, Species, and Other Natural Products
BFRI	Bangladesh Forest Research Institute
BSP	Biodiversity Support Programme
CBD	Convention on Biological Diversity
cbh	circumference at breast height
dbh	diameter at breast height
ECOSOC	Economic and Social Council
FAO	Food and Agricultural Organization of the United Nations
GATT	General Agreement on Tarrifs and Trade
GIS	Geographic Information System
HHS	Household Survey
HKH	Hindu Kush-Himalayas
ICIMOD	International Centre for Integrated Mountain Development
IIED	International Institute for Environment and Development
IKS	Indigenous Knowledge System
ILO	International Labour Organization
IPR	Intellectual Property Rights
ISE	International Society of Ethnobiology
IVI	Importance Value Index
KIS	Key Informant Survey
LSE	Landscape Elements
NEPED	Nagaland Environmental Protection and Economic Development
NRM	Natural Resource Management
NTFP	Non-timber Forest Products
PARDYP	People and Resource Dynamics' Project
PBR	People's Biodiversity Registers
PBR	Plant Breeders' Rights
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal

Contents

Chapter 1
Introduction

Introduction

The classical approach to ethnobotanical studies has been oriented to building up inventories with a special focus on documentation of the local uses of various plants and their parts. The wider issues related to the utility of research processes and the findings to local populations have been ignored for the most part.

With the inception of participatory approaches and recognition of local knowledge systems in community-level development and conservation programmes, progressive change has taken place in the way applied ethnobotanical research is conducted. Ethnobotany has assumed the status of a distinct branch of natural science, and there has been a proliferation of terms to describe the specialised subdivisions of study; for example, ethnobiology, ethnoecology, ethnomedicine, ethnomycology, socioethnobotany, and so on (Schultes 1995). The nature and scope of the field has thus expanded and diversified.

The scope of inquiry is reflected in the questions asked by its researchers. Specific questions asked by ethnobotanists include the following: what plants are available? what plants are recognised as resources? what social, political, biological, economic and ecological factors cause particular plants to be perceived as resources? how does the use of certain resources influence the use/availability of others? how is ethnobotanical knowledge distributed among the human population? what do people think about plants? how do they differentiate and classify elements of their natural environment? from what resource zones are plant products harvested? how are they used? What are the economic and financial benefits derived from plants? how are plant resources maintained? what effect does their management have upon the structure of local vegetation? what effect does their management have upon the structure and functioning of local institutions? how have the human activities and their consequences influenced the evolution of local plant populations? for what purposes are resources needed? to what stresses are human populations adapting? are human choices of particular resources adaptive? if so, to what are they adaptive? how are human adaptive strategies affected by change? what changes are presently occurring, and what changes have taken place in the past? (Alcorn 1995).

As can be seen from these questions, modern ethnobotany is concerned with the totality of the place of plants in a culture (Ford 1978). It is the study of plant human interrelationships embedded in dynamic ecosystems of natural and social components. Put another way, ethnobotany is the study of contextualised plant use. Plant use and plant human interrelationships are shaped by history, by physical and social environments, and by the inherent qualities of the plants themselves'.

This reflects the breadth and depth of ethnobotanical studies. However, limitations of time, technical and financial resources, and sometimes lack of confidence in the researcher by the local community and restricted access to indigenous knowledge pose practical constraints in getting the answers to many of these questions. In order to facilitate improvement in the quality of ethnobotanical information in the HKH region, ICIMOD carried out a project, 'Promotion of Sustainable and Equitable Use of Plant Resources by the Application of Ethnobotany.'

This project was launched in partnership with the 'People and Plant Initiative' of the World Wide Fund for Nature (WWF), United Nations Educational, Scientific and Cultural Organization (UNESCO), and the Royal Botanical Gardens, Kew. The foundations for this partnership are founded on the recognition that traditional use of biologically diverse resources in the mountain region of the Himalayas not only reflects a diverse resource-use pattern, but also the methods of maintaining biological diversity in mountain ecosystems by mountain people.

Many people in rural communities have detailed and profound knowledge of ecological properties of locally occurring plants and rely on them for their foods, medicines, fuel, building materials, and other products. These resources are often governed and regulated by localised natural resource management systems that form the basis for decision-making. Since the majority of land-based production systems in the Himalayan region operate under indigenous knowledge systems, they are not only of value to the cultures from which they evolve, but also to scientists and planners who strive to improve conditions in rural societies. ICIMOD, with its strong commitment to sustainable development in the region, has founded the project on the following public policy principles.

- The principle that all development projects addressing issues related to agriculture, livestock and pasture, agroforestry, forestry, land-use planning, watershed management, and other natural resource management fields should take into account the traditional wisdom and expertise of the local inhabitants.
- The principle that the interface between people and nature must be addressed in conservation projects that propose setting aside productive lands as protected areas for the conservation of biodiversity. They should take into account the perspectives, uses, and traditional methods of management of natural resources by local inhabitants.
- The principle that the intellectual property rights of people with indigenous knowledge, including special ethnobotanical knowledge, should be respected.

In recognition of a programme approach that emphasises the application of ethnobotany in community development and conservation, many interrelated activities were considered to be important, These activities were identified in a planning meeting attended by specialists from six HKH regional member countries: Bangladesh, Bhutan, China, India, Nepal, and Pakistan and by associates of the 'People and Plants Initiative' from WWF, UNESCO, and the Royal Botanical Gardens, Kew. Training for young ethnobotanists was considered a key ingredient. Two principal activities were undertaken in this respect: field training workshops and financial assistance to enable them to carry out field research.

Four national and one subregional field-training workshops on applied ethnobotany were held in partnership with national institutions. The National Agricultural Research Council of

Pakistan organized the national workshop jointly with WWF Pakistan in Islamabad; Kunming Institute of Botany organized the national workshop for China in Kunming; King Mahendra Trust for Nature Conservation and Tribhuvan University together organized the national workshop for Nepal in Chitwan; the Applied Environmental Research Foundation together with the NEPED (Nagaland Environmental Protection and Economic Development) Project of the Government of Nagaland organized the national workshop for India in Kohima; and the Bangladesh Forest Research Institute organized the subregional workshop for Bhutan and Bangladesh in Chittagong.

Each of these workshops ran for an average duration of six days with participants and resource persons totalling about 25 in each workshop. The participants came from a variety of national, regional, and local institutions representing governments, autonomous scientific and educational bodies, and voluntary sector agencies. Nearly half of the time in each workshop was devoted to theoretical orientation and to teaching useful methods of ethnobotanical research. It was followed by visits to the nearby community villages and forest areas for practical exercises and trial of different methods. The proceedings for each of these workshops have been published separately as resource material and full references are provided in Annex 1.

Case studies and study grant proposals were invited from workshop participants and others. A total of fifteen such studies was selected for support: five in Nepal, four in China, and two each in Pakistan, India, and Bangladesh. These studies had a duration of one year and were largely undertaken by young researchers. Some of them did field research work for dissertations as part of regular degree programmes, while others came from various non-government organizations to strengthen their ongoing work in conservation and community development by improving their expertise in ethnobotany. The second chapter presents a brief overview of the research methods used by the investigators. This is an effort to provide the benefits of experiential learning to all those who are associated with applied ethnobotanical research, particularly in the Hindu Kush-Himalayan region. This overview is followed by a third chapter describing the important methods that have proved useful in initiating and conducting applied ethnobotanical studies on a variety of themes.

Issues associated with the ethics of community-based research, in general, and those dealing with indigenous knowledge and technologies are of prime significance. Experience shows that research in rural areas has been extractive in many ways and has contributed little to the well-being and empowerment of local communities. More recently, biological prospecting has become a big threat. It causes the loss of the potential economic interests of the custodians of indigenous knowledge. It is perceived to offer considerable potential for expanding our knowledge of biological resources and for providing sustainable commercial opportunities and positive local incentives for conservation. It has therefore attracted considerable attention from governments in developing countries that perceive in them a valuable opportunity to generate economic benefits from biodiversity conservation (Wells 1997). However, there are many slips between the cup and the lip in this matter, and both conservation and development practitioners feel that there is every chance that these benefits might not reach the local communities and might actually leave them much poorer than at present. The fourth and final chapter of this paper looks at some of these issues and discusses recent and ongoing efforts to safeguard the interests of the custodians and users of indigenous knowledge and technology.

Chapter 2
Review of Methods Used in Case Studies

Introduction

A review of the methods used in the fifteen case studies reveals a trend in initiating and undertaking research. All the researchers began by selecting the site and carrying out preliminary observations and discussions to arrive at a better understanding of the range and breadth of issues in their area of interest. Following this process, they reviewed the literature and selected different tools from the methods available for collecting the necessary data and information. A brief introduction to each study with a review of the methods used by the investigators follows. Please refer to Annex 2 for a complete reference to the study reports.

2.1 *Sustainable Management and Conservation of Medicinal Plants in the Jingpo Community, Southwest Yunnan, China*

Jingpo is a large community in the eastern Himalayan region. The community is found in parts of Myanmar and China. The *Jingpo* live in small hamlets comprising of 20-30 households. This study focussed on Jinzhu village in southwest Yunnan which has a total population of 125 individuals in 21 households. Very little ethnobotanical information is available about these people. They have been marginalised in the wake of increasing commercial pressure and logging of forests on the Myanmar/China border. This report basically covers the process of preparing an inventory on the useful flora of the *Jingpo*. It was carried out by Yang Yongping of the Kunming Institute of Botany, Kunming, Yunnan, and focussed especially on the following.

a) Identifying and preparing an inventory of all plant species used in traditional remedies
b) Investigating folk classification systems for medicinal plants
c) Documenting indigenous knowledge on the use and management of medicinal plants

Various ethnobotanical and taxonomic methods, such as key informant interviews using structured questionnaires, personal observation, and collection of voucher specimens of plants for correct identification were used. Ethno-taxonomic nomenclature was elicited on the following criteria.

i) The names of plants give indications to the inherent characteristics of plants. For example, *Bum Shibyri*, the local name of *Litsea cubeba*, means that it tastes hot. *Mimosa pudica*, locally called *Myog hog*, means the 'touch me not' plant.
ii) The names of plants reflect some physiological reaction, e.g., The local name of *Pang kair*, *Sargentoboxa cuneat*, means that one feels hungry.

iii) The names indicate the external morphological characteristics of the plants. For example, *Zu Jurin*, the name of *Toddalia asiatica*, indicates a plant with sharp thorns on its stem.
iv) The names indicate a close relationship with animals, e.g., *Byo Chuban* (*Cleorodendron serratum*), means that insects like this plant; *Byo Byuni myog* (*Plantago major*) indicates that frogs prefer to stay under this plant.
v) For some medicinal plants, the local names describe curative properties, e.g., *Haqzuang mui* (*Asparagus cochin-chinensis*) indicates that the plant can be used as an anti-inflammatory and to stop bleeding.

In order to assess the spatial and temporal distribution of medicinal plants, seven ecological zones were identified based on local knowledge: paddy fields; fallow land less than three years' old; and primitive forest, home gardens or around settlements, secondary forest, and cultivated fields.

2.2 Application of Indigenous Knowledge of Fodder Trees in Kalikasthan, Rasuwa District, Nepal

This study focussed on documenting farmers' management practices in relation to plantation on private land; recording important fodder trees in terms of quality, production, and associated ethnobotanical information. Additional aspects included understanding the role of livestock in the local economy and suggesting measures to improve the fodder situation in the area. Agriculture and livestock farming are inseparable in mountain areas. However, because of the growing population, land holdings are becoming fragmented and reduction in the area of pastureland is being caused by conversion of pastures for cereal cultivation. Livestock farming in the mid-hills of Nepal has been a steady source of income and a source of manure. Fodder trees provide fuelwood as well as fodder. People have traditionally followed and evolved agroforestry practices that are based on sound ecological understanding and economic judgements. The researcher, Sunil Acharya of the National Herbarium at Godavari, was guided by Dr. N.P. Manandhar in this work. Dr. N.P. Manandhar retired as the Head of the National herbarium and currently provides advisory services in the area of plant sciences.

Methods followed by the investigators included using a structured questionnaire in all the 21 households in the study area, informal discussions on various issues with local political workers and teachers, personal observations of agroforestry plots, and collecting herbarium specimens for identification. They also recorded farmers' perceptions on the quality of fodder and effect of trees on food crop production; and they also analysed the management and process of lopping and drew up a list of fodder trees with lopping and plantation periods as well as ethnobotanical information on other traditional uses of important species.

2.3 Study on Ethnobotany and Conservation of Sinopodophyllum hexandrum, Diphyleia sinensis, and Fritillaria cirrhosa in the Zhongdian Tibetan Autonomous County, Yunnan, China

The Government of the People's Republic of China is promoting floriculture on a large scale on the subalpine natural grasslands of Zongdian Tibetan Autonomous County. These areas are and have been important areas for medicinal plants and other products (almost 600 species of medicinal plants used in Tibetan medicines are found in Zongdian). Two species, viz., *Sinopodophyllum hexandrum* and *Diphyleia sinensis,* were scientifically validated a decade ago for containing anti-cancerous compounds. This led to a very high level of demand for these two species for chemical extraction. There is a dire need to supplement these plants with cultivated sources. *Fritillara cirrhosa* is considered to be one of the best wide-spectrum medicines for respiratory diseases. Therefore, the project's purpose was to document the local classification and uses of the three species and set up demonstration plots in farmers' fields to standardise and promote their cultivation and marketing. Important questions about the economic viability of small-scale and decentralized production of medicinal plants were also addressed.

The project was undertaken by Qi Shunhua of Yunnan University under the supervision of Professor Hu Zhihao, also of that university. Local traditional health care practitioners and Tibetan doctors working in the local hospital were interviewed using a semi-structured questionnaire. Personal observation and interaction took place with farmers in the village to persuade them to undertake cultivation of the three plants. Phytochemical analysis of the collected rhizomes and seeds was carried out in the laboratory..

2.4 *Investigation of the Status of Indigenous Medicinal Plants and Their Conservation in the Newar Community: A Case of Bungamati VDC, Lalitpur, Nepal*

This study was concerned with the status of indigenous medicinal plants. Their status was assessed according to their availability and socioeconomic and cultural significance among the *Newar* ethnic group. Efforts were also made to examine and understand traditional health care practices in Bungamati. The two investigators, Meena Pokhrel and Rupa Shrestha, worked closely under the guidance of Dr. Ram Kumar Sharma, an expert in the use of participatory rural appraisal methods. Various PRA tools have been used in the study and the methodology, as summarised by the investigators, is presented on page 8.

In addition to the study, a project on cultivation of 32 species of plants found to be economically useful was initiated in a demonstration area situated within the premises of Tri Ratna Cooperative School within the Bungamati VDC.

2.5 *Genetic Diversity, Distribution Pattern, Germination and Ethnobotanical Uses of Alnus nepalensis and A. nitida in Lumle and the Pokhara Region of Gandaki Zone, Nepal*

Alnus nepalensis and *Alnus nitida* are multipurpose tree species that are much preferred in the mid-hill region. Some of the reasons for their popularity are:

a) they are among the best known modulated non-legumes;
b) the root systems grow very rapidly, root suckers freely proliferate, and they can tolerate extremes of moisture, temperature, and pH;
c) they are shade tolerant and moderately frost resistant trees and act as excellent 'nurse trees'; and
d) the wood dries quickly and burns easily without characteristic odour.

Methodology for Case Study 2.4

Study Concern	Verifying indicators	Study Tools
Ethnobotanical inventory	• Identification of economical, cultural, and medicinal plants in Bungmati • Traditional health care system	• Field observation and self judgement • Herbarium collection and identification • Resource map • Review of secondary sources • Key informant survey • Household survey
Socioeconomic Inventory of the study site	• Population size and settlement pattern • Language and ethnicity • Social group/classes and their interdependency • Survival strategies • Gender analysis	• Review of CBS data • VDC profile • Social map • Key informant survey • Household survey
Economic Importance of Plants	• Direct economic value • Annual edible commodities available • Annual collection of firewood • Annual collection of construction material • Annual collection of medicinal plants • Annual collection of fodder	• Household survey • Key informant survey • Case study
Sociocultural Importance of Plants	• Use of plants in community festivals/rituals/occasions • Seasonal farming • Belief in and perceptions on the use of indigenous plants	• Key informant survey • Case study • Household survey
Inventory of Practice and Trends in the Traditional Health Care System	• Belief and degree of dependency of people • Identify herbal practitioners, and traditional faith healers and their status in the community • Role of herbal healers in use and conservation of plant resources	• Household survey • Key informant survey • Case study

The study tried to determine the genetic variability in the two species, select the most suitable genotypes, conduct seed viability tests, and document ethnobotanical uses of Alnus. The study was carried out by Bharat Sah of the Central Department of Botany, Tribhuvan University, Kirtipur, and was supervised by Prof. B.N. Prasad of the same department. The method of field level data collection was a household survey with a structured questionnaire. Informal personal interviews with key informants were also carried out. To assess genetic diversity, a number of parameters was recorded (such as diameter at breast height) at the start as well as at the end of the study; seed length in millimetres, number of seeds per 100 milligrams, and study of chromosome numbers in *Alnus nepalensis*.

2.6 *Community-based Case Study on Sal (Shorea robusta) Forest Management and Sal Seed Collection for Commercial Potential*

Five community forests out of 45 community forests in Makawanpur district were selected for the study on sal forest management. The particular focus was on the historical background and relationship between indigenous and community forestry practices. The study was led by Sangeeta Rajbhandari of the Central Department of Botany, Tribhuvan University, Kirtipur in association with Virendra Kumar Karna and Nabina Dongol of the same department. Most of the information was obtained through primary data collection using the interview method with structured and unstructured questionnaires and personal observation at different sites. The questionnaire for the household respondents contained the following sections.

a) Socioeconomic and demographic information
b) Past and present forestry practices
c) People's participation in community forestry management
d) Use of sal parts
e) Role of indigenous knowledge in forest management
f) Relationship between indigenous and community forest management

The data thus obtained were analysed using the standard deviation chi-squared method. Preference for species was noted by ranking.

2.7 *Ethnobotanical Survey of Rare Medicinal Herbs in the Buffer Zone of the Valley of Flowers' National Park, Chamoli, Garhwal, India*

The Valley of Flowers' National Park is a high altitude protected area in Garhwal Himalayas. The park and its buffer zones are rich in medicinal plants and the local people in this area have considerable knowledge of ethnobotany. These people are gradually shifting from a subsistence ecoomy to a market economy, mainly due to an increase in tourism and mountaineering activities. In addition to the adverse impacts on habitats, overextraction of medicinal plants for commercial purposes in response to increased demand has exerted tremendous pressure on the existing plant populations. In all 112 species of medicinal plants have been recorded to be in use by the local population. Of these, 23 species are rare and endangered ; and they include five species enlisted in the Red Data Book of Indian Plants.

This study was carried out by. C.P. Kala, Wildlife Institute of India, Dehradun, under the guidance of Dr. G.S. Rawat of the same Institute. He collected ethnobotanical information using semi-structured and unstructured questionnaires as well as direct observations in the field. Each household was surveyed for information on the quantity of medicinal plants extracted from the wild. Verification of data was carried out by repeated interviews with more than one informant. To study the effects of various anthropogenic activities on the population of medicinal plants, 25 quadrats of 50 X 50 cm each were laid in the different sampling units. Sampling units were identified after stratifying the area in different pressure zones and identifying various landscape elements in each of the pressure zones. The entire study area was stratified into three broad pressure zones:

1. the Valley of Flowers, being a protected area, was considered to be a control site;
2. the buffer of the park, which is under severe pressure due to tourism and livestock grazing, was taken as a high pressure zone; and
3. Khiron Valley, which is grazed mostly by sheep and goats, was taken as a moderately disturbed (grazed) area.

