BIODIVERSITY ACTION PLAN

FOR

BHUTAN

THIMPHU, BHUTAN

DECEMBER, 1997

FOREWARD

Ever since the inception of the planned socioeconomic development in 1961, the Royal Government's policy has been to ensure that the process of development in all its aspects is consistent with maintaining the environmental and cultural integrity of the country. Bhutan's late entry into the development process has also meant that it has been able to avoid many of the unfortunate trappings of unbridled modernization, including the undermining of its cultural and religious traditions. This late start has been a blessing in disguise, as we have been able to learn from the mistakes of others who have trodden the path before us.

Bhutan can be justifiably proud that in 1988 the Kingdom was identified as one of the ten Biodiversity hotspots of the world. It has also been identified as the centre of 221 Global Endemic Bird Areas. Bhutan's ecosystem harbours some of the most exotic and endemic species of the eastern Himalayas, and the country has the highest proportion of forest cover and of protected areas of any Asian nation.

The preservation of the country's rich biological diversity can be attributed to two factors, the visionary and enlightened leadership and the strong conservation ethic of the Bhutanese people. Conservation is not a new idea to the Bhutanese. Buddhist teachings and practices have fostered a respect for all life forms and a deep reverence for nature. The profound respect for the natural world is a central tenet of Buddhism. Buddhism believes in conservation of nature and giving back to the earth what one has taken from it, and also in the sanctity of life. The importance of protecting nature in all its manifestations has permeated Bhutanese consciousness and has become integral to the Bhutanese way of life. Therefore, preservation of the environment, as well as of sacred and cultural heritage sites in an integral part of the Bhutanese value system. Bhutan has chosen a "middle path" in its development efforts by adopting a policy of sustainable development integrating conservation and economic development. In Bhutan's 8th Five Year Plan, for the first time, a complete chapter dedicated to Environmental including Biodiversity and Development succinctly demonstrates the persevering political will and strong commitment of the Royal Government to these principles.

The wise and conservative environmental policies have rendered Bhutan as the only country in the region that has been able to increase the area under forest cover from 64 % in the early sixties to 72.5 % now. 26.23 % of the total land area representing all climatic and Biodiversity zones is under protected area management, protecting an unknown number of species and Flora and Fauna and invaluable genetic material. Bhutan can boast of an environment which is still largely intact and in its pristine state. There is also national consensus for conservation and preservation as

was aptly demonstrated in 1995 when the 73rd session of the National Assembly mandated that the country must maintain not less than 60% of the country under forest cover for all times to assure that long term sustainability takes precedence over short-term economic gains.

The unspoiled ecosystems of Bhutan hold a reservoir of invaluable genetic material. Although we do not yet know the full identity or value of this material, we certainly know that it cannot be replaced if it is destroyed. The unusual weather conditions which can accompany global warming, besides other disasters, can significantly affect species of wild plants and animals, lead to major shifts in the balance of important ecosystems. The global community cannot afford to ignore this prognosis. But Bhutan is in a particularly favourable position to conserve our Biodiversity in the face of possible climate change, since our protected areas provide extensive and unbroken links from lowland subtropical zones to the highest alpine zones.

Bhutan has adopted the Rio Declaration on Environment and Development and is a signatory to both the Rio Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. As a follow-up to our commitment made at Rio de Janerio, the National Assembly ratified these Convention during its 73rd session in 1995. In supporting these conventions, Bhutan has committed itself to protecting the many rare, endangered and endemic species within its borders and upholding a national, regional and global responsibility. Bhutan, with other parties to the Convention on Biological Diversity has initiated actions within our means to address the concerns expressed in Rio. Including actions to translate the ideals of the Convention into Action. Bhutan is also the first country in the world to create a Trust Fund dedicated to environment protection.

As we work to create a future where our pristine environment is still intact, scientific knowledge and technological expertise will be crucial. Nothing, however, will be more important to human well-being and survival than the wisdom to appreciate that however, great our knowledge, our ignorance is also vast. In this ignorance we have taken huge risks and inadvertently gambled with survival. Now that we know better, we must have the courage to be cautious, for the stakes are very high. We owe that much, and more, to our children.

This Biodiversity Conservation Strategy and Action Plan provides a framework for action that will enhance Bhutan's ability to ensure the productivity, diversity and integrity of its biodiversity and natural systems, and as a result, its ability as a nation to develop sustainably. Our success in implementing this Action Plan will be determined, in large measure, by the degree to which all parts of society adopt its vision and principles and contribute to achieving its goals, and I call on the nation as a whole to wholeheartedly support this critically important endeavor.

C. Dorji
Minister, Planning Commission
Chairman, National Environmental Commission

KEY POINTS OF THE ACTION PLAN

The Biodiversity Strategy and Action Plan is organized into five chapters. The first two represent an inventory of what Bhutan has at present in terms of biodiversity and efforts to conserve and use it wisely. The last three chapters represent the Action Plan proper. On the basis of the information in the first two chapters, chapters 3 and 4 present the actions which need to be done to conserve and sustainably use the biodiversity. The last chapter presents options for actions which Bhutan can take to realize additional benefits from its rich biodiversity.

What follows is the summary of the key points in the Action Plan proper, chapters 3,4, and 5:

Chapter 3 - Direct Actions for Conservation and Sustainable Use
3A - Wild Biodiversity Resources

Protected Area System:

- **Complete the establishment and management of the protected area system which adequately protects the full range of the nation's ecosystems and species.**
- **Prepare guidelines for the preparation of management plans for protected areas.**
- **Accelerate the phased approach to preparing and implementing management plans.**
- **Complete the review of the biodiversity, biophysical and socioeconomic situations of the current protected areas.**
- **Review and evaluate progress under the management plans every year.**

Buffer Zones and Enclave Zones

- **Give priority attention to developing management strategies for buffer and enclave zones, around and in protected areas.**
- **Promote participation and involvement of local communities in conservation and development efforts and seek to bring them benefits from conservation and sustainable use of biodiversity**

Promote In-Situ Conservation of Wild Crop Relatives and Wild Plants for Food Production

Conservation Outside of Protected Areas

- **Continue and expand the Integrated Conservation and Development Projects, intended to bring development benefits to people who are inhabitants or who live in the vicinity of the protected areas; and monitor the results.