2.8 *Ethnomedicobotanical Studies of Gurung Communities in Bichaur Village, Lamjung, Nepal*

There are many remote areas in the Himalayan region where modern medical health care is not available. Thus, the traditional healing system plays an important role in maintaining the physical and physchological well-being of the vast majority of people in such areas. It has been observed that, when the allopathic system is introduced into a village; the complementarity of the two systems in terms of integrated health care practices is not emphasised. In fact, there is a certain level of mistrust in the traditional medical system. The project focussed on the current use of herbal medicines and the problems of the *Dhami* and *Jhakri* (local healers). A local workshop was also organized to initiate two-way communication between the *Dhami-Jhakri* and allopathic health care workers and to promote and continue appropriate and discourage and discontinue inappropriate traditional health practices. Another objective of the workshop was to increase awareness about prophylactic measures such as immunisation, family planning, nutrition, and environmental hygiene. The study, led by Ila Shrestha of the Nepalese Society for Systematic Collection, also produced a detailed inventory of all the medicinal plants; herbarium plants were also collected. They conducted household surveys using a structured questionnaire, identified and interviewed key informants, and carried out meetings with interest groups.

2.9 *Ethnobotany of Fruit Plants and Its Application for Conservation and Community Development in Drosh Valley, Chitral, Pakistan*

The North West Frontier Province of Pakistan is well known for fruit cultivation. The focus of the project was to assess the traditional ways of propagation, pruning, harvesting, and protection against insects, disease pests, and grazing animals. The study was supervised by Prof. Farrukh Hussain, Chairman, Botany Department, University of Peshawar, Peshawar. After a general survey and preliminary discussions with the elders in the area, 36 villages were selected.

In each village, interviews were carried out by randomly selecting the local inhabitants and administering a structured questionnaire. The questionnaire was divided into two parts. The first part included personal information such as name, locality, age, education, and the knowledge of the respondent regarding wild or cultivated fruit plants; likes or dislikes in terms of varieties of fruit, and the criteria for ranking the fruit/variety in the area. This part of the questionnaire also looked at the general problems of the area related to agriculture, horticulture, forestry, communication, and health and educational facilities. The second part of the questionnaire was specific about individual fruit varieties. The investigations assumed that a person had enlisted the names of fruit or their varieties in order of preference in terms of quality, prevalence, or commercial value in that area. Thus, the position in the free listing task was taken as the preferred rank. The research team interviewed a total of 728 individuals who included respondents in different age groups, educational levels, and professions such as farmers, labourers, shopkeepers, government servants, and school/college students.

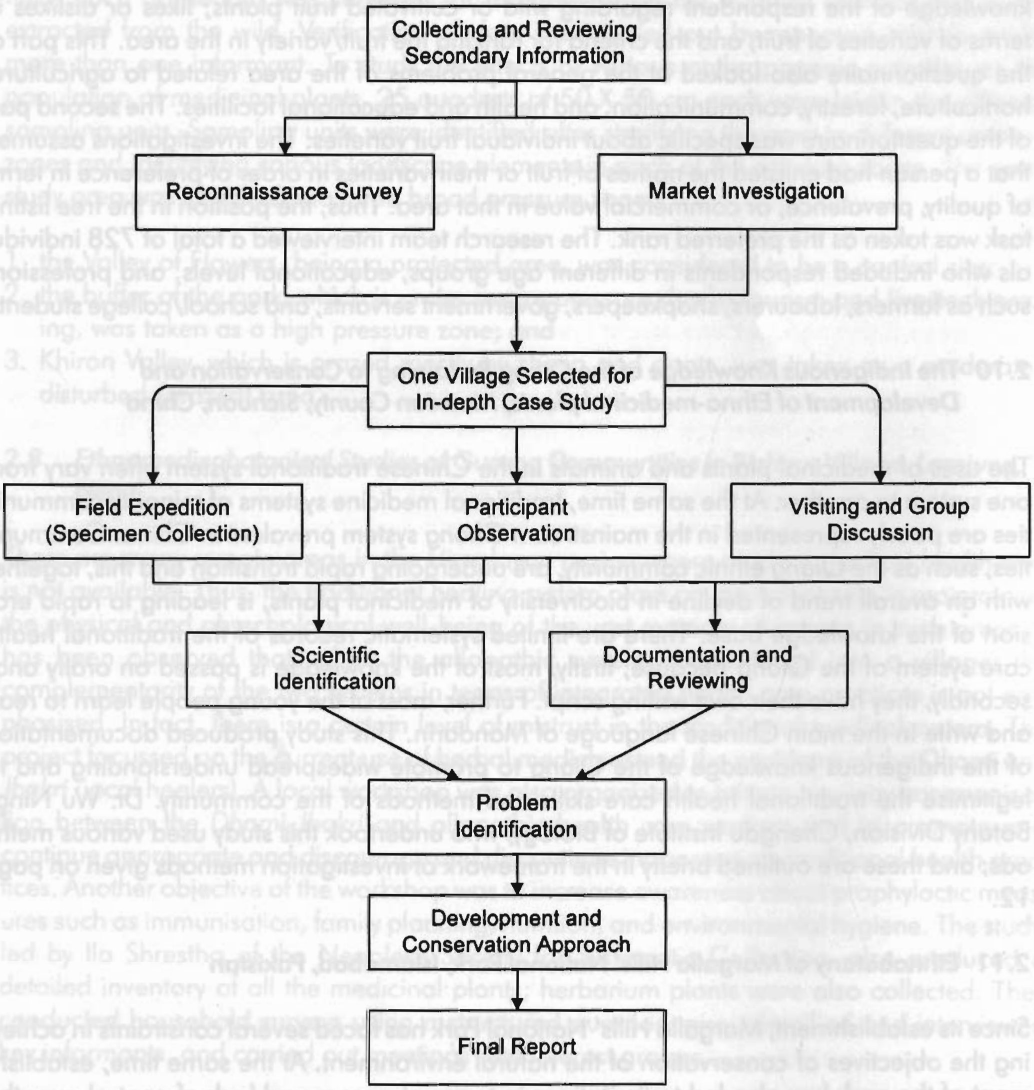
2.10 The Indigenous Knowledge of the Qiang Pertaining to Conservation and Development of Ethno-medicinal plants, Maoxian County, Sichuan, China

The uses of medicinal plants and animals in the Chinese traditional system often vary from one system to another. At the same time, traditional medicine systems of minority communities are poorly represented in the mainstream *Ghong* system prevalent in China. Communities, such as the *Qiang* ethnic community, are undergoing rapid transition and this, together with an overall trend of decline in biodiversity of medicinal plants, is leading to rapid erosion of the knowledge base. There are limited systematic records of the traditional health care system of the *Qiang* because, firstly, most of the knowledge is passed on orally and, secondly, they have their own writing script. Further, most of the young people learn to read and write in the main Chinese language of Mandarin. This study produced documentation of the indigenous knowledge of the *Qiang* to promote widespread understanding and to legitimise the traditional health care skills and methods of the community. Dr. Wu Ning, Botany Division, Chengdu Institute of Biology, who undertook this study used various methods; and these are outlined briefly in the framework of investigation methods given on page 12.

2.11 Ethnobotany of Margalla Hills' National Park, Islamabad, Pakistan

Since its establishment, Margalla Hills' National Park has faced several constraints in achieving the objectives of conservation of the natural environment. At the same time, establishment of the park has also led to limitations in terms of access and lack of control over the resources on the part of the villages inside and on the periphery of the park. This study, undertaken by Mohammad Ibrar Shinwari of Quid-e-Azam University, was part of the field work towards award of the M Phil. degree. The researcher focussed on documentation of folk uses of medicinal plants found in the park. This study was supervised by Dr. Mir Ajab Khan. It used primary data collected in the field through interviews, personal observations, and guided transect walks. Interviews were held with the local inhabitants by using a structured questionnaire. Among the selected key informants were *Hakim* (herbalists), *pansari* (medicinal plant vendors), and the park management. In order to access information from the women, two girl students were included in the team. In order to make quantitative assessments, questions regarding quantities of particular plant resource uses, rate of consumption, and availability and market value were included in the questionnaire.

Framework for Investigation Methods Used in Case 2.10



2.12 *Preliminary Studies in the Ethnobotany of the Chittagong Hill Tracts, Bangladesh, and Its Linkages with Biodiversity*

This study provides a list of 1, 995 plant species in 63 families. All species here are arranged alphabetically and bear *Chakma*, *Marma*, and *Tripura* names (wherever possible) in addition to Latin names. Voucher specimens have been collected and preserved at the Bangladesh Forest Research Institute (BFRI). The study was jointly undertaken by Dr. M.K. Alam of BFRI and S.K. Khisa of Chittagong Hill Tracts' Development Board, Government of Bangladesh. An intensive effort was made to document as many ethnobotanical species as possible, using various techniques such as free listing, village market surveys, and homestead surveys. Additional records on folk taxonomy, perception about different uses, tree management practices, and seasonality of harvests were put together based on rapid unstructured interviews and observations.

2.13 *Ethnobotanical Study of Traditional Farm Cultivation Practices Based on Alder Tree (Alnus nepalensis) by the Naga Tribes of Nagaland, India*

In traditional *Naga* society the use of land influences all aspects of social life. The *Naga* practice two types of agricultural system. One is *jhum*/swidden cultivation in which paddy, millet, taro (*Colocasia esculenta*), yams, cotton, maize, chilli (*Capsicum annuam*), and cucumbers are grown. The second type is terraced wet rice cultivation in which terraces are cut into the hill slopes. The flooding on these terraces is carefully controlled by using bamboo and other local materials as water conduits. In these fields, old alder trees are maintained and pollarded after every four to six years. The alder tree is a nitrogen-fixing plant and yields a lot of biomass. The current study is focussed on a survey of alder-based farming systems in the state of Nagaland, identification of all the plants associated with it, and various crops used by different *Naga* tribes. Laboratory analysis of soil samples collected from different areas was used to evaluate indigenous knowledge aspects, particularly in relation to nitrogen availability.

2.14 *Ethnobotany and Conservation of Allium hookeri Thwaites and Allium wallichii J Kunth in Tengchong County, Yunnan Province, China*

These two species of *Allium* are multicultivar vegetables with local ethnic characteristics. There is an increasing demand for them, particularly as more and more people from other communities are recognising their nutritional value. This is leading to a decrease in availability. The pressure is particularly acute on *Allium wallichii* which is found in the natural state only. The current work was to collect an inventory of local cultivars of *Allium* and systematically collect indigenous knowledge about these species and conduct cultivation trials with farmers. This study was carried out by Huang Ji of the Department of Biology, Yunnan University, for a Master's dissertation. He interviewed local peasant farmers belonging to the *Lisu* community and local officials and agricultural extension workers. He made personal observations on the growth of *Allium sp* and collected local cultivars for laboratory analysis of amino acids and for cytology research.

2.15 *Ecology and Indigenous Management of Tribal Home Gardens: A Case Study of the Marma Community in Bandarban Hill District, Chittagong, Bangladesh*

Home gardens are a widespread agroforestry system. The life of the *Marma* people and their socioeconomic activities in the study area are centred around the hills and their resources. Home gardens feature as an important component of their landscape. This study undertook a vegetation inventory to determine species' composition and diversity and elicit knowledge from farmers about propagation, cultivation, management, and uses of home garden plants. Dr. Millat-e-Mustafa from the Institute of Forestry and Environmental Studies, University of Chittagong, undertook this research. He carried out a vegetation survey by listing the species present in the home gardens. A tree-use matrix exercise (Freudenberger 1994) was then conducted with the farmers and their families to determine the use of species. Family members were interviewed by using a semi-structured questionnaire. This guided interview addressed five broad topics as follow.

Question 1: "What planting materials do you use for your home garden?" This was to elicit farmers' knowledge about regeneration procedures with different home garden plants. The reasons for using various types of planting material for different species were ascertained through further questions.

Question 2: "What are the sources of different planting materials?" This was to establish the relative contribution of different sources of planting materials to the home gardens.
Question 3: "Do you follow any criteria to select mother trees in collecting planting materials?" This retrieves farmers' knowledge about the introduction of improved varieties of species in their home gardens.

Question 4: "Do you carry out weeding, lopping, pruning, thinning, coppicing, and pollarding in your home garden?" Weeding and thinning determine the horizontal structure of the home gardens, whereas pruning determines how the farmers regulate sunlight in their home gardens.

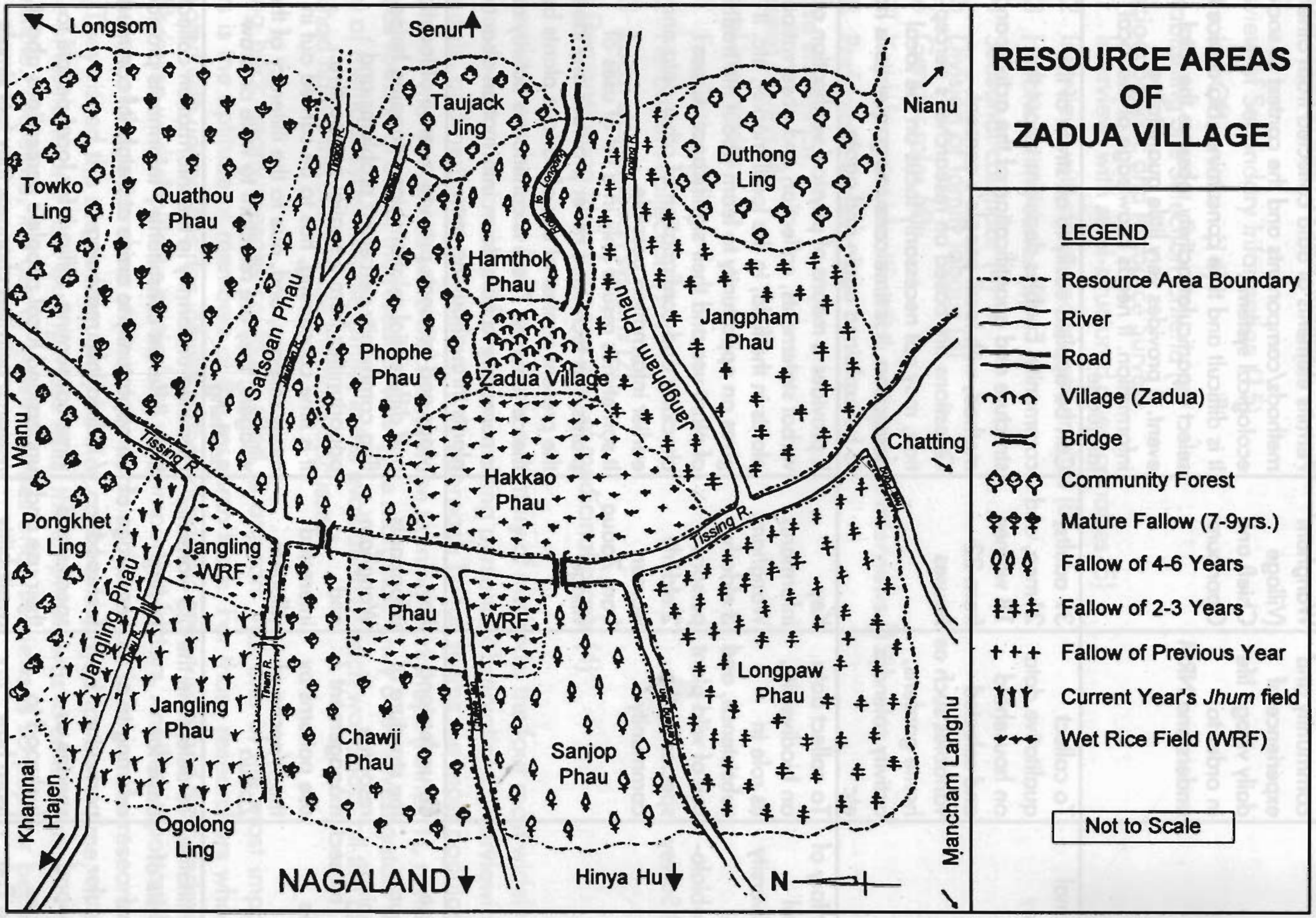
Question 5: " Do you water and manure your home garden plants?" This question was to arrive at an idea of the efforts needed to manage a home garden. If the reply was 'yes' the frequency and quantity of watering and manuring, and the name of the species to which these were applied, were determined with further questions.

ICIMOD Research Fellowship Study: *The Use of Indigenous Knowledge in Mountain Natural Resource Management: A Case Study of the Wancho Community, Tirap District, Arunachal Pradesh, India*

This study was undertaken by Dr. Archana Godbole as a part of her ICIMOD research fellowship work in 1996-97. The specific objectives of this research work were assessment of the indigenous knowledge system (IKS) used for traditional agricultural and agroecosystems, documentation of the natural resource use patterns, and assessment of the role of women and others in the Wancho Community in natural resource management. She carried out village resource mapping and a brief ethnobiological survey to assess the extent of plant use today. The summary of her methodology is provided in the table below, and one of the village resource maps prepared is given as Map 1 on page 15.

Preliminary Analysis of Methods Used

The above-mentioned studies depict a general trend in approach. Most of the researchers start with a review of secondary information and data followed by a visit to the site for informal discussions and personal observations in order to revise the research questions. These unstructured interviews are followed by administration of semi-structured or structured questionnaires, mostly at the household level. In the process, some key informants are identified for detailed discussion on particular traditional practices and aspects of indigenous knowledge. As a result, they present some of the analyses carried out of this information. This approach can be largely grouped together with Rapid Rural Appraisal methods. In addition, an important aspect of ethnobotanical studies is making inventories of useful plants, and so substantial efforts are expended by researchers in floral collection, herbarium preparation, and in identification. The studies that focussed on biochemical analysis of plant parts, such as seeds and rhizomes, collected the samples necessary for laboratory analysis. In one study, soil samples were also collected for nutrient analysis. Some researchers also attempted to draw resource maps and seasonal calendars and to make transect walks in


RESOURCE AREAS OF ZADUA VILLAGE
LEGEND
Resource Area Boundary
River
Road
Village (Zadua)
Bridge
Community Forest
Mature Fallow (7-9yrs.)
Fallow of 4-6 Years
Fallow of 2-3 Years
Fallow of Previous Year
Current Year's Jhum field
Wet Rice Field (WRF)
Not to Scale
Longsom
Senur
Nianu
Chatting
Wanu
Khamnai Hajen
NAGALAND
Hinya Hu
Mancham Langhu
N
Towko Ling
Quathou Phau
Satsoan Phau
Taujack Jing
Hamthok Phau
Duthong Ling
Jangpham Phau
Jangpham Phau
Phophe Phau
Zadua Village
Hakkao Phau
Tissing R.
Pongkhet Ling
Jangling WRF
Jangling Phau
Jangling Phau
Ogolong Ling
Chawji Phau
Phau
WRF
Sanjop Phau
Longpaw Phau

Summary of Methodology Used for Case Study 2.15

Method	Purpose	Sample Size	Advantages / Disadvantages
Participant Observa-tion	To gain understanding of the research community and experience of daily village life in order to understand NRM	Total village (men and women) in *Wangham* (Village Chief) and *Gaonbura.*	Provides an opportunity to understand the research community. Also provides a context in which other methods are developed and refined. Permits elements of data collected from other methods/components and the context of socio-ecological systems. It is difficult and time consuming. No choice to select a particular activity, observe the total event. It provides very little quantitative information. It needs knowledge of the local language.
Informal Survey	To collect qualitative data on household and selected variables such as home gardens, activity calendar etc	39 adults, 21 men, and 18 women from 22 houses	Can be applied easily to all strata of the community. Enables decisions about the structure and quantification of the activity and method, with local people's consent. Questions are based on researcher's percep-tion, may not necessarily focus on the local perception. It is time consuming, questions have to be explained again and again.
Inventory of Useful Biodiversity and Ethnobiolo-gical Survey	To collect data on biodiversity, its role in subsistence, and use of wild plant species by the community	Key informants *Wangham,* 3 elderly persons 2 elderly women from Zadua village	It provides a means of physical verification of verbal statements, collection and observation of plants in the field, in the local market, etc. It gives an opportunity to learn about the traditions of plant use and their significance. Cross checking and confirmation of other data and earlier information possible. It sometimes results only in a list of uses of plants, this technique never provides any idea of the present context of use of various plants by the community. There is continuous activity as it is necessary to note down information about all plants throughout the year.
Village Resource Mapping and Transect Walks	To understand the structure of resource management / use patterns by the *Wancho* of Zadua	Key informants, *Wangham* and interested villagers.	Maps and transects provide a sense of location and differential relationships. Mapping helps to flag community perceived problems and opportunities from a spatial perspective. It is time consuming, has to be carried out in many sessions, and, due to the illiteracy of the villagers, they are reluctant to write or draw anything.
Quantitative Analysis of Use of Particular Fuelwood Species Using Pair Ranking Method	To determine the basis for referring to a particular species as fuelwood to learn how *Wancho* people perceive fuelwood species	23 women. having knowledge of fuelwood species and their use and availability	Permitted uniformity in the information collected from different consultants / informants provided an opportunity to arrive at insight of community's / individuals' reasoning Time consuming, difficult for local people to understand local people's perceptions about research activities changes, they feel simple documentation is complicated when it is called research

order to complement the information from market surveys. A summary of various methods used by all the researchers is presented below. The number against the method reflects the number of studies that have used it in some form or the other.

Methods Used in the 15 Case Studies

1. Review of Secondary Information (15)
2. Personal Observation (14)
3. Establishing Site Selection Criteria (4)
4. Socioeconomic and Resource Surveys
   - 4.1 Interviews with semi-structured questionnaires (5)
   - 4.2 Interviews with structured questionnaires (8)
   - 4.3 Historical time series (2)
   - 4.4 Seasonal calendar (4)
   - 4.5 Division of family labour (3)
   - 4.6 Gender roles (4)
   - 4.7 Key Informant identification and guided interviews (12)
   - 4.8 Preference ranking (4)
5. Case studies (5)
6. Market surveys (4)
7. Floral inventories
   - 7.1 Free listing (4)
   - 7.2 Herbarium collection (11)
   - 7.3 Local classification systems (2)
8. Demonstration trials for cultivation of medicinal plants (4)

In general, as can be seen from the above summary of methods, the four most widely-used tools are review of secondary information, making personal observations, interviewing key informants, and herbarium collection. This approach by far seems the most popular one. While many more methods were discussed in the training workshops (Annex 1), revision of methods for actual use in the research was quite marginal. Only a few investigators used a variety of methods systematically, while, in the evaluation of each workshop, all the participants had hailed the utility of the methods discussed.

Looking back, many reasons could be cited. It appears that one of the most important factors is the aptitude of members of the research team. For those researchers who were associated with universities, the interest of their academic supervisors and their understanding of how the work should be carried out were important factors. Another important factor is that most of the researchers were not residents of the places in which the research took place They visited the site as frequently as they could and stayed for some time; at best a couple of weeks in one visit. During these visits, the emphasis was to collect data as quickly as possible. Therefore, the use of questionnaires and interviews is so popular because it allows one to accumulate a lot of information in a short time. Although due emphasis was placed in training workshops to measure and carry out in practice various methods to verify and supplement the information collected through interviews with primary data, not many researchers followed the advice.

The importance of preparing maps, walking transects, and conducting ecological surveys in the various resource areas of the local community was also highlighted during the training workshops, but these aspects were also neglected by most of the researchers. Some of the main reasons for this are that such activities are time-consuming, require good rapport with the community, and also require certain special skills such as the ability to negotiate and resolve conflicts. Above all, such exercises raise certain expectations amongst the people, and this means that follow-up after the study is needed. In most instances, researchers came from academic institutions or organizations far away from the place of research and thus had little confidence in making concrete contributions beyond the research itself.

Another important factor that has come to light is the lack of discussions with all the stakeholders. This is an essential element in order to present a more balanced and complete picture of the issues related to the thematic subject of research. In general it is true that all traditional societies are going through rapid transition in terms of their value systems, and this affects resource use patterns as well as the wisdom associated with such use. Therefore, in addressing any issue, it has become vital to carry out an assessment from as many aspects as possible, discussing it with all the major stakeholders and decision-makers. Somehow, the researchers here concentrated on the custodians of indigenous knowledge only and failed to interview other stakeholders.

These are some of the messages that can be drawn from the process and the results of these case studies and study grants. These and other factors such as size of the area covered in terms of resource use and patterns of usage and so on, are significant aspects in mountain areas. Keeping this in mind the following section has been written to outline and explain some methods for qualitative, quantitative, and spatial assessment. These methods include participatory mapping, resource dependence profiles, profile diagrams, and systematic data collection for statistical analysis.

The most important factor in carrying out applied research with a community is that the results of the study should be useful to it. Very few researchers carried out activities, such as public meetings, at the beginning of the work to inform people of the nature of work to be pursued. At the same time, only limited investigation reports were returned to the community. To reinforce the importance of sharing study results with the host community, a section on the moral paradigm of ethnobotanical research has been added for the reference of researchers working on applied ethnobotany in future.

Chapter 3
A Selection of Appropriate Tools for Mountain Environments

The fact that most of the development interventions in mountain areas have not had the desired level of impact, in the HKH in particular, can be attributed to the application of generalised development models and measures without a clear understanding of mountain conditions. While the recognition that socioeconomic and natural resource surveys in mountain areas should reflect the specific mountain conditions has gained firm ground over the last decade; incorporation of mountain specificities in interventions designed to solve the problem of mountain areas has not been successful (Jodha 1997). These mountain conditions, also referred to as mountain specificities, are reflected through inaccessibility, fragility, marginality, the diversity of mountain areas, and their specific niche (Jodha and Shrestha 1993). These mountain specificities provide both constraints and opportunities for sustainable mountain development.

The nature of the mountain specificities and the features of conventional development approaches that tend to disregard the imperatives of these specificities as described by Bhatia et al. are as follow.

- *Although mountain areas require situation-specific and discriminating development measures, the conventional development strategies tend to impose generalised models and measures evolved elsewhere. The mismatch between the features of generalised programmes and the imperatives of mountain conditions leads to several negative side effects.*
- *The interrelationships among different mountain characteristics call for an integrated approach to minimise the negative externalities of managing the specific problem, but the conventional development approaches deliberately segregate activities by sector or by administrative unit, thereby eroding the organic integrity of multiple-interlinked, diversified production systems in mountain areas.*
- *Since the low carrying capacity of mountain resources is well known, management of the pressure on them should be integral to development strategies. Conventional approaches, however, focus mainly on the supply side, giving disproportionately little attention to the demand aspects. The increased physical and market attention, and the state's greater focus on increased production rather than on resource protection, deliberately increases the overall pressure on mountain resources to an unsustainable level.*
- *Upgrading resources to handle the constraints of fragility and marginality and to create infrastructures reducing inaccessibility, as well as harnessing mountain niche, are important prerequisites for mountain area development. The conventional development strategies address these issues, but without sufficient territorial analysis and only selectively, primarily to meet the specific needs of the mainstream economy, e.g., for timber or*

hydropower, paying insufficient attention to the side effects on local people, local resources, and environmental stability in general. Selective overextraction of mountain resources and their exchange on terms not favourable to mountain areas are other negative side effects. Positive developments, such as improved accessibility, harnessing of mountain 'niche', and transformation of limited areas within the mountains have not benefitted the region in general, but often generate corridors of development with backlashes on neighbouring areas.

- *Factors such as inaccessibility, fragility, marginality, and diversity, realities of the mountain situation, remain unperceived or ignored by mainstream decision-makers. A consequence of this is disregard of the rationale of traditional resource management systems, including local resource-centred diversification, local resource regeneration and recycling, local demand rationing, and the formal or informal institutional arrangements that support the above. This is illustrated by the narrow focus on research and development concentration of support services and investment in more accessible areas and scant attention to the importance of biomass production, common property resources, and community-based approaches.*

In view of these mountain specificities, topical issues in applied ethnobotany are those that deal primarily with traditional practices related to natural resource use and sharing amongst the different knowledge and occupational groups in a given area. For example, the occupational groups could be those which collect, use, store, or trade medicinal plants, and so there are multiple stakeholders with a range of skills competing for a share of the resource. The competition for resources is not limited to one occupational group alone, as there are other users, such as those involved in grazing livestock in habitats rich in medicinal plants, and these may come into conflict with those who rely on the productivity of medicinal plants in one way or the other. State-sponsored conservation is gradually becoming another key competitor for resource partitioning (formalised sharing) through protection measures.

The collective methods referred to as Participatory Rural Appraisal (PRA) have evolved and refined methodology for socioeconomic and natural resource information collection providing ample opportunity for greater convergence of social, economic, and ecological parameters. For a quick recap, these methods are briefly described in Box 3.1 as outlined by Chambers 1996.

Experience is beginning to show that some of these methods have an edge over others in mountain areas. For example: participatory mapping, resource dependence profile, and complementary ecological methods such as profile diagrams and quantitative techniques of systematic data collection followed by statistical analysis etc. Some of these methods are, therefore, described in greater detail.

3.1 Participatory Mapping

One of the first steps to developing an understanding of the area spatially is by carrying out a participatory mapping exercise. Maps help identify elements that are of importance to different groups of people. They can examine a great breadth of subject matter and allow for a range of types of map to be produced for different uses (IDS 1996). Maps provide the following features.

Box 3.1: Participatory Rural Appraisal Methods

- Participatory mapping and modelling: people's mapping, drawing, and colouring on the ground with sticks, seeds, powders, etc or on paper to make social, health, or demographic maps (of the residential village); resource maps of village lands or of forests; maps of fields, farms, and home gardens; thematic maps (for water, soils, trees, etc) ; service and opportunity maps; and so on —; making 3-D models of watersheds and so on. These methods have been among the most popular 'discoveries' and can be combined with or lead to wealth or well-being ranking, watershed planning, and health action planning
- Local analysis of secondary sources: participatory analysis of aerial photographs (often best at 1:5000) to identify soil types, land conditions, land tenure, and so on — also satellite imagery
- Estimates, comparisons and counting: often using local measures, judgements, and materials such as seeds, pellets, fruit, stones, or sticks as counters or measures, and sometimes combined with participatory maps and models
- Transect walks: systematically walking with key informants through an area, observing, asking, listening, and discussing; identifying different zones, local technologies, and introduced technologies; seeking problems, solutions, and opportunities; and mapping and/or making diagrams of resources and findings (Transect walks now take many forms - vertical, loop, along a watercourse, combing. etc)
- Time line and trend and change analysis: chronologies of events, listing major local events remembered with approximate dates; people's accounts of the past, of how customs, practices, and things close to them have changed; ethno-biographies - local histories of a crop, an animal, tree, a pest, a weed; diagrams and maps showing ecological histories; changes in land use and cropping patterns; population and migration; fuels used; education, health, and credit and the causes of changes and trends in a participatory mode, often with estimation of relative magnitudes
- Seasonal calendars - distribution of days of rain, amount of rain or soil moisture, crops, agricultural labour, non-agricultural labour, diet, food consumption, sickness, prices, animal fodder, fuel, migration, income, expenditure, debt, etc
- Daily time use analysis: indicating relative amounts of time, degrees of drudgery, etc of activities, sometimes indicating seasonal variations
- Institutional or 'chapati'/Venn diagrams: identifying individuals and institutions important in and for a community or group, or within an organization, and their relationships
- Linkage diagrams: of flows, connections, and causality. This method has been used for marketing, nutrient flows on farms, migration, social contacts, impacts of interventions and trends, etc
- Well-being grouping (or wealth ranking) - grouping or ranking households according to well-being or wealth, including those considered to be the poorest—a good lead into discussions of the livelihoods of the poor and how they cope
- Matrix scoring and ranking, especially using matrices and seeds to compare through scoring, for example, different trees or soils or methods of soil and water conservation, varieties of a crop or animal, fields on a farm, fish, weeds, conditions at different times, and expression of preferences

Box 3.1 Cont.....

- Local indicators, e.g., what are poor people's criteria of well-being and how do they differ from those we assume for them?
- Team contracts and interactions - contracts drawn up by teams with agreed norms of behaviour; modes of interaction within teams to include changing pairs, evening discussions, mutual criticism, and help; how to behave in the field, etc (the team may be outsiders only, local people only, or local people and outsiders together)
- Shared presentations and analysis in which maps, models, diagrams, and findings are presented by villagers and/or outsiders, especially to village or community meetings and checked, corrected, and discussed. Brainstorming, especially joint sessions with villagers
- Contrast comparisons - asking group A to analyse group B and vice versa. This has been used for gender awareness, asking men to analyse how women spend their time.
- Drama and participatory video on key issues, to express problems and explore solutions
- Alternatives to questionnaires: A new repertory of participatory alternatives to the use of questionnaires which generate shared information that can be assembled into tables.

Source: Chambers, R. 1996.

- A framework for discussion about the relative location of resources
- An indication of important resources using maps as a spatial guide
- An indication of the issues that affect or are affected by these resources
- An analysis of the current status or condition of a location
- An awareness of existing facilities or natural resources
- Creation of a focus of interest in discussion about resources
- Stimulation of debate about the importance of specific resources
- Identification of elements that are important to different groups
- Development of a basis for comparison of different perspectives
- Creation of a baseline for assessing change over a period of time

In addition to understanding at the spatial level, maps also provide insights into the inter linkages of one land-use type with another in a landscape. Mountain communities are dependent on these diverse land uses for meeting subsistence and commercial needs at different times of the year. Often the principles underlying the management and use of this resource catchment by the local people are based on ecological knowledge gained from experiences that have taken place over hundreds of years. For example, in a mountain village, the landscape arrangement varies from undisturbed forest areas to those under heavy management ; hence different land-use types can be seen. As per Swift et al. (1996), a generalised gradient might move from unmanaged vegetation with restricted use to 'casual' management (including shifting cultivation, home gardens, and multiple-use commons) — to low-intensity management (including traditional compound farms and rotational fallow) — to middle-intensity management (including horticulture, pasture-mixed farming, and alley farming) — to high intensity management (including crop rotation, multi-cropping, alley cropping, and intercropping) — and finally to modernism (plantation, orchards, and intensive cereal and vegetable production).

This broad stratification can lead to a finer level of analysis of varying habitats in these land-use types, thus providing further assistance to decisions involving sampling and survey design. In '*Srishtigyan*: A Methodology Manual for People's Biodiversity Register' by Chhatre et al. (1998), the basis and methods for analysing landscape elements and geographic elements have been explained as per the details given in Box 3.2.

Box 3.2. A Methodology Manual for People's Biodiversity Registers (PBRs)

<u>Logic of the Methodology</u>

The documentation of the PBR involves an innovative method of looking at biodiversity and its use at the village level. The PBR would contain information on the entire resource catchment of the village concerned, irrespective of the distance from the village or the frequency or volume of use. The relationship between the village society and surrounding nature is usually complex, and there are many overlapping and interconnected uses that characterise this relationship. In order to understand this relationship, it is important to start with the flow of materials from nature through the village society as well as society outside.

<u>Landscape Elements</u>

For the purpose of documenting the PBR, the resource catchment is divided into Landscape Elements. A landscape element (LSE) is a patch within a landscape, homogeneous in appearance and distinct from surrounding patches. These LSEs may belong to a variety of LSE types, e.g., a pond, road, forest, habitation, etc. Several individual LSEs in a landscape may represent each LSE type. Thus, there may be five ponds or three forest patches or two roads. Alternatively, we can say that there are five elements belonging to the LSE pond, three to the LSE type forest, and two to the LSE type road. Each patch is a separate LSE. Its type could be any of these or others. For our purposes, we may consider only LSEs as patches larger than 0.25 ha (which are easily seen and distinguished from a distance), an agricultural field for example. Another distinction could be the linear elements, e.g., stream, road, canal, etc, that are long enough (say 100m or more). A landscape is thus composed of several patches (LSEs) belonging to a few types (land or water; linear or polygonal). Additionally, only the visually distinguishing features of a landscape element may be considered for its identification, irrespective of its past status or present access regimes. An illustrative list of possible landscape element types is given below.

Box 3.2 Cont.....

Forest: Any area with a natural or semi-natural growth of trees with various types of undergrowth would fall into this category. It could be further sub-divided into good natural forest, degraded forest, and scrub categories. A scrub forest would constitute bushes and shrubs mostly (including tree species). Mangroves and littoral forests along sea coasts would also fall into this category.

Plantation: Any tree crop on public or private land comprised of one or a few tree species being cultivated for commercial or non-commercial purposes would constitute a plantation. Examples include Poplar, Eucalyptus, Chir Pine, Teak, etc

Orchard: Any tree crop being cultivated intensively on private land for commercial purposes would constitute an orchard. Examples include coffee, tea, apples, areca nuts, oranges, etc.

Grassland: Any area on which grass is grown for fodder or grazing would be grassland. It could be public or private land. A distinction could be made between those areas closed to grazing for part of the year and those open for grazing throughout the year. The latter could be termed permanent pastures.

Cropland: All areas devoted to the production of agricultural crops would fall into this category. This could be further subdivided into rainfed and irrigated lands. Fallow, both long and short, would be included.

Barren Areas: There may be some areas in the village landscape that do not harbour any visible biomass or life. Examples of such areas could be rocky cliffs, sandy beaches, permanent snows, etc. These would be classified as barren. However, this should not be confused with 'wastelands' classified by the forest department or other state agencies.

Habitation: This is the area that is generally known as the village where homesteads are located. The pattern of habitation is extreme, ranging from a cluster of huts placed very close together to houses widely distributed over the landscape. Depending upon the situation, the Habitation LSE type may have to be clubbed with Cropland or Forest as the case may be. Whatever may be the case, it should be borne in mind that homesteads are sites that usually contain a wide variety of plants and animals— vegetable gardens, fruit and food trees, medicinal plants, etc.

Roads and Paths: A road in a village has a distinct biodiversity profile owing to its special status. It has been seen that new plants, such as weeds, enter the village through the roads and can be observed by its side before they spread to other LSEs.

Lakes: Lakes are larger water bodies of natural or man-made origin that are spread across a few villages. Lakes would include waterbodies created by dams. Naturally, they have a distinct appearance and biodiversity profile.

Ponds: Ponds are small water bodies, usually made by people and restricted to the boundaries of one village. They could be privately or communally owned.

Box 3.2 Cont.....

Backwaters: Bodies of water shrink during the dry period, exposing substantial amounts of land that are put to various uses by local communities. These areas, lying between the full reservoir level and the dead storage level of waterbodies, could be considered as separate LSEs.

Rivers and Streams: These would include all waterbodies with flowing water. They could be subdivided into perennial and seasonal, according to their characteristics.

Wells: Wells constitute an important resource in a village, especially from the point of view of drinking water for humans and livestock in arid and semi-arid areas. Information on the location of wells in the village is a useful planning tool.

Canal: A canal passing through a village affects the biodiversity of the area by causing changes in the moisture regime. It provides habitat for species that otherwise could not have established themselves.

Source: Chhatre et al. 1998

3.2 Resource Dependence Profile

The land-use pattern that emerges from participatory mapping is the starting point for gathering information for resource dependence profiles and livelihood analyses. When information is gathered about natural resources used in the community, the focus is on the types of resource used (or not used), how and for what purpose they are used, and who the users are. It begins to address equity issues such as who has greater access to resources and who has limited use or is excluded all together (Freudenberger 1994). Many methods are useful in such an analysis and some have been described in Participatory Rural Appraisal Tools and Techniques (Bhatia et al. 1998).

Transects - A systematic walk with a few key informants through an area observing, asking, listening, discussing, and identifying different zones and local technologies; seeking problems, solutions, opportunities; and making maps and diagrams of resources and other findings. This technique has the advantage of leading to field-based observations that can be discussed with local people.

Historical Transects - Historical transects illustrate changes, particularly in land use, over time, although these have been used also to indicate other aspects of historical information that have a spatial dimension. Most commonly, a period of several decades is covered—predominantly to identify changes that have occurred over time and space and examine the implications and causes of these changes.

Matrix Ranking - Matrix ranking helps to elicit information about local people's preferences with regard to tree species, types of livestock, crop varieties, and so on and the criteria on which those preferences are based. While the criteria are listed to the left, the preferences that are to be compared with one another are listed on top.

Wealth Ranking – This is a method that helps categorise households according to wealth or well-being in the community. Key informants first develop the parameters they think are important to consider while ranking households and then place households in appropriate categories based on those parameters.

Seasonal Calendar - This important PRA tool is applied to collect seasonal information such as intensity of rainfall or soil moisture, land use or cropping patterns, migration patterns, food availability, and monthly income and expenditure patterns. Local people use sticks or straw of different lengths along with counters (e.g., seeds) to chart out the relative quantities of some variables on the ground. Seasonal calendars also help record the views of the village about problems and opportunities.

Trend Line/Diagram - Trend lines are developed according to village perspectives to show patterns of change along with the causes, for example, rainfall, crop production, soil loss, deforestation, livestock holdings, and other topics of concern to the community. A group of local people knowledgeable about the topics to be examined is approached to help with this.

Venn or Circle Diagrams - Venn or circle diagrams are used as a tool to discuss the relative importance or position of different factors, commonly institutional or social structures, in a community. Key informants are asked to rank community institutions in order of importance and to construct diagrams that indicate the relationships between and among village units. Circles of different sizes and colours represent organizations, institutions, or prominent people. Their relationships to each other and relative importance in the community can be mapped out by placing these circles on the ground in relation to each other.

Semi-structured Interviews - This technique, also known as informal discussions, is considered the core of good PRA. It is a kind of open discussion, with open-ended questions, that can take place anywhere in the community, either with individuals and/or groups of key informants. Mental or written check-lists can be used. These conversations can take place on the path while observing community activities, over the garden fence, and in fields or homes.

In many circumstances, ethnobotanical research indicates that detailed analysis of non-timber forest products is required. This is also one of the most well-researched areas and many publications are available on the subject (FAO 1990; SPWD 1992). The two principal streams of analysis are the economic evaluation and sustainable harvest. Godoy et al. (1993) have carried out an excellent review of the four important aspects of quantity, price, marginal costs, and sustainability. They suggest that researchers should distinguish between two types of quantities: the inventory (stock quantity in the forest) and the flow (the quantity actually used by people). The difference in value between the flow and the inventory can be substantial and can depict the actual and potential profits. The authors have cited various studies to conclude that the most accurate method of placing a value on the products is to identify, count, weigh, and measure the NTFPs as they enter the village each day/ time. To address the problem of scattered users, a random sample of villages and households is observed. Although extractors may give accurate information, it is better to complement the information by direct observations. There are many measurable quantitative characteristics in vegetation ecology that have been described by Jha (1998) as per the paper presented in the national training workshop for Nepal held by the HKH ethnobotany project.

Quantitative Characteristics

Several vegetation characteristics are often measured or estimated with considerable precision. These are usually determined for individual species, although they can be used for whole strata of vegetation. The most common quantitative characteristics are: (a) frequency: percentage of sampled units in an area in which a species occurs; (b) density: number of individuals per unit area; (c) coverage: the percentage of soil surface covered by the vertical projection of the plant canopy; and (d) basal area: for tree species only, the cross-sectional area of tree trunks at 1.37m above the ground (expressed in square metres per hectare of land).

There are several methods for measuring important species; each method has advantages for certain types of vegetation and for certain purposes. The quadrat (or plot) method describes the vegetation inside an area of known size. Within this area density, frequency, basal area, and cover is determined by counting and measuring plants. For small plants (e.g., herbaceous plants, mosses, and lichens), a standard sampling quadrat can be constructed of wood or wire, or can be delimited by use of the stick and radius method. Large quadrats can be used to measure forest trees.

Plot-less methods of several types can be used for both large and small plants. In shrub vegetation or where there are small plants, the line intercept technique works well. For trees, the point-centered quarter method is effective.

Quadrat Method

Size of Quadrat for Forest: With a piece of string and three nails, an L-shaped structure is formed in the field. Thereafter, using another piece of string and a nail, an area of 5m x 5m is differentiated. All the plant species present in the area are recorded. The sample area is then enlarged to 10m x 10m, 15m x 15m, 20m x 20m, and so on. In each enlargement, the additionally occurring species are listed separately. The sample area is increased until the species added to the list become negligible.

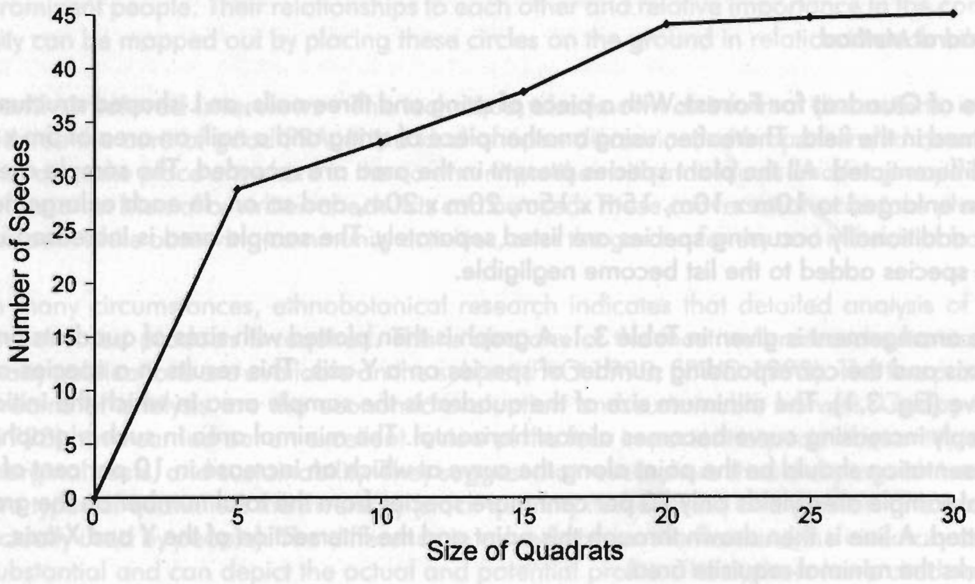
The arrangement is given in Table 3.1. A graph is then plotted with sizes of quadrats on an X-axis and the corresponding number of species on a Y-axis. This results in a species-area curve (Fig. 3.1). The minimum size of the quadrat is the sample area in which the initially, steeply increasing curve becomes almost horizontal. The minimal area in such a graphical presentation should be the point along the curve at which an increase in 10 per cent of the total sample area yields only 10 per cent more species from the total number on the graph plotted. A line is then drawn through this point and the intersection of the Y and X-axis, this marks the minimal requisite area.

This method appears theoretically sound, but field sampling and subsequent computation may take such a lot of time that its practicability seems limited. Hence, the International Forestry Resources' Institution (IFRI) in the USA has fixed circular areas of 10m, 5m, and 3m in radius for tree, shrub, and ground vegetation, respectively.

Table 3.1: Size of Quadrat and Number of Species Recorded to Determine Requisite Size of Quadrat

Size (m)	No. of species on different sites						per cent Increase in No. of species
	1	2	3	4	5	Av.	
5 x 5	27	26	31	30	28	28.4	0
10 x 10	37	30	33	35	30	33.0	4.6
15 x 15	40	39	30	37	35	37.8	4.8
20 x 20	44	42	46	41	45	43.6	5.8
25 x 25	46	43	47	42	43	44.2	0.6
30 x 30	47	45	42	44	44	44.4	0.2
							10% = 4.4

Figure 3.1: Species' Area Curve to Determine Requisite Size of the Quadrat for Analysis of the Vegetation



In spite of the lack of an absolute criterion for the minimal area, the species' area curve remains an important practical guide to quadrat size. In an area that measures tens of hundreds of hectares, plots or strips of forest are chosen that cover some three to five per cent of the total surface area.

On grassland, the sampling area can commence from 20cm X 20cm and should then be enlarged to 30cm x 30cm, 40cm x 40cm, 50cm x 50cm, and so on.

Number of Quadrats: After determining the requisite size of the quadrats, 20 to 40 quadrats of that size are laid down randomly in the study area. Species occurring in each quadrat are noted. Data are tabulated as shown in Table 3.1. Then again, a graph is plotted entering the number of quadrats on the X-axis and the number of species on the Y-axis. Here also, the point at which the curve starts to straighten out gives the minimum number of quadrats required for adequate sampling in the study area (Fig. 3.2).

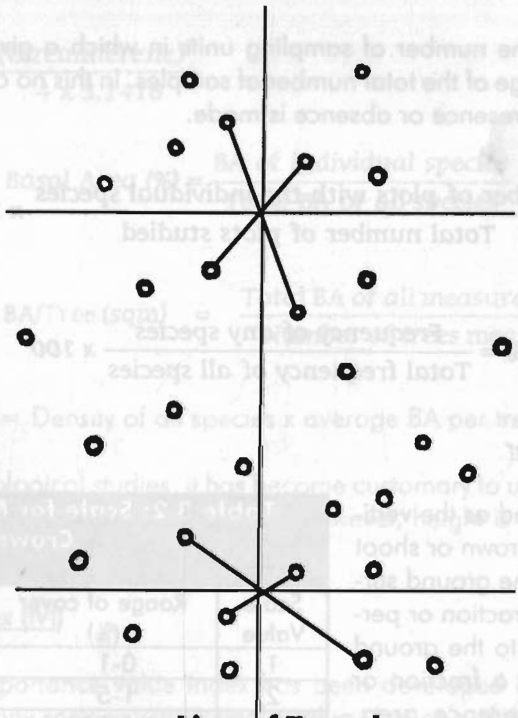


Figure 3.2. Species and Number of Quadrat Curves to Determine the Requisite Number of Quadrats for Analysis of Vegetation

Measurement of Density

Density denotes the average number of individuals of a given species out of the total of samples examined in a study area (the species may or may not occur in all the quadrats).

$$Density\ (ha) = \frac{Total\ number\ of\ plants\ of\ individual\ species}{Total\ number\ of\ quadrats\ studied\ x\ area\ of\ quadrats} x\ 10{,}000 sq.m$$

$$Relative\ Density\ (\%) = \frac{Density\ of\ individual\ species}{Total\ density} x\ 100$$

Density is usually used for large plants that have distinct individuals. For numerous plant species, counting becomes too time-consuming and, for vegetatively reproducing plants, it is impossible to determine what represents one individual. For rhizomatous grasses, for example, determining density is not feasible. Alternatively, one might choose to count an important, distinct, and less numerous plant part, for example, inflorescence.

Measurement of Frequency

Frequency indicates the number of sampling units in which a given species occurs. It is expressed in percentage of the total number of samples. In this no counting is involved, just a record of species' presence or absence is made.

$$Fequency\ (\%) = \frac{Number\ of\ plots\ with\ the\ individual\ species}{Total\ number\ of\ plots\ studied} x\ 100$$

$$Relative\ Fequency\ (\%) = \frac{Frequency\ of\ any\ species}{Total\ frequency\ of\ all\ species} x\ 100$$

Measurement of Cover

Usually cover is defined as the vertical projection of the crown or shoot area of a species to the ground surface, expressed as a fraction or percentage of a species to the ground surface expressed as a fraction or percentage of a reference area. Measuring the actual vertical projection downwards to the ground of plant crowns enclosed in sampling plots is time consuming, but a visual estimate of cover can often be made.

Table 3.2: Scale for Measurement of Crown

Scale Value	Range of cover (%)	Mid-point of cover (%)
1	0-1	0.5
2	1-5	3.0
3	5-25	15.0
4	25-50	37.5
5	50-75	62.5
6	75-95	85.0
7	>95	97.5

A suitable scale for use on small plots is given in Table 3.2.

The average cover for a species in the plots can be estimated by assigning the mid-point of cover to each plot with a given scale value for a species and then averaging the mid-point values for all plots. Plots from which the species is absent are included in the average with a value of zero.

$$\text{Relative Cover (\%)} = \frac{\text{Cover of species A}}{\text{Total cover of all species}} \times 100$$

Basal Area

The basal area is one of the chief characteristics determining dominance and the nature of the community. It refers to the ground actually penetrated by the stems. Basal area can be measured through:

$$\text{BA (SQM)} = \pi r^2 \text{ or } \frac{3.1416 \times (\text{diameter})^2}{4}$$

$$\text{or BA} = \frac{(\text{Circumferene})^2}{4 \times 3.1416}$$

$$\text{Relative Basal Area (\%)} = \frac{\text{BA of individual species}}{\text{Total BA of all species}} \times 100$$

$$\text{Average BA/Tree (sqm)} = \frac{\text{Total BA of all measured trees}}{\text{Number of trees measured}}$$

Total BA per ha (sqm) = Density of all species x average BA per tree.

(In North American ecological studies, it has become customary to use tree basal area stem cover as an estimate of dominance. In forestry, however, height is used as an estimate of dominance).

Importance Value Index (IVI)

The concept of an importance value index has been developed in order to express the ecological success of any species with a single value. Any one of the tree quantitative parameters (density, cover, frequency) may be interpreted as an importance value. This depends on which of the values the investigator considers most important for a particular species, group of species, or community. For example, tree seedlings may occur with a high frequency in an undergrowth layer, whereas in terms of cover, they may be insignificant. Hence the sum of the relative value of these parameters is often used for the presentation and conclusion of results.

IVI = RD + RF + RC *

The importance value of a species reaches a maximum of 300 in stands consisting of only one tree species. The IVI may be converted into importance percentage by dividing IVI by three. The use of relative rather than actual parameters is of limited information value.

Plot-less Method

Plot-less sampling means sampling without a prescribed area unit. Plot-less methods are available for all three, commonly-used quantitative parameters (frequency, density, coverage). Usually the Point-centre Quarter and Line Intercept methods are employed as plot-less methods.

Point - centre Quarter Method

The relationship between density and distance between trees is the basis of the quarter method: as plants become denser, the distance between them decreases. A compass line is established and a point located systematically along the line is chosen as a sampling point. An imaginary line perpendicular to the compass line is used to divide the area around the point into four quarters (Fig. 3.3). The distance from the sampling point to the nearest tree in each quarter is measured, and the species and diameter or circumference at breast height of each of the four trees are recorded.

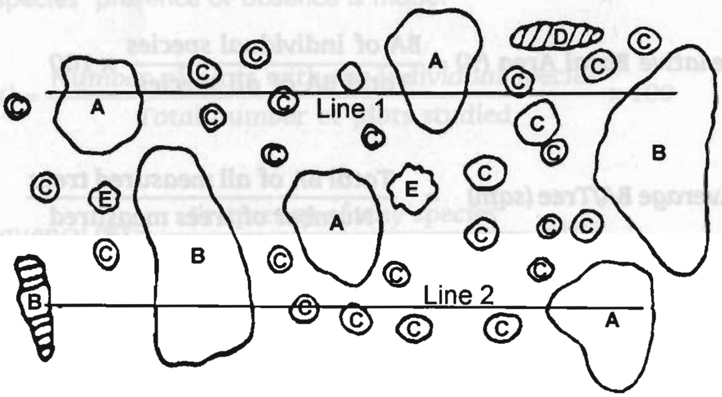


Figure 3.3: An Illustration of the Estimation of Cover Using Line Intercept

The sampling points should be far enough apart, so that trees in the front quarters of one point are not re-sampled in the back quarters of the next points, twenty metres is a common distance in many forests. At least 40 points should be measured in order to provide reasonable data; and more if rare species are of interest. The quadrat method may be combined with the quarter method by measuring understorey vegetation, sampling, and seedlings in a plot.

* Earlier emphasis was on relative dominance

$$Mean\ distance\ (d) = \frac{Sum\ of\ all\ points\ to\ tree\ distances}{Number\ of\ distance\ measured}$$

Mean area occupied by an individual tree - d^2

$$Density\ (tree\ per\ ha)\ D = \frac{10{,}000m^2}{M\ in\ m^2}$$

$$Relative\ Density\ (\%) = \frac{No.\ of\ individuals\ of\ species\ A \times 100}{Total\ No.\ of\ all\ species\ measured}$$

$$Densit\ of\ species\ A\ (per\ ha) = \frac{Total\ trees / ha \times RD\ of\ sp.\ A}{100}$$

$$Frequency\ (\%) = \frac{No.\ of\ sampling\ points\ at\ which\ species\ A\ occurred\ at\ least\ once \times 100}{Total\ No.\ of\ sampling\ points}$$

Cover by Line Intercept

The line intercept method is especially valuable for determining cover where vegetation makes travel difficult, or where plots are troublesome to establish. After the boundaries of the stand have been determined, sampling lines are established through it at appropriate intervals, usually by means of a metric tape. The distance of occurrence of each species along the edge of the tape is measured and recorded by species (Fig. 3.4). The following measurement on the intercept, calculations can be carried out by

$$Cover\ (\%) = \frac{Total\ distance\ measured\ for\ sp.\ A \times 100}{Total\ distance\ of\ lines}$$

$$RC\ (\%) = \frac{Distance\ measured\ for\ species\ A \times 100}{Total\ distance\ measured\ for\ all\ species}$$

Indices of Similarity of Species

The simplest similarity indices compare samples of vegetation only in terms of which species are present. A few commonly used indices are:

$$IS_J = \frac{C}{A + B - C} x\, 100\ (Jaccard's)$$

$$IS_S = \frac{2C}{A + B} x\, 100\ (Sorenson's)$$

Where,

IS = Index of similarity

A = Total number of species in one sample
B = Total number of species in the other sample
C = The number of species occurring in both samples

Measurement of Tree Size

The size of a tree is described by the size of its trunk (circumference, diameter) and by its total height (Field data sheet).

Trunk Size

Trunk size is usually determined at a height of 1.37m above the average level at the base of the tree, called breast height. Trunk size can be expressed as its circumference (cbh) or diameter (dbh) at breast height. Measurement of the circumference is easy to take with an ordinary measuring tape. If the diameter is desired, the tree is assumed to be circular, and dbh is calculated.

$$dbh = \frac{cbh}{\pi} (where\ \pi = 3.1416)$$

Sometimes a special 'diameter tape' is used. This tape is calibrated to read the diameter of a circle of the same circumference as the tree. Often tree trunk size is expressed as the area of its cross section at breast height, called basal area (BA).

Tree Height

Tree height is usually calculated from two measurements: distance from the tree to the observer and the angles from the eye of the observer to the base and to the top of the tree. The horizontal distance (d) can be measured directly. However, on steep slopes, horizontal distance must be calculated using the distance from the eye to the base of the tree (D) and the angle of the measurement D from the horizontal (b), so that

$$d = D \cos \beta$$

From d and the angle a and b, one can calculate the height (H) of the tree,

$H = d \tan \beta$

The angle can be measured using a simple instrument constructed from a circular protraction. Tree height is also measured by using the Abney Level (Field data sheet).

Volume of a Tree Trunk

In some studies, the volume of a plant part, usually the trunk of a tree, can be used as an index of its biomass or of its worth as a commercial product (lumber, firewood). If the trunk is cylindrical, volume would equal H x BA. Because the trunk tapers, this value is too high. Often the form of the trunk approximates a parabolic shape and volume is calculated as follows:

$$V\,(m^3) = \frac{BA \times H}{2}$$

Estimating the Harvest of Forest Products

There can not be uniform ways of estimating the quantity of different types of non-timber forest products; so researchers improvise techniques for each type of resource. For fruit-bearing plants, the yield per individual can be measured at harvest time by either using binoculars to spot fruit on the tree or simply by counting the fallen fruit. The thickness and surface area of bark gathered for any purpose can be measured and, for medicinal or edible herbs, recording the number and size of bundles harvested can be calculated. These measurements can be converted to weight in kilogrammes by weighing a sub-sample of the collected material and then multiplying by the total potential amount that can be gathered per individual or per unit area (Martin 1995).

Many programmes have looked closely at the question of sustainability of non-timber forest products on project sites throughout the world in different biological and cultural settings; e.g.., the Biodiversity Support Programme (BSP). The BSP is a USAID-funded consortium of the World Wildlife Fund, The Nature Conservancy, and the World Resources' Institute. A primer on this subject authored by Peter (1994) and brought out by the BSP has recommended six basic steps for achieving sustainability in exploitation of non-timber forest products: (i) species' selection, (ii) forest inventory, (iii) yield studies, (iv) regeneration surveys, (v) harvest assessments, and (6) harvest adjustments. Peter emphasised collection of baseline data about the current density and productivity of the species concerned and monitoring the impact of harvesting in order to make appropriate adjustments in harvest levels and techniques as depicted in Figure 3.4. Decisions concerning choice of appropriate tools from the many methods that have been described would depend on the nature of the non-timber forest product and the local conditions.

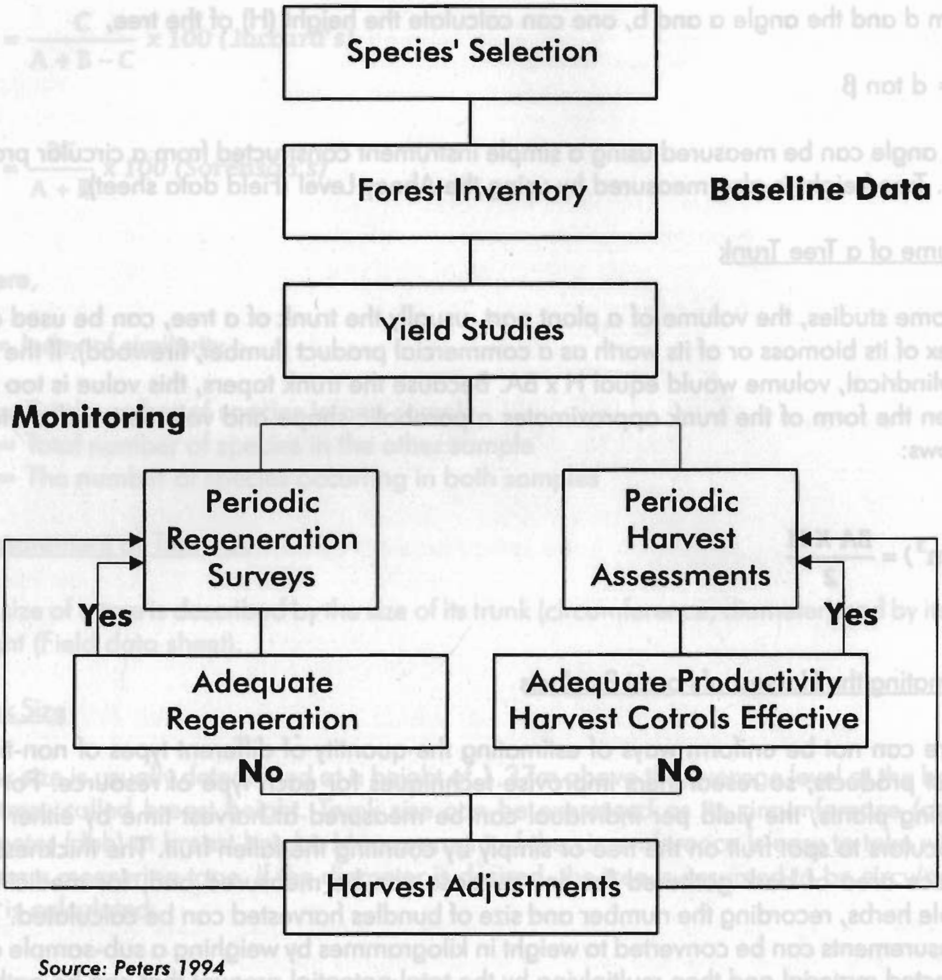


Figure 3.4: Baseline Data Monitoring and Adjustment in Harvesting Techniques

3.3 Profile Diagrams

Profile diagrams, for many decades, have been an extremely popular approach to understanding the structure of vegetation through recognition of more or less continuous layers of vegetation on the basis of height. Ecologists have used this approach extensively to simplify and describe the organization of complex vegetation types. This technique was pioneered in the tropics by Davis and Richards (1933). It involves a complete visual representation of the stratification of the community in a profile diagram. A properly drawn profile diagram can be very informative, giving a diagrammatic representation of features that cannot be concisely and effectively conveyed by a written description alone. In particular, a series of profile diagrams is an excellent way to show variations within a heterogeneous area or along a gradient of environmental changes. Over the years, profile diagrams have been used by ethnobotanists to understand the native logic in making decisions about multicropping plantations and agroforestry practices. These local, indigenous practices, particularly with regard to agroforestry, have been documented by Aumeeruddy (1994), using profile diagrams effectively.

More recently, Aumeeruddy and Michon (in press) used forest architectural profiles as an ecological approach to understanding agroforestry dynamics. The forest architectural profile has been used to understand the structure, ecology, and dynamics of agroforests in Sumatra as well as in other parts of the world. First described by Oldeman (1974) as a method of understanding the dynamics of tropical forests, this technique of analysis was adapted to agroforestry systems by Michon (1985).

In the architectural analysis of forests, trees are considered to be dynamic building elements in the natural landscape. They are thus classified according to their developmental stage as:

'trees of the future',
'trees of the present'; and
'trees of the past'.

The current mixture is subdivided into several 'vegetation layers' corresponding to the different strata in which tree crowns occur. Their description gives a momentary 'snap-shot' of the forest architecture and provides a framework that facilitates a vision of the forest in the future.

In an agroforest, each plant is both a structural element of an architectural landscape and a component of an agricultural production system. Therefore plants are classified as:

'plants with potential production',
'plants in actual production', or
'plants in declining production'.

The group of fully productive plants can be subdivided into 'producing elements' in the same way as the 'trees of the present' can be subdivided into their structural elements.

In the field, the application of this technique involves drawing every tree within a 50m x 20m plot. The trees are drawn to scale in plan and in profile with regard to crown size, height, height to first main branch, crown diameter, and diameter at breast height. The scale drawing (1cm = 1m) includes each tree relative to its coordinates in the plot. This facilitates the analysis of different layers of production and of the efficiency in use of available space. The dynamic changes, which may occur in the overall structure of the garden over a long period, are also evident.

Architectural forest profiles of this sort constitute visual transcriptions that are better than pictures or endless tables of figures. They contain a complete set of data, and these data can also be used to calculate densities, frequencies, coverage, and so on. They enable the comparison of different agroforestry systems from different areas and provide an archive document that may be used later to monitor changes in the structure and composition of such systems.

Though many studies have described vegetation structure through profile diagrams, detailed procedures of field work and drawing have rarely been explained in the methodology. The following procedure for producing a profile diagram has been adapted from Hall (1992) by Dr. M. Millat-e-Mustafa who presented it in his report on the Marma Home Gardens of Bangladesh.

Size of the Plots

To obtain a representative sample of a vegetation type, it is necessary that it is of at least a certain size to cater for variations imposed by small-scale relationships with the environment (e. g., the concentration of regeneration near a particular parent tree). It is also advisable to ensure that bias is avoided in terms of what the diagram eventually shows. The diagram should not be produced with the purpose of showing a particular feature, for example. Both these potential problems can be overcome by using a large rectangular plot. A line of four contiguous 25m x 25m plots is considered adequate and it gives a profile length of 100m. If the assessment is full for the entire strip, one can use any portion of the 25m width for depicting the diagram. If an assessment of the entire strip is required, a portion of the 25m width can be used to draw a diagram.There are two approaches to this. The first is needed when different profiles are to be compared; here the width must be the same in each one. The second is used when the profile is only to show a particular example: here the choice of width depends on the informativeness of the resulting diagram. The widths commonly used in forests are 5m, 7.5m, and 10m. If, as recommended here, the full 100 x 25m area is assessed first, the choice of width for the diagram can be decided as it is being drawn. If it is less than 12.5m, it is possible to have two separate strips and diagrams from the area, giving a certain measure of replication. If the structure is of interest with special reference to a particular species, the entire 25m width will be useful.

Setting Out the Plot

On slopes, plots along contours are recommended. If the influence of a local feature on the vertical structure is being examined, then the alignment should cross it. On flatter terrain with less features; the alignment should be on a cardinal point of the compass - this makes any subsequent alignments faster and less subject to error. It is also necessary to decide whether a 100m is a horizontal distance or a distance measured over the ground. To set out the plot, it is always advisable to mark all corners, including the corners of the individual 25m x 25m units, with stakes or ranging poles and connect them with string.

Field Measurement

For the purpose of the diagram, what is to be enumerated must be defined. Either a height or a diameter criterion will do. Diameter is preferred because it allows more readily for extension of assessment to woody climbers : with a height criterion, climber data become anomalous. A diameter of three centimetres at breast height is commonly used as the minimum for inclusion. If combination with a standard plot assessment is anticipated, data collection may extend to three further categories of plant on a presence/absence basis with a separate assessment for each 25m x 25m. The categories are (a) regeneration (too small to enumerate) of species represented in high numbers, (b) regeneration of species potentially able to reach sizes large enough for enumeration but apparently not doing so, and (c) other vascular plants. Very high numbers can present serious difficulties, delaying progress and making it worth considering a review of either or both plot size and size criterion depending upon the amount of time available.

Provision for the following information should be kept in the data collection pro forma.

i) Origins of data must be specified in general terms (date of field work, personnel, locality, sample number/profile number) and specifically with respect to the plot (which unit of the four making up the 100m x 25m strip) and to the position within each unit.
ii) Location coordinates need two columns, e.g., one could be headed 'down' and the other 'across' in the case of slopes.
iii) Every plant should be given a reference number as the enumeration proceeds, regardless of whether or not its name is known. In case of unknown species, provision for a temporary code name and a remark on a feature by which it can be recognised again should be kept.
iv) Plant characteristics fall into two categories: the characteristics of the crown (the height from which it starts, the height it reaches, how far it spreads horizontally) and the stem (diameter or girth measurement at breast height).
v) Environmental information should cover the general conditions of the site - elevation, slope, and surface features such as gaps in the canopy, thickets, rocks, roads, paths, streams, recent tree falls, recent exploitation, saw pits, buildings, and old habitations.

Characterising the Plant

When the plant is enumerated it must be characterised both by its location and by its own features. Three main points to look at are: the stem characteristics, the vertical disposition of the crown, and the spread of the crown. The stem is measured at breast height. If there is more than one stem large enough for inclusion originating from a single base, each must be measured and recorded. The crown features are only considered in detail for self-supporting plants, because of the difficulty of deciding where climber crowns are. The tree crown into which the climber disappears is observed and this climber is referred to on the proforma instead of giving crown details.

With self-supporting plants, first where the crown begins and the full height have to be determined. Note first that all heights recorded should relate to the point at which the stem emerges from the soil: in steep terrain, with trees that lean to one side, it is important to remember so that the approach is consistent. The crown base is taken as the first permanent living branch – if the bole forks, for example, the fork is the base of the crown. Epicormic shoots obviously below the general crown level can be ignored. Crown height is the highest point reached. Smaller plants can be more accurately estimated by using a two-metre ranging pole as a scale and knocking or shaking the plant will often make the position of the top clearer. Larger trees give difficulties. Conditions in the forest do not permit satisfactory use of instrumentation, because the presence of foliage at all levels obscures the higher levels. The practice is to move around to a position from where one can gauge the topmost parts; and see a two-metre ranging pole positioned at the base. It is better to have several people estimate the height and agree on a value. This is not ideal, but with experience a team becomes sufficiently consistent and accurate, and there is no alternative when it is not permissible to cut the tree.

The crown spread could be taken as a horizontal projection of the crown vertically down to the soil, but this would be far too time-consuming and would entail collecting data that would not instantly be adding much value to the profile diagram. So, for quick work, attention is limited to spread on only one line – the long axis of the 100m x 25m strip— because this represents what would appear to an observer if he/she looked at the forest as he/she will look at the finished diagram. Again, it relates the spread to where the plant leaves the soil. This can be achieved by standing beneath the extremity of the crown and, if necessary, moving across the strip perpendicularly until the line from the observer to the plant base is parallel with the long axis of the 100m x 25m strip. Now the horizontal distance to the point at which the plant leaves the soil will give the crown spread.

So far, all data recorded relate to trees/climbers rooted within the demarcated strip. However, not all of the canopy is derived from these trees: some of it extends into the strip from trees rooted outside. These extensions should also be recorded.

For each case, note the positions along the boundary which are vertically beneath the crown periphery. Note where the plant is rooted in relation to the plot. Note the maximum projections of the crown into the plot. Note the depth of the projecting crown where it crosses the boundary. Give the plant a code name or its proper name.

Drawing the Diagram

First, produce the map showing the horizontal distribution of all the plants enumerated and of those outside with crowns extending into the strip. These are plotted using the coordinate information and indicated by their reference numbers. Graph paper or squared paper for this map and a scale of five mm to represent one metre are usually used. Decide which tree the observer will reach first on his/her way across the 100m x 25m strip. This will be the first to be shown as a complete tree. Next mark the spread of the crown to each side and lightly outline a rectangle enclosing the crown. Within this, draw in the crown outline aiming at the highest point (this being directly over the rooting point) and the widest visible part (this being half way between the highest point and the crown base), giving symmetry about a horizontal axis. Label the crown and trunk. Repeat the process with the tree next–closest to the plot boundary and so on. Parts obscured by trees already drawn are not shown.

Now estimate the horizontal spread by assuming symmetry about a line parallel with the long axis of the strip passing through the crown. Sketch another rectangle with one side fixed by the extent of the crown spread, as before, and the other fixed by an assumption that, if the spread recorded is equal on each side, the crown has a circular horizontal projection. If it is eccentric, assume a width of twice the average of the two extensions. Draw in the horizontal shape of the crown within the rectangle. Now estimate the vertical depth of the crown, assuming the middle height is the widest part and that there is symmetry about a horizontal plane through this. Represent the spread further into the strip as a lightly drawn rectangle with the lowest side at the height of the crown base to the tree top, only including half the crown in this rectangle. Draw in an outline of this half of the crown. Knowing how far the tree is rooted from the boundary of the section of the plot selected for the diagram will allow a line to be drawn indicating where, if at all, the boundary could be projected to intersect the crown. If it intersects, the heights of the top and bottom of the parts of the canopy intruding are known. A line similarly drawn to represent the boundary on the drawing of the horizontal projection will indicate the length of the boundary below the crown. Use the length and the height to make another rectangle. Draw, within this, the intrusion of the crown as it will appear to an observer standing at the edge of the profile strip.

For trees rooted outside the whole 100m x 25m plot, the procedure is slightly different. Here direct observations are made on the position and shape and height of the intruding crown. The crown intrusion should be indicated on a map and also sketched on graph paper in a vertical sense, making the same assumptions as before about horizontal symmetry. If a line other than the 100m x 25m plot boundary is used to demarcate the strip depicted in the diagram, the dimensions for constructing rectangles (within which an appropriate outline can be drawn) can be obtained from the map and the graph-paper sketch.

Climbers are indicated by connecting their rooting point, with a sinuous line representing the stem, to the crown of the tree into which they disappear. Number the stem and indicate the presence of the climber in the crown with its reference number.

For visual impact it helps to shade the crowns to draw attention to the individuals in the diagram that belong to different species or ecological groups (e.g., potential emergent, potential upper canopy species). Four profile diagrams of home gardens in different parts of Bangladesh drawn by Dr. Millat-e-Mustafa are given in Figure 3.5.

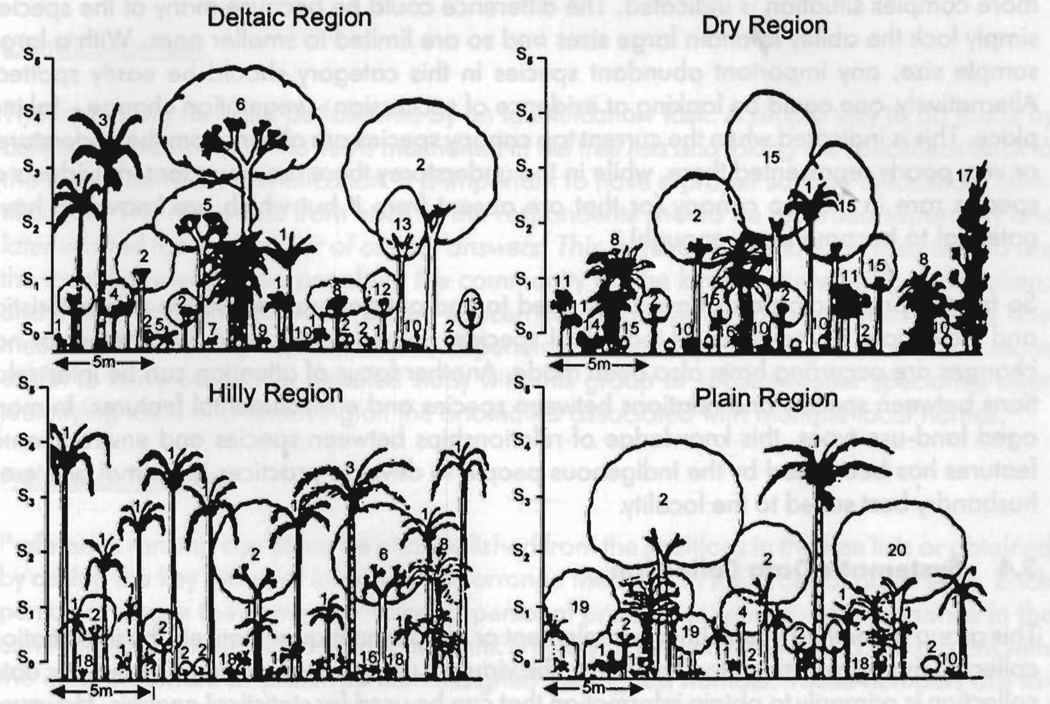


Figure 3.5: Profile Diagram of the Traditional Home Gardens in Bangladesh

Indications from the Completed Diagram

There is little sense in going to the trouble of making a profile diagram unless we know what we want it to show. It actually shows the vertical arrangement of crown foliage above the forest floor. Everything is not shown because some of the foliage is contributed by plants that are too small to enumerate, but, for any vegetation for which this technique is useful, the method recommended will cover over 95per cent of the foliage.

The general features shown are the general canopy height and how any protruding emergent crowns relate to this. It can also be seen whether the foliage is spread throughout the vertical range or concentrated in certain layers and, because of our large sample size, in addition we can see localised changes in gross structure and the exact nature of such changes.

We can acquire still more information if we have named our plants. Whether or not there are distinct layers of foliage, we can see if there are differences between the species that contribute to the upper canopy and those that contribute to the under-storey. If the same species are represented well at all levels and there is a wide distribution of foliage overall, it can be safely concluded that regeneration is taking place. However, if it is well represented wherever there is foliage, but there is a layer with little foliage in the profile, this could indicate that regeneration has ceased (no small plants) or is erratic (poor representation in intermediate sizes).

Where differences are evident between the species well represented at different levels, a more complex situation is indicated. The difference could be because many of the species simply lack the ability to attain large sizes and so are limited to smaller ones. With a large sample size, any important abundant species in this category should be easily spotted. Alternatively, one could be looking at evidence of succession – vegetation change – taking place. This is indicated when the current top canopy species are absent from the understorey or very poorly represented there, while in the understorey there are abundant individuals of species rare in the top canopy (or that are absent from it but which are known to have potential to become large enough).

So far, the profile diagrams have been used to find out general vegetation characteristics and indications of the status of individual species. Some inferences about whether or not changes are occurring have also been made. Another focus of attention can be inter-relations between species and relations between species and environmental features. In managed land-use types, this knowledge of relationships between species and environmental features has been used by the indigenous people to develop practices in animal and crop husbandry best suited to the locality.

3.4 Systematic Data Collection

This group of methods can either complement or supplement quantitatively the information collected through participatory methods. The virtue of using popular tools in systematic data collection is primarily to obtain information that can be used for statistical analysis. However, one important starting point in using these tools is the definition of a domain for the subject of interest that not only limits the scope of data collection, but also helps to build up the data more systematically.

Since most ethnobotanical research depends on interviewing, the domain can be defined as an organized set of words, concepts, or sentences, all on the same level of contrast, that jointly refer to a single conceptual sphere. For greater precision, the domain should be defined by the informants. There are many ways to compile the list of items to define the domain of study items. The most useful general technique is the Free Listing Task. Steps described by Weller and Romney (1988) and Martin (1995) are mentioned as follow.

Free Listing

This technique helps us to understand whether the domain is considered culturally important and easily recognisable by the people being interviewed. By framing the right question, free listing can provide a fairly complete set of native categories. When people are asked to recall things, they tend to list the most significant ones. In addition, prominent categories are cited by almost everybody, thus giving some idea of the things that are culturally the most important. This information given helps the researcher to come up with a ranking index. This index can be used to decide the size of the data set to be included in the domain.

It also helps the researcher to decide the number of respondents for the free listing task. However, for a medium-sized domain (less than 100 or so total categories), the inquiry should be carried out with approximately 20-30 people. Once it is observed that most of the responses given by new informants are being repeated from the old lists, the sample can be considered to be complete. A composite list can be obtained by accumulating information from all the lists.

Identification Task

The free listing task can be followed by an Identification Task. A simple way to do this is by collecting specimens of the items mentioned in the free lists and taking the specimens back to the respondents for identification. It is important to have a proper sample to facilitate identification. The responses from each of the respondents should be recorded separately and later verified for the number of correct answers. This technique provides an idea of who are the most knowledgeable people in the community for the kind of study being undertaken; and it also helps to resolve confusion concerning synonyms for the same item. This is one method of identifying key informants, depending on the objective of the survey. It is more useful to carry out further detailed study with this group of subject matter specialists after identifying tasks and removing all the anomalies associated with multiple local names.

Preference Ranking

Preference ranking can either be accomplished from the positions in the free lists or obtained by asking the key group of informants to arrange the items in the order of preference. Each person arranges the items according to personal preference, perceived importance in the community, or any other criterion. Each rank is given an integer value (1,2,3, and so on) with the most important or preferred item assigned the highest number. These numbers are totalled for all respondents, giving an overall ranking for the item by the sample group of respondents. Efforts should be made to cross-check this order of preference with data obtained from interviews or other sources to see if there is consistency in the responses. A more complex version of preference ranking, useful for ranking based on multiple dimensions, is known as Direct Matrix Ranking. Direct Matrix Ranking takes into consideration several attributes at a time to provide more composite scores of the overall multiple use value of the items.

Pair-wise Ranking

In a paired comparison task, items are presented two at a time and respondents are asked which is 'more' or which is 'less'. For n items, a pair comparison design creates n (n-1)/2 pairs. For example, if we wanted someone to order ten items using this method, we would then create 45 pairs and place them in random order both within and between pairs. For each pair, respondents are asked which is 'more'. A total order is obtained by totalling the number of times each item is chosen. To tabulate the responses, simply add up all the codes or ranks assigned to each item and present them as shown in Table 3.3.

Table 3.3:. Scores and Ranks Assigned to Each Item Using Pairwise Ranking Method

A	B	C	D	E	F	G	H	I		SCORE	RANK
									A		
									B		
									C		
									D		
									E		
									F		
									G		
									H		
									I		

In order to gain insight into people's reasoning, respondents can be asked to describe why one option is better or worse than the other. In addition, you can ask if the preferred item has any negative qualities or if the one not chosen has any positive aspects. Some researchers ask for these comments after each choice, whereas others prefer respondents to complete the entire task before giving their general observations on the overall pattern that emerges.

Pile Sorting

Pile sorting is initiated after the study items have been selected for more detailed data collection. In pile sorting, informants are asked to sort either the items or cards, each bearing the name/figure of an item, into piles so that items in a pile are more similar to each other than they are to items in separate piles. In the unrestricted version of the pile sorting task, respondents can make as many or as few piles as they wish. In the restricted version of the pile sorting task, respondents are asked to create a specific number of piles. Respondents are generally asked to group items according to their similarity, without reference to specific criteria. The respondents rather than the researcher decide what criteria are more appropriate and determine similarity. Pile sorting is easy to administer and allows for the collection of data among a large number of items.

Pile Sort Tabulation

An item-by-item similarity matrix is created from each individual's sort by tabulating the co-occurrence of items in piles, so that items that are together are counted as similar. For example, if we collected data on the similarity of seven items and a respondent put items A, B, and C together in a pile, D and E in a pile, and left F and G by themselves (see Table 3.4), we would create a seven by seven table to tabulate similarity among the items. Since A,B, and C are categorised together, A and B are similar, B and C are similar, and A and C are similar. Since D and E are also put together in a pile, D and E are considered to be similar. Thus, each pair would get 'a point of similarity'. This is indicated in the table by the number one. For this individual, all other pairs are 'dissimilar and are recorded as zeros. Similarity matrices are tabulated for each individual and then combined across people. The similarity matrix can then be analysed by a descriptive method such as hierarchical clustering or multi-dimensional scaling.

Table 3.4: An Individual's Items Sorted into Piles

A			
B	D		
C	E	F	G
Pile 1	Pile 2	Pile 3	Pile 4

Since A,B,C were together in a pile:

cell (A,B) = 1
cell (A,C) = 1
cell (B,C) = 1

	A	B	C	D	E	F
B	1					
C	1	1				
D	0	0	0			
E	0	0	0	1		
F	0	0	0	0	0	

3.5 Statistical Data Analysis

There have been attempts in recent years to incorporate suitable quantitative methods of research into ethnobotanical studies and undertake data collection, processing, and interpretation using statistical tools. Different approaches are available for collecting and analysing the quantitative ethnobotanical data, depending mostly upon the objectives of the researcher and the study. Barik (1998) has observed the following types of ethnobotanical studies in which the quantitative methods have been quite effective in deriving results and drawing conclusions.

i) Importance of vegetation to different groups
ii) Comparing the uses of plants by ethnic communities through sample plots or flora of the region
iii) Studying the importance of different vegetation types to a particular community
iv) Determining the relative importance (or uses) among different medicinal plants, families, and species

The data processing techniques in ethnobotany may range from calculating a simple index to complex computational techniques of multivariate analysis such as classification, ordination, and constrained ordination. The problems in ethnobotany may be classified into two broad categories statistically. A class of problems in which measurements are taken only of one attribute or response variable and for which data so obtained are analysed through a set of techniques called univariate analysis. The other class of problems deals with the measurements of a set of different variables and the statistical techniques applied to such data are called multivariate analysis. Because of the complexities involved in most ethnobotanical phenomena, it is more the norm rather than the exception that ethnobotanical researchers need to collect observations on many different variables. The three most widely used multivariate analysis techniques are regression analysis, principal component analysis, and cluster analysis. In order to demonstrate the use of one such technique, steps involved in cluster analysis of the following example are provided as described by Barik (1998).

The basic data for this example is taken from the final report of an ICIMOD research fellowship study (1996-97) by Dr. Archana Godbole. The title of her manuscript is 'The Use of Indigenous Knowledge in Mountain Natural Resource Management: A Case Study of Wancho Community, Tirap District, Arunachal Pradesh, India'. Dr. Godbole made a shortlist of 15 species (A - O) as important sources of fuelwood in Zadua village. In order to determine the overall preference for fuelwood, she carried out pairwise ranking with 23 women respondents (1 - 23) from the village. The names of species and respondents are given as Annex 3. The results of this pairwise ranking exercise are summarised in Table 3.5, referred to as the basic data matrix.

Statistical analysis of this data was carried out by Dr. Moe Myint, GIS Specialist at ICIMOD, using cluster analysis. The utility of cluster analysis of such data is that the respondents can be grouped according to their resemblances based on their response to questions about species' preferences in the 'Paired Comparison of Fuelwood Species' data. The respondents in each cluster should have a number of common characteristics that set them apart from the respondents of other such clusters. More convincingly, the objective is to classify the informants into groups so that informants within a particular group are more similar to each other than the informants between the clusters. These clusters of informants may represent different ethnic groups or people from different socioeconomic backgrounds.

Step 1. Obtaining the Basic Data Matrix

The basic data matrix for 'Paired Comparison of Fuelwood species' by women respondents according to the preference for each species, is given as Table 3.5.

Step 2. Standardising the Basic Data Matrix

The basic data matrix is standardised so that groupings of respondents and preferences match more distinctly. The result is as follows (Table 3.6).

Table 3.5. Ranking Given by Women (1-23) According to Preference of Each Species (A-O)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
A	15	15	15	13	15	14	14	15	15	14	14	13	15	15	15	15	15	15	15	14	13	15	16
B	13	14	13	9	14	15	15	14	14	8	15	14	14	14	13	13	13	14	14	15	13	14	14
C	13	13	14	9	12	13	13	13	3	3	13	4	2	12	13	14	3	8	13	13	12	12	13
D	11	12	12	7	13	11	10	12	12	6	9	11	11	13	12	9	13	13	12	11	11	13	12
E	3	3	2	2	2	2	2	3	4	2	2	4	5	2	2	2	3	4	3	1	3	2	3
F	11	10	9	5	7	6	6	10	10	5	7	3	9	7	10	12	8	2	10	5	5	7	10
G	4	3	7	5	4	3	3	3	1	3	4	2	1	4	4	7	7	8	4	3	2	4	3
H	5	5	6	3	8	6	6	5	6	7	5	4	5	8	4	5	6	4	5	5	6	8	5
I	7	8	4	7	5	9	9	8	10	8	9	11	11	5	4	4	8	2	8	9	10	5	8
J	7	8	7	11	8	8	6	8	9	8	5	4	9	8	7	7	10	1	8	5	8	8	8
K	2	2	3	4	2	5	5	2	4	13	3	4	8	2	3	3	2	12	2	5	6	2	2
L	7	7	4	13	5	9	10	7	6	12	12	10	5	5	7	5	12	10	6	9	8	5	7
M	10	11	10	11	10	4	4	11	6	11	9	4	4	10	10	9	8	6	11	4	3	10	11
N	6	5	11	15	10	12	12	5	12	15	7	15	13	10	9	9	5	6	6	12	13	10	5
O	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1

Table 3.6

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
A	0.552	0.552	0.552	-1.987	0.552	-0.718	-0.718	0.552	0.552	-0.718	-0.718	-1.987	0.552	0.552	0.552	0.552	0.552	0.552	0.552	-0.718	-1.987	0.552	1.821
B	-0.256	0.332	-0.256	-2.607	0.332	0.920	0.920	0.332	0.332	-3.195	0.920	0.332	0.332	0.332	-0.256	-0.256	-0.256	0.332	0.332	0.920	-0.256	0.332	0.332
C	0.632	0.632	0.871	-0.321	0.394	0.632	0.632	0.632	-1.751	-1.751	0.632	-1.513	-1.990	0.394	0.632	0.871	-1.751	-0.560	0.632	0.632	0.394	0.394	0.632
D	-0.070	0.466	0.466	-2.213	1.002	-0.070	-0.606	0.466	0.466	-2.749	-1.142	-0.070	-0.070	1.002	0.466	-1.142	1.002	1.002	0.466	-0.070	-0.070	1.002	0.466
E	0.372	0.372	-0.698	-0.698	-0.698	-0.698	-0.698	0.372	1.442	-0.698	-0.698	1.442	2.512	-0.698	-0.698	-0.698	0.372	1.442	0.372	-1.768	0.372	-0.698	0.372
F	1.291	0.915	0.539	-0.964	-0.212	-0.588	-0.588	0.915	0.915	-0.964	-0.212	-1.716	0.539	-0.212	0.915	1.667	0.163	-2.092	0.915	-0.964	-0.964	-0.212	0.915
G	0.070	-0.466	1.678	0.606	0.070	-0.466	-0.466	-0.466	-1.538	-0.466	0.070	-1.002	-1.538	0.070	0.070	1.678	1.678	2.213	0.070	-0.466	-1.002	0.070	-0.466
H	-0.398	-0.398	0.365	-1.925	1.892	0.365	0.365	-0.398	0.365	1.129	-0.398	-1.162	-0.398	1.892	-1.162	-0.398	0.365	-1.162	-0.398	-0.398	0.365	1.892	-0.398
I	-0.141	0.265	-1.360	-0.141	-0.954	0.671	0.671	0.265	1.078	0.265	0.671	1.484	1.484	-0.954	-1.360	-1.360	0.265	-2.173	0.265	0.671	1.078	-0.954	0.265
J	-0.432	0.152	-0.432	1.905	0.152	0.152	-1.016	0.152	0.737	0.152	-1.601	-2.185	0.737	0.152	-0.432	-0.432	1.321	1.905	0.152	-1.601	0.152	0.152	0.152
K	-0.708	-0.708	-0.382	-0.057	-0.708	0.269	0.269	-0.708	-0.057	2.875	-0.382	-0.057	1.246	-0.708	-0.382	-0.382	-0.708	2.549	-0.708	0.269	0.595	-0.708	-0.708
L	-0.322	-0.322	-1.432	1.899	-1.062	0.418	0.788	-0.322	-0.692	1.529	1.529	0.788	-1.062	-1.062	-0.322	-1.062	1.529	0.788	-0.692	0.418	0.048	-1.062	-0.322
M	0.632	0.970	0.632	0.970	0.632	-1.396	-1.396	0.970	-0.720	0.970	0.294	-1.396	-1.396	0.632	0.632	0.294	-0.044	-0.720	0.970	-1.396	-1.734	0.632	0.970
N	-1.061	-1.348	0.375	1.523	0.087	0.662	0.662	-1.348	0.662	1.523	-0.774	1.523	0.949	0.087	-0.200	-0.200	-1.348	-1.061	-1.061	0.662	0.949	0.087	-1.348
O	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	4.587	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209	-0.209

Step 3. Computing the Resemblance Matrix

This next step in cluster analysis is to compute a Q-mode resemblance between the respondents (1-23). Although any of the numerous resemblance functions available could be used, distance measures have been used for multi-state characteristics' data in 'Paired Comparison of Fuelwood Species' because of their heuristic value. The results of the Resemblance matrix based on the Bray - Curtis Index (measure of similarity) are as follow.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	0.000																						
2	3.151	0.000																					
3	13.710	5.687	0.000																				
4	0.000	0.000	0.000	0.000																			
5	8.215	3.849	3.771	0.000	0.000																		
6	0.000	10.612	21.276	0.000	10.101	0.000																	
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000																
8	3.151	0.000	5.687	0.000	3.849	10.612	0.000	0.000															
9	8.994	4.090	6.658	0.000	5.134	8.237	75.368	4.090	0.000														
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000													
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000												
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000											
13	3.422	2.692	3.417	14.334	3.092	3.046	4.250	2.692	1.341	6.890	5.975	25.133	0.000										
14	8.215	3.849	3.771	0.000	0.000	10.101	0.000	3.849	5.134	0.000	0.000	0.000	3.092	0.000									
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.084	0.000	0.000								
16	0.000	89.303	0.000	0.000	56.570	0.000	0.000	89.303	35.354	0.000	0.000	0.000	4.687	56.570	0.000	0.000							
17	4.136	2.707	3.756	0.000	3.428	5.870	11.812	2.707	2.906	34.795	16.802	0.000	2.462	3.428	12.950	8.569	0.000						
18	7.353	4.928	5.824	0.000	5.087	7.847	16.160	4.928	4.610	54.887	29.623	0.000	2.817	5.087	18.013	12.228	2.640	0.000					
19	1.985	0.416	4.095	0.000	2.846	8.004	55.076	0.416	3.481	0.000	0.000	0.000	2.527	2.846	0.000	17.719	2.466	4.327	0.000				
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.920	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.349	0.000	0.000	0.000	27.624	42.211	0.000	0.000	0.000		
22	8.215	3.849	3.771	0.000	0.000	10.101	0.000	3.849	5.134	0.000	0.000	0.000	3.092	0.000	0.000	56.570	3.428	5.087	2.846	0.000	0.000	0.000	
23	2.027	0.345	3.818	0.000	2.883	5.574	14.321	0.345	3.124	145.233	28.469	0.000	2.452	2.883	11.415	9.132	2.306	3.985	0.596	0.000	76.271	2.883	0.000

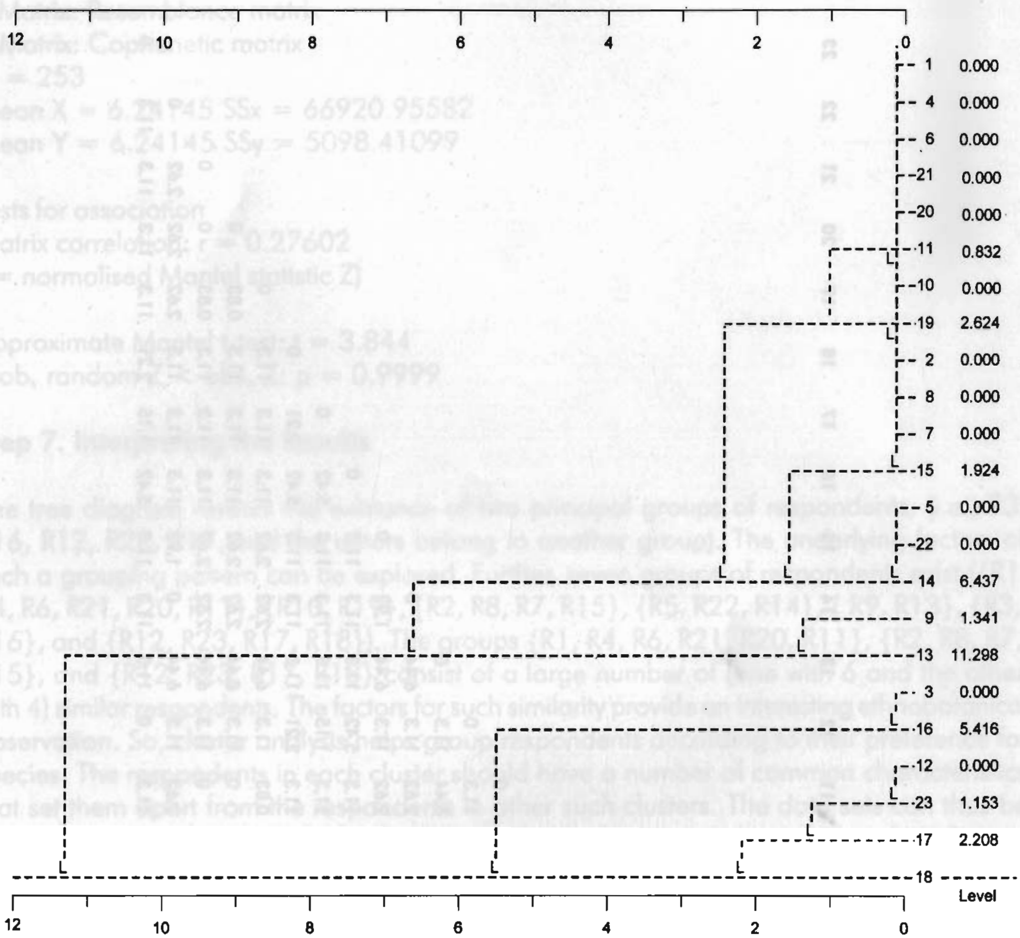
Step 4. Executing the Clustering and Obtaining the Tree Matrix

The clustering technique used here is a sequential, agglomerative, hierarchical, and non-overlapping procedure based on the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) method of clustering. The result of the tree matrix based on the UPGMA is as follows.

1	0.0000000
4	0.0000000
6	0.0000000
21	0.0000000
20	0.0000000
11	0.8323634
10	0.0000000
19	2.6236309
2	0.0000000
8	0.0000000
7	0.0000000
15	1.9242874
5	0.0000000
22	0.0000000
14	6.4372405
9	1.3413647
13	11.2976978
3	0.0000000
16	5.4159862
12	0.0000000
23	1.1531470
17	2.2081708
18	------------

Step 5. Drawing the Tree or Dendrogram.

The tree matrix derived above produces a tree on a scale showing the clustering scheme as follows.



Step 6 Computing the Cophenetic Matrix and Cophenetic Coefficient, and Plotting

A tree is not exactly like the data matrix it represents. It is necessary to know how well the tree and the resemblance matrix matches. The values that appear in the table below came from the tree and are compared with those of the basic data matrix.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0																						
2.62	0																					
11.3	11.3	0																				
0	2.62	11.3	0																			
2.62	1.92	11.3	2.62	0																		
0	2.62	11.3	0	2.62	0																	
2.62	0	11.3	2.62	1.92	2.62	0																
2.62	0	11.3	2.62	1.92	2.62	0	0															
6.44	6.44	11.3	6.44	6.44	6.44	6.44	6.44	0														
0.83	2.62	11.3	0.83	2.62	0.83	2.62	2.62	6.44	0													
0	2.62	11.3	0	2.62	0	2.62	2.62	6.44	0.83	0												
11.3	11.3	5.42	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	0											
6.44	6.44	11.3	6.44	6.44	6.44	6.44	6.44	1.34	6.44	6.44	11.3	0										
2.62	1.92	11.3	2.62	0	2.62	1.92	1.92	6.44	2.62	2.62	11.3	6.44	0									
2.62	0	11.3	2.62	1.92	2.62	0	0	6.44	2.62	2.62	11.3	6.44	1.92	0								
11.3	11.3	0	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	5.42	11.3	11.3	11.3	0							
11.3	11.3	5.42	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	1.15	11.3	11.3	11.3	5.42	0						
11.3	11.3	5.42	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	2.21	11.3	11.3	11.3	5.42	2.21	0					
0.83	2.62	11.3	0.83	2.62	0.83	2.62	2.62	6.44	0	0.83	11.3	6.44	2.62	2.62	11.3	11.3	11.3	0				
0	2.62	11.3	0	2.62	0	2.62	2.62	6.44	0.83	0	11.3	6.44	2.62	2.62	11.3	11.3	11.3	0.83	0			
0	2.62	11.3	0	2.62	0	2.62	2.62	6.44	0.83	0	11.3	6.44	2.62	2.62	11.3	11.3	11.3	0.83	0	0		
2.62	1.92	11.3	2.62	0	2.62	1.92	1.92	6.44	2.62	2.62	11.3	6.44	0	1.92	11.3	11.3	11.3	2.62	2.62	2.62	0	
11.3	11.3	5.42	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	0	11.3	11.3	11.3	5.42	1.15	2.21	11.3	11.3	11.3	11.3	0

The Cophenetic Matrix is computed as follows.

The result of matrix comparison between the cophenetic matrix and the resemblance matrix is as follows.

X Matrix: Resemblance matrix
Y Matrix: Cophenetic matrix
N = 253
Mean X = 6.24145 SSx = 66920.95582
Mean Y = 6.24145 SSy = 5098.41099

Tests for association
Matrix correlation: r = 0.27602
(= normalised Mantel statistic Z)

Approximate Mantel t-test: t = 3.844
Prob. random Z < obs. Z: p = 0.9999

Step 7. Interpreting the Results

The tree diagram reveals the existence of two principal groups of respondents, (i.e., R3, R16, R12, R23, R17, and the others belong to another group). The underlying factors of such a grouping pattern can be explored. Further, seven groups of respondents exist ({R1, R4, R6, R21, R20, R11}, {R10, R19}, {R2, R8, R7, R15}, {R5, R22, R14}, { R9, R13}, {R3, R16}, and {R12, R23, R17, R18}). The groups {R1, R4, R6, R21, R20, R11}, {R2, R8, R7, R15}, and {R12, R23, R17, R18} consist of a large number of (one with 6 and the other with 4) similar respondents. The factors for such similarity provide an interesting ethnobotanical observation. So, cluster analysis helps group respondents according to their preference for species. The respondents in each cluster should have a number of common characteristics that set them apart from the respondents in other such clusters. The data sets can thus be reduced to homogenous groups or clusters with an objective to demonstrate the relationships of the respondents to each other and to simplify their relationships so that some general statements about the class of respondents can be made. In ethnobotanical research, often most interest lies in knowing the preferences for species and the reasons behind it. It may relate to peoples different ethnicity, socio-economic situations. Ethnobotanists have used cluster analysis to find out the preferred traits in a wide variety of agricultural crops encompassing studies on evaluation of seed selection criteria and analysis of highly diverse agronomic practices.

Chapter 4
Issues of Ethics and Guidelines for Ethnobotanical Research

The research on local uses of plant products and other associated aspects of indigenous knowledge of communities residing in or in close proximity to the forests is becoming increasingly popular. The evolution and practice of participatory research methods have made a big contribution in bringing the rural communities closer to science and the practice of management of natural resources. At the same time, it has led to greater recognition of the wisdom of people and brought their old methods and techniques to the limelight. There is a kind of information explosion on indigenous knowledge of traditional communities and its relevance to society at large. While it is true that many aspects of indigenous knowledge are of great value to all of us; many of us in the modern world tend to regard it as free. Not only this, there are commercial corporations and business ventures flourishing on the knowledge base and indigenous resources of people with the help of modern technology and sharing almost no profits with them. So, though there remains a humane justification for collecting and sharing ethnobiological information, the cause of safeguarding the interests of the community that creates and parts with the knowledge has to be supported. There are many international commitments that are being promoted in order to justifiably generate and share knowledge. At the same time there are counterproductive commercial agreements that are putting the whole effort in jeopardy by promoting the interests of private corporations and heavily industrialised countries. They are promoting a system of intellectual property rights (IPRs) over bio-cultural resources that serve not only as a means of economic domination but also as a means of discouraging recognition of local innovations in knowledge generation. Therefore, this section is devoted to discussion on major developments that relate to this complex issue and conduct of a responsible ethnobotanist.

4.1 Introduction to Intellectual Property Rights

The world's present intellectual property system has its roots in 19th century European efforts to promote the interests of private industry in scientific and industrial growth. There are five principal forms of intellectual property rights: patents, plant breeders' rights, copyright, trademarks, and trade secrets. These are explained briefly in Box 4.1. These laws give inventors monopolies and discourage competitors. Legally, in order to get a patent in most countries, three basic criteria have to be met, namely, a product or process must be:

- new (or can claim 'absolute world novelty'),
- non-obvious (that is, includes a real inventive step), and
- useful (has commercial application).

In return for depositing a sample of the patented product or process and describing it so that others skilled in the art can replicate it, inventors get the right to:

- exclusive monopoly over the invention for 17 - 25 years,
- royalties (a surcharge above the normal sale price) on the use of their invention, and
- control of access and the right to set the conditions for sale of the invention, meaning the right to deny or vary costs depending on the customer and market conditions.

Box 4.1. The Five Principal Forms of Intellectual Property Rights

1. *Patent:* A legal monopoly that covers a wide a range of products and processes, including life forms. To receive a patent, inventions must meet three basic criteria. They must be novel, useful, and non-obvious.
2. *Plant Breeders' Rights:* A law that grants a plant breeders' certificate to those who breed new plant varieties. PBR are governed by two international agreements under the Union for the Protection of New Varieties of Plants (UPOV).
3. *Copyright:* This is a legal framework intended to protect artistic and cultural works such as books, illustrations, photographs, and television programmes from being duplicated and/or transmitted without the author's permission.
4. *Trademarks:* A legal monopoly over a name or a linguistic or visual symbol.
5. *Trade Secret:* An intellectual property right used when inventors do not wish to patent in order to protect themselves from competitors. Unlike patents, trade secrets do not require inventors to publish and have no time limit.

It was not so long ago that plants and life forms could be patented. One of the first international agreements, the Union for the Protection of New Varieties of Plants (UPOV), was signed in 1961 to protect plant breeders' rights (PBR). This was the time when public and private seed corporations were beginning to expand business across the globe as part of the Green Revolution technological package. There are two operative UPOV conventions dated 1978 and 1991. The 1978 convention allows farmers to save and replant PBR-protected seed from their harvests, whereas the 1991 version restricts the rights of farmers to save seeds and makes PBRs more like patents, extending the scope of the monopoly granted to the certificate holder. The first patent on a genetically engineered micro-organism was granted in the United States in 1980. In 1987, The US Patent and Trade Mark Office ruled that animals can receive patents too.

The late 20th century has seen the further development of patent systems around the patenting of life forms that are products of biotechnology and industrial manipulation of genetic materials. This is based on the idea that genes are inventions and products because the process of isolation, extraction, and *ex vivo* replication of biological material requires techniques that human beings alone are capable of putting into practice and which Nature is incapable of accomplishing by itself.

4.2 Implications of IPR Mechanisms for Mountain Communities

The above-mentioned concepts of intellectual property differ radically from most rural and indigenous systems of knowledge and innovation prevalent in mountain communities. Here, society perceives knowledge and innovation as collective creations and not as commodities.

This creation of knowledge by the community is held in trust for future generations, and it is unheard of for farming communities to grant unlimited rights to land and resources or to permit ownership of the process of life. Concepts such as stewardship or custodianship come much closer to rural realities than exclusive monopoly or intellectual property. For example, it is widely recognised that traditional farming practices have contributed immensely to the promotion and management of agricultural biodiversity and to the development of modern varieties. However, genetic material from a land race, patented by a breeder, gives him/her all claims to the material, whereas the farmer from whose farm the material was taken has no rights to it. The logic is that, even when a land race is used in a commercial plant variety, breeders almost always extract and adapt a gene or gene complex to make one of several hundred components in a new plant variety. Considering the alternative option of a farmer trying to obtain PBR to be eligible for protection, he/she would have to prove that the variety is:

- distinct: distinguishable by one or more characteristics from any other variety that is commonly recognised;
- stable: remains true to its description after repeated production or propagation;
- uniform: homogeneous with regard to the particular feature of its sexual reproduction or propagation; and
- novel: that it has not been offered for sale or marketed in the source country, or for longer than four years in any other country.

The farmer or his community would have to prove that they were the only ones to use the land race or breed the cultivar in addition to all the above legal requirements. Moreover, some of the prerequisites are actually in conflict with the farmers' breeding priorities, as they prefer varieties that possess variability and adaptability–and thus try to create cultivars with intra-varietal genetic diversity. This is just one example of how the different forms of patents are biased towards industrial society. A balanced picture of the advantages and disadvantages of the various forms of IPRs for local communities is presented in Box 4.2.

Four member countries of the HKH region have already accepted membership of the World Trade Organization (WTO) and are thus required to reform their patent laws in accordance with the provisions of the General Agreement on Trade and Tariffs (GATT) and Trade Related Intellectual Property Rights (TRIPS). Many things would change as a result of these measures. For example, farmers would have to pay expensive patenting fees to be able to buy genetically engineered seeds. These seeds would not only be more expensive than the conventionally bred seeds, but they also cannot be saved for the next crop as the patented variety belongs to the patent holder. Higher prices than at present for practically all other inputs, particularly agrochemicals, would be baneful to small farmers. Only a small section of farmers with a relatively large land holding would enjoy the economies of scale and would be able to sustain themselves. Small and marginal farmers, a majority in the HKH, would be particularly disadvantaged on account of their limited working capital and high vulnerability to risks.

Lifting the existing regime of subsidies being advocated under the GATT provisions would deprive farmers. At the same time, the capability of national and state agricultural research agencies to provide new varieties would diminish as scientists and breeders would be denied access to patented varieties for further breeding. Progress and innovation in breeding

Box 4.2: Advantages and Disadvantages of Various IPR Mechanisms for Local Communities

Mechanism	Advantages	Disadvantages
Patents	Can safeguard knowledge legally Available in most countries	Limited term of protection Applications expensive and require legal advice Protect knowledge of individual inventors, not collective knowledge of communities Difficult and expensive to defend
Petty patents	Can safeguard knowledge legally More traditional knowledge may be more protected than under patents Compared with patents, less expensive application procedure and shorter and less stringent examination	Available only in a few countries No international agreements to facilitate application in different countries Shorter period of protection than patents
Copyright	Easy to obtain Long period of protection	Protects expression of ideas but not knowledge itself Protection period not indefinite Subject matter must be in a physical form
Trademarks	Inexpensive Indefinite protection period, although may have to be renewed periodically May attract more customers to products of indigenous traders and trading organizations	Does not protect knowledge *per se*
Trade Secrets	Can protect traditional knowledge with commercial application Can protect more knowledge than the other IPR types Can be traded for economic benefits by contract Inexpensive to protect	Available in fewer countries than patents and copyrights

Source: Possey and Dutfield 1996.

will depend on the affordability of patent fees. Live resources, such as genes and living cells as well as characteristics such as 'high protein' and 'dwarfedness', would become the private property of biotechnology companies. Research and extension will suffer because of restrictions on the free exchange of information, and increased privatisation of research would lead to further internalisation (secrecy) of research results. As a consequence, the current problem with global food supply would be aggravated and would influence those communities most who are not self-sufficient in food production such as the population of the HKH region.

This scenario poses tremendous challenges to ethnobotanists and all those who work with local communities. Therefore, many international efforts are currently taking place to counter the threats of the IPR mechanisms mentioned above.

Box 4.3: The Role of Community Knowledge in Global Development

Health and Medicine	Food and Agriculture	Environment and Diversity
Local: 80% of the South's medical needs are met by community healers using local medicine systems.	Almost 90% of the South's food requirements are met through local production. Two-thirds are based on community farming systems.	Almost 100% of the biodiversity 'hot spots' are in areas nurtured by indigenous communities and/or bordering the South's farming communities.
Global:25% (and growing) of western patented medicines are derived from medicinal plants and indigenous preparations.	90% of the world's food crops are derived from the South's farming communities and continue to depend on farmers' varieties in breeding programmes.	The wild relatives of almost every cultivated crop are found in biologically-diverse regions of the South and are nurtured by indigenous communities.
Market: The current value of the South's medicinal plants to the North is estimated conservatively at US$32 billion annually.	The direct commercial value derived from farmers' seeds and livestock breeds is considerably more than US$5 billion a year.	90% of the world's most biologically-diverse lands and waters have no government protection and are nurtured exclusively by rural communities.

Source: Rural Advancement Foundation International, Canada.

<u>International Obligations to Safeguard Community Interests</u>

Several International Environmental and Human Rights' instruments, some legally binding, such as International or Global Treaties, Regional Conventions, and Bilateral Agreements, and others non-binding, such as declarations, etc, reaffirm the obligation of nations to recognise and respect the rights of traditional communities in the management of natural resources and the involvement of people and communities in conservation of natural resources.

One significant development along these lines is the concept of Farmers' Rights. As described in the FAO's international undertaking on Plant Genetic Resources, farmers' rights mean rights arising from the past, present, and future contributions of farmers in conserving, improving, and making available plant genetic resources. These rights aim to achieve the following.

- Assist farmers and farming communities, in all regions of the world, especially in the areas of origin/diversity of plant genetic resources (useful for HKH farmers) in the protection and conservation of plant genetic resources and of the natural biosphere
- Allow farmers, their communities, and countries in all regions to participate fully in the benefits derived, at present and in future, from the improved use of plant genetic resources through plant breeding and other scientific methods

While the directives and principles mentioned above are soft laws, there are more legally binding treaties such as the Convention on Biological Diversity (CBD). All the eight HKH countries have either signed and/or ratified the CBD. Its Article 8 (j) states that Parties are obliged to:

- ensure that a fair share of the benefits go to indigenous and local communities when others use their knowledge or the resources that they have conserved;
- ensure that people of indigenous and local communities receive recognition and acknowledgement for their contributions to universal knowledge and welfare;
- help indigenous and local communities to develop their own economic uses of their traditional knowledge and associated biological resources which are consistent with traditions of sustainable use; and
- ensure protection of the rights of indigenous and local communities over their knowledge, innovations, and practices as a part of the broader goal of achieving protection of their cultural heritage.

Advocates of these clauses are arguing (Downes 1997) that the term 'equitable sharing of benefits' should be defined by reference to the costs incurred by indigenous and local communities in conserving their knowledge and associated biodiversity, rather than by reference to the value patents or an 'effective *sui generis* system' or both.

Heritage rights, such as those provided by the World Heritage Convention, which all the HKH countries, except Bhutan, have signed, provide another important instrument in favour of indigenous and local communities. In a special report of the UN Economic and Social Council (ECOSOC) on cultural and intellectual property rights, heritage is defined as:
"everything that belongs to the distinct identity of a people and which is theirs to share, if they wish, with other people. It includes all things which international law regards as the creative production of human thought and craftsmanship, such as songs, stories, scientific knowledge and artworks. It also includes inheritances from the past and from nature, such as human remains, and naturally occurring species of plants and animals with which a people has long been connected."

This concept of heritage is applicable to both the CBD and the FAO international undertaking on Plant Genetic Resources. It brings us to one of the greatest drawbacks of the property rights' system currently being promoted. It assumes that property rights are individually or privately held. It is easy to challenge this under the ECOSOC provisions that *'the protection of cultural and intellectual property is connected fundamentally with the realisation of the territorial rights'* and tenurial rights are recognised by the 1989 ILO Convention 169: *'the* *right of ownership, collective or individual, of the members of the population concerned over the lands which these people traditionally occupy shall be recognised.'* Both heritage rights and rights over territory are inalienable, non-individual rights. They are elements of communal rights that have been recognised for indigenous communities by international law. The HKH region is one of great diversity. It has many indigenous communities and respective national governments should translate the provisions of these directives and principles into policy and action while negotiating other international agreements. These elements of communal rights must also be extended to other local farming communities in the HKH. The experience generated in the region clearly demonstrates that increased community control over resources is critical to the improvement and widening of development options. The fight for greater intellectual, biological, and cultural property rights is central to the wider struggle for people's rights to gain control over their livelihoods; and this is basic to the sustainable development paradigm.

<u>International Networks</u>

Many innovative measures are being discussed in institutions and networks that work with the indigenous people. The Working Group on Traditional Resource Rights affiliated to the Oxford Centre for the Environment, Ethics and Society is carrying out pioneering work. It is promoting the concept of a Community Intellectuals' Rights' Act which provides for the establishment of a *sui generis* system for plant varieties. The Centre has also attempted to include the local community as the 'innovator' and defined plant variety in a more practical sense. 'Plant Variety' shall include a plant species or category of a lower level (such as land race) or any part thereof or germplasm therein, whether domesticated or not, used in accordance with established customs, practices, and laws by local communities for a particular purpose that requires prior knowledge of a particular property of the plant such as food, medicine, or dye. In addition to such holistic definitions, the proposed act covers aspects of custodianship, free exchange amongst communities, use for commercial purposes, registration of invention, proof of invention, etc. What is more important, the act provides for co-ownership amongst communities that share the same knowledge so that they can carry the same rights, duties, and obligations.

International Conferences and Symposia in the related fields have also been making efforts to safeguard the interests of the community. The Manila declaration concerning the ethical use of biological resources was made at the Seventh Asian Symposium on Medicinal Plants, Species, and other Natural Products (ASOMPS VII) held from 2 to 7 February 1992. It made strong recommendations, some of them have been listed below.

- For all collections, the authorising agreement (s) should include provision for any subsequent commercial development that may eventually arise.
- Internationally recognised professional societies should develop a code of ethics that facilitates the formation of equitable partnerships in the development of new products from biological material.
- Mandatory royalty or license agreements should be established to ensure fair and equitable distribution of benefits.

The International Society of Ethnobiology (ISE) has also been very active in releasing guidelines and standards of practice. It mainly recognises and emphasises support to the efforts of indigenous peoples, traditional societies, and local communities to undertake their own research, collections, databases, and publications. The code of conduct and standards of practice were agreed upon at the first ISE meeting in Belem in 1998. The purpose of this code of ethics, as specified in the draft put out at the 4th ISE held in Kenya in September 1996 is stated as follows.

i) To protect and/or mitigate the adverse effects of research and related activities of ethnobiologists that can disrupt or disenfranchise indigenous peoples, traditional societies, and local communities from their customary and chosen lifestyles
ii) To provide a set of guidelines, principles, standards, and policies to govern the conduct of ethnobiologists and all members of the ISE engaged in or proposing to be engaged in the research, collection, and use of traditional knowledge or collections of flora, fauna, or any other element found on community lands or territories

The Principles of this Code are intended to embrace, support, and embody the established principles and practices of international law and customary practice as expressed in the United Nations Declaration of Universal Human Rights and the Draft Declaration of Rights of Indigenous Peoples. The following principles are the fundamental assumptions that form the Code.

1. Principle of self-determination
2. Principle of inalienability
3. Principle of minimum impact
4. Principle of full disclosure
5. Principle of prior informed consent and veto
6. Principle of confidentiality
7. Principle of active participation
8. Principle of respect
9. Principle of active protection
10. Principle of good faith
11. Principle of compensation
12. Principle of restitution
13. Principle of reciprocity
14. Principle of equitable sharing

There are several scientists and institutions that have laid down very strict ethical guidelines for accessing and exploring biodiversity. The Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) based in Ahmedabad, India, follows a very strict process of initial disclosure of information. As detailed by Professor Anil Gupta of SRISTI, in the initial contact with the community the researcher:

- should carry out all communications in the local language;
- must explain the nature and purpose of the proposed research, including its duration, the geographic area in which research will take place, and the research and the collecting methods;
- must explain the foreseeable consequences of the research for resources, people, and accessors, including potential commercial value;

- should explain the potential non-commercial values such as academic recognition and advancement for the researcher;
- should explain any social and/or cultural risks;
- must notify the community at large by some means, e.g., public meeting;
- should consider explaining the guidelines that the researcher is following, as well as his/her practice in previous similar research projects;
- should be willing to provide copies of relevant project documents, or summaries thereof, preferably including the project budget in the local language (in the case of commercial prospecting researchers must share such documents);
- must agree on a protocol of acknowledgements, citation, authorship, and inventorship as applicable, either citing local innovators or conservators, or respecting requests for anonymity;
- must share findings at different stages with the providers; and
- must not engage in bribery or in making false promises.

An innovative approach adopted by *Sristi Jigyasa Parivar*, another Indian organization based in Bangalore, is that of the People's Biodiversity Register (PBR). The general approach followed in PBR has been briefly outlined in Section 2.1.The process includes working with the existing local village-level institutions. In the initial contact, the issues related to the importance of documenting the resources of the village are discussed. Depending on the interest in the village, the process for compilation of the Biodiversity Register is initiated and, after completion, the database is left with the village authorities. In this way people in the village have the required information as well as control over it.

The field of ethnobotanical research is more vibrant and complex now then ever before in history. The interest in indigenous knowledge and natural products is phenomenal, and there is more awareness about non-extractive and participatory research that benefits local communities. UNESCO, WWF, and the Royal Botanical Gardens, Kew – initiative on People and Plants – consider these times of crisis for any professional concerned with biological or cultural diversity since '*both are disappearing at an alarming rate. For economists and ethnobotanists, as well as natural product chemists, there is an urgent need to publish a broadly accepted, practical set of guidelines for creation or research partnerships that not only benefit people but other forms of life*' (Cunningham 1996).

Acknowledgements for Section III

This paper is based on the information available in many public interest publications brought out by Rural Advancement Foundation International, Canada; Genetic Resources Action International, Spain; Gene Campaign, India; Southeast Asia Regional Institute for Community Education, Philippines; and Programme for Traditional Resource Rights of the Oxford Centre for the Environment, Ethics and Society, UK.

References

Alcorn, J.B.,1995. 'The Scope and Aims of Ethnobotany in a Developing World'. In Schultes, R.E. and. Reis S.V (eds) *Ethnobotany: Evolution of a Discipline*, pp23-29. London: Chapman and Hall.

Aumeeruddy, Y., 1994. 'Local Represeantations and Management of Agroforests on the Periphery of Kerinci Seblat National Park, Sumatra, Indonesia.' *People and Plants* Working Paper, No. 3, October 1994. Paris: UNESCO.

Aumeeruddy-Thomas, Y., 1998. 'Advice From the Field:' *People and Plants Handbook. Issue No. 5*. Paris: WWF, RBG, Kew and UNESCO.

Aumeeruddy-Thomas, Y., and Michon, G. (In Press).. 'Advice From the Field – Understanding and Translating Multistratified Agroforestry Systems: Lessons from Sumatra.' *People and Plants Handbook Issue 6*. Paris: WWF, RBG, Kew and UNESCO.

Barik, S.K., 1998. 'Application of Multivariate Statistical Analysis in Ethnobotany.' Report submitted to Division of Ecological Sciences, UNESCO. Unpublished MS p 52. Paris: UNESCO.

Bhatia, A.; Sen K.C.; Pandey, G.; and Amtzis, J., (eds), 1998. In *Capacity-Building in Participatory Upland Watershed Planning, Monitoring and Evaluation: A Resource Kit*, p 180. Kathmandu: ICIMOD and PWMTA, FAO.

Bhatia, A.; Pelinck, E.; and Rastogi, A.,1998. 'Community Focussed Approaches to Biodiversity Conservation.' In *Report on the International Meeting on Himalaya Ecoregional Cooperation*, pp 215-251. Kathmandu: UNDP.

Chambers, R., 1994. 'The Origins and Practice of Participatory Rural Appraisal' World Development, Vol. 22, No. 7, pp953-969.

Chambers, R., 1996. 'Relaxed and Participatory Appraisal Notes on Practical Approaches and Methods.' Unpublished notes for teaching. UK: University of Sussex and IIED.

Chhatre, A.; Sheshagirrao, P.R.; Ghate, U.; Pramod, P.; Ganguly A.; and Gadgil, M., 1998. 'Srishtigyaan: A Methodology Manual for People's Biodiversity Registers,' Unpublished Report. p109. Bangalore: Srishti Jigyasa Pariwar C/O Centre for Ecological Sciences, Indian Institute of Science, Karnataka.

Cunningham, A.B., 1996. 'Ethics, Biodiversity, and New Natural Products Development,' p44. Gland: WWF International.

Davis, T.A.W. and Richards, P.W., 1933. 'The Vegetation of Moraballi Creek, British Guiana: An Ecological Study of a Limited Area of Tropical Rain Forest.' *Journal of Ecology* 21: 350-72.

Downes, D., 1997. 'Using Intellectual Property as a Tool to Protect Traditional Knowledge.' CIEL Discussion Paper prepared for the Convention on Biological Diversity, Workshop on Traditional Knowledge, Madrid, November 1997.

Ford, R.I., 1978. 'Ethnobotany: Historical Diversity and Synthesis.' In Ford, R. I. (ed), *The Nature and States of Ethnobotany.* Anthropological Papers, No. 67, p33-49 Ann Arbor MI: University of Michigan. Museum of Anthropology.

Falconer, J. and Koppell, C.R.S., 1990. 'The Major Significance of 'Minor' Forest Products: The Local Use and Value of Forests in the West African Humid Forest Zone'. In *Forests, Trees and People Community Forestry Note 6*, p231. Rome: FAO.

Freudenberger, K.S.,1994. *Tree and Land Tenure Rapid Appraisal Tools.* Rome: FAO.

Godoy, R.; Lubowski, R.; and Markandya, A., 1993. 'A Method for the Economic Valuation of Non Timber Tropical Forest Products'. In *Economic Botany*, 47 (3), pp220-233.

Hall, J.B., 1992. 'Profile Diagrams.' In *UDSM/IDRC Forest Research Training Course*, p12. Morogoro: Division of Forestry, University of Dar es Salaam.

Institute of Development Studies, 1996. *'Mapping: Participatory Appraisal Methods'*, p7. Paper compiled by Carolyn Janes. Brighton: IDS and University of Sussex.

Jha, P.K., 1998. 'Environment, Plant Resources and Quantitative Estimation Methods for Vegetation Analysis.' In Shrestha, K.K.; Jha, P.K.; Shengji, P.; Rastogi, A.; Rajbhandary, S.; and Joshi, M. (eds), *Ethnobotany for Conservation and Community Development: Proceedings of the National Training Workshop in Nepal,* pp42-57. Kathmandu: Ethnobotanical Society of Nepal.

Jodha, N.S. and Shrestha, S., 1993. 'Sustainable and More Productive Mountain Agriculture: Problem and Prospects.' In *Proceedings of the Tenth Anniversary Symposium of ICIMOD*, p53. Kathmandu: ICIMOD.

Jodha, N.S., 1997. 'Mountain Agriculture'. In Messerli, B. and Ives, J. (eds), *Mountains of the World: A Global Priority,* pp313-336. New York: The Parthenon Publishing Group.

Poffenberger, M.; McGear, B.; Ravindranath, N.H.; and Gadgil, M. (eds), 1992. 'Diagnostic Tools for Supporting Joint Forest Management System.' *Joint Forest Management Field Methods Manual, Volume 1, pp102.* New Delhi: Society for Promotion of Wasteland Development.

Poffenberger, M.; McGean, B.; Khare, A.; and Campbell, J. (eds), 1992. 'Community Forest Economy and Use Pattern: Participatory Rural Appraisal (PRA) Methods in South Gurjarat, India.' *Joint Forest Management Field Methods Manual, Volume 2*, pp79. New Delhi: Society for Promotion of Wasteland Development.

Martin, G.J., 1995. 'Ethnobotany: A People and Plants Conservation Manual', pp267. London: Chapman and Hall.

Michon, G., 1985. 'De l'Homme de la Forêt au Pausam de l'Arbre. Agroforesteries Indonensiennes.' p273. Theses de doctorate. France: Université de Montpellier.

Millat-e-Mustafa, M., 1998, 'The Ecology and Indigenous Management Techniques of Tribal Home Gardens - A Case Study of Marma Tribe in Rangamati Hill District, Bangladesh.' Unpublished Report. Kathmandu: ICIMOD.

Oldeman, R.A.A., 1974. L'Architecture de la Forêt Guyanaise, Memoire ORSTOM. Paris: ORSTOM.

Peters, C.M., 1994. *Sustainable Harvest of Non-timber Plant Resources in Tropical Moist Forest: An Ecological Primer*. Washington DC: Biodiversity Support Programme.

Philips, O.L.B. and Gentry, A.H., 1993. 'Quantitative Ethnobotany.' *Economic Botany* 47: 15-32.

Posey, D.A. and Dutfield, G., 1996. *Beyond Intellectual Property: Towards Traditional Resource Rights for Indigenous Peoples and Local Communities*. Ottawa: IDRC.

Rural Advancement Foundation International (no date). 'Enclosures of the Mind: Intellectual Monopolies. A Resource Kit on Community Knowledge, Biodiversity Development and Conservation Programme', p78. Prepared for the Community Biodiversity Development and Conservation Programme by Anne Gillieo. Canada: RAFI, IDRC, CBDC.

Schultes, R.E., 1995. Preface in *Ethnobotany: Evolution of a Discipline*, p11-14. Schultes, R.E. and Reis, S. (eds). London: Chapman and Hall.

Swift, M.J.; Vandermeer, J.; Ramakrishnan, P.S.; Anderson, J.M; Ong, C.K.; and Hawkins, B.A., 1996. 'Biodiversity and Agroecosystem Function'. In Mooney, H.A, Cushman, J.H., Medina, E., Sale, O.E. and Sculze, E.D. (eds) *Functional Roles of Biodiversity: A Global Perspective*. London: John Wiley and Sons Ltd.

Waller, S.C. and Romney, A.K., 1988. *Systematic Data Collection. Qualitative Research Methods. Series 10*. Newbury Park, UK: Sage Publications.

Wells, M.P., 1997. 'Biodiversity Conservation and Local Development Aspirations: New Priorities for the 1990s.' In Pushpagandhan, P.; Ravi, K.; and Santhosh, V. (eds) *Conservation and Economic Evaluation of Biodiversity*, Volume 2, pp465-482. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Annex 1

1. Ethnobotany and Its Application to Conservation: Proceedings of the First Training Workshop in Pakistan, Sept 16 – 24, 1996, p227 incl. annexes. Shinwari, Z.K.; Khan, B.A.; and Khan, A.A. (eds), National Herbarium/Pakistan Agricultural Services Academy, Pakistan Agricultural Research Centre, Islamabad, Pakistan.

2. Ethnobotany for Conservation and Community Development: Proceedings of the National Training Workshop in Nepal, January 6-13, 1997, p162 incl. annexes. Shrestha, K.K.; Jha, P.K.; Shengji, P.; Rastogi, A.; Rajbhandari., S.; and Joshi, M. (eds), Ethnobotanical Society of Nepal, Kathmandu, Nepal.

3. Applied Ethnobotany: Proceedings of the National Training Workshop on Applied Ethnobotany in China, April 23-30, 1997, p211 incl. annexes. Shengji, P.; Long Chunlin, Xu Jianchu and Wang Chun (eds). Kunming Institute of Botany, Yunnan Nationality Press.

4. Applied Ethnobotany in Natural Resource Management – Traditional Home Gardens. Highlights of the Training Workshop in India, June 18-23, 1997, p97 incl. annexes. ICIMOD, Kathmandu, Nepal.

5. Applied Ethnobotany: Proceedings of the Subregional Workshop on Applied Ethnobotany, Dec.17 – 22, 1997, p145 incl. annexes. Bangladesh Forest Research Institute, Chittagong, Bangladesh.

Yang Yongping, 1997. Sustainable Management and Conservation of Medicinal Plants in the Jingpo Community, South West Yunnan, China'. Unpublished Report, p20 incl. annexes and pl. ICIMOD, Kathmandu.

Manandhar, N.P. and Archarya, S.K., 1997. Application of Indigenous Knowledge of Fodder Trees in Kalikhastan, Rasuwa District, Nepal. Unpublished Report, p27 incl. annexes and pl. ICIMOD, Kathmandu.

Hu Zhihao and Qi Shunhua, 1997. Study on Ethnobotany and Conservation of *Sinopodophyllum Hexandrum*, *Diphyleia Sinensis* and *Fritillaria Cirrhosa* in the Zhongdian Tibetan Autonomous County in Yunnan, China. Unpublished report, p20. ICIMOD, Kathmandu.

Pokhrel, M.; Shrestha R.; and Sharma, R.K., 1998. The Investigation on the Status of Indigenous Medicinal Plants and Their Conservation in the Newar Community, A Case of Bungamati VDC, Lalitpur, Nepal. Unpublished Report, p61 incl.annexes and pl. ICIMOD, Kathmandu.

Prasad, B.N. and Sah, B., 1997. Genetic Diversity, Distribution Pattern, Germination and Ethnobotanical Uses of *Alnus Nepalensis* and A. Nitida in Lumle and Pokhara Region of Nepal. Unpublished Report, p34 incl.annexes and pl. ICIMOD, Kathmandu.

Rajbandhary, S.; Dangol, N.; Karna, B.K., 1997. Community-based Case Study on Indigenous System of Sal (*Shorea robusta*) Forest Management. Unpublished Report, p64 incl.annexes and pl. ICIMOD, Kathmandu.

Kala, C.P., 1998. Ethnobotanical Survey of Rare Medicinal Herbs in the Buffer Zone of Valley of Flowers National Park, Chamoli, Garhwal, India. Unpublished Report, p35. ICIMOD, Kathmandu.

Shrestha, I., 1998. Ethnomedicobotanical Studies of Gurung Communities in Bichaur Village, Lamjung, Nepal. Unpublished Report. p70, incl. annexes and pl. ICIMOD, Kathmandu.

Hussain, F., 1998. Ethnobotany of Fruit Plants and Its Application for Conservation and Community Development in Drosh Valley, Chitral (Hindu Kush-Himalaya Region) of Pakistan. Unpublished Report, p175 incl. annexes and pl. ICIMOD, Kathmandu.

Wu Ning, 1998. Qiang's Indigenous Knowledge on the Conservation and Development of Ethno-medicinal Plants, Maoxian County, Sichuan, China. Unpublished Report, p28. ICIMOD, Kathmandu.

Shiwari, I. and Khan, M.A., 1998. Ethnobotany of Margalla Hills National Park, Islamabad, Pakistan. Unpublished Report, p100 incl. annexes and pl. ICIMOD, Kathmandu.

Alam, M.K. and Khisa, S.K., 1997. Preliminary Studies in Ethnobotany of Chittagong Hill Tracts, Bangladesh and Its Linkage with Biodiversity. Unpublished Report, p25. ICIMOD Kathmandu.

Changkija, S.; Yaden, A.; and Aier, A., 1998. Ethnobotanical Study on Traditional Sustainable Cultivation-based on Alder Tree (*Alnus nepalensis*) Practices by the Naga Tribes of Nagaland, India. Unpublished Report, p39 incl. annexes and pl. ICIMOD, Kathmandu.

Huang, Ji., 1998. Ethnobotany and Conservation of Allium Hookeri Thwaites and Allium Wallichi J Kunth in Tengchong County, Yunnan, China. Unpublished Report, p14. ICIMOD, Kathmandu.

Millat-e-Mustafa, M., 1998. The Ecology and Indigenous Management Techniques of Tribal Home Gardens - A Case Study of Marma Tribe in Rangamati Hill District, Bangladesh. Unpublished Report, p30. ICIMOD, Kathmandu.

Godbole, A., 1997. The Use of Indigenous Knowledge in Mountain Resource Management: A Case Study of Wancho Community, Tirap District, Arunachal Pradesh, India. Unpublished Report, p69 incl. annexes and pl. ICIMOD, Kathmandu.

Annex 3

Women Respondents for Pairwise Comparison of Fuelwood Species

Name	Code	Name	Code
Dashu Wangsu	1	Chenuo Wangpan	13
Dalu Wangsu	2	Phaichoi Wangsu	14
Mungdam Wangsu	3	Phejing Wangpan	15
Tahu Wangsu	4	Pheson Wangpan	16
Leyehoi Wangsu	5	Nyeoli Wangsu	17
Phomsa Wangsu	6	Nyalai Wangsu	18
Zadon Wangsu	7	Toyngm Wangsu	19
Moeli Wangsu	8	Thalem Wangpan	20
Phelai Wangsu	9	Zhikhau Wangpan	21
Gymwai Wangpan	10	Nichang Wangsu	22
Hetoi Wangpan	11	Jenou Wangsu	23
Toleyem Wangpan	12		
Title			

Wancho name of fuelwood		Botanical Name	Code
Puak		*Macaranga denticulata*	A
Puakmi		*Mallotus tetracoccus*	B
Gnut		*Dendrocalamus spp.*	C
Ottan		*Saurauia roxburghii*	D
Phu		*Albizia sp.*	E
Hen		*Sterospermum sp.*	F
Hetpha		*Ficus semicordata*	G
Chablu		*Litsea monopetela*	H
Nyakay		*Itea macrophylla*	I
Zapzan		*Eurya acuminata*	J
Offang		*Ficus hirta*	K
Chicklong		*Syzygium cumini*	L
Zhak		*Schima wallichi*	M
Zhamlau		*Cedrela serrata*	N
Nyapha		*Arallia sp.*	O

ICIMOD

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats 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.

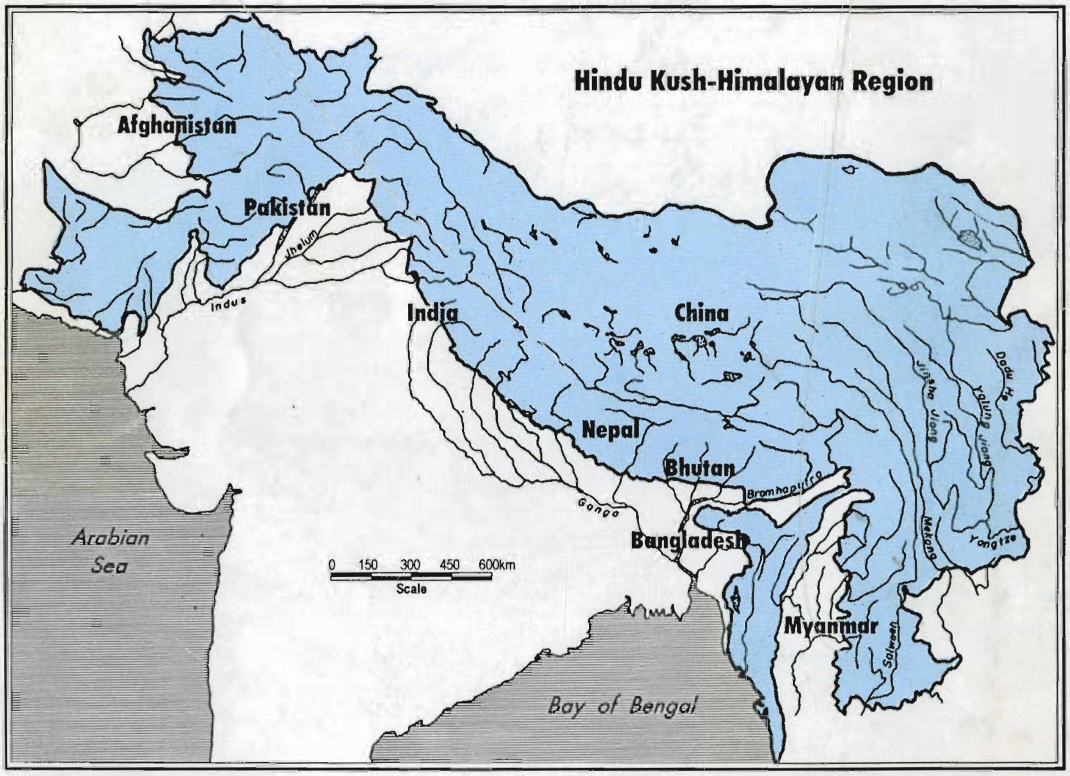
ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment 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.

Mountain Natural Resources' Division

Mountain Natural Resources constitutes one of the thematic research and development programmes at ICIMOD. The main goals of the programmes include i) Participatory Management of Mountain Natural Resources; ii) Rehabilitation of Degraded Lands; iii) Regional Collaboration in Biodiversity Management; iv) Management of Pastures and Grasslands; v) Mountain Risks and Hazards; and vi) Mountain Hydrology, including Climate Change.

Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bhutan
- India
- Nepal
- Bangladesh
- China
- Myanmar
- Pakistan



International Centre for Integrated Mountain Development (ICIMOD)

4/80 Jawalakhel, G.P.O. Box 3226, Kathmandu, Nepal

Telephone : (977-1-525313)
e-mail : distri@icimod.org.np
http : www.icimod.org.sp

Cable : ICIMOD, NEPAL
Fax : (977-1) 524509
(977-1) 536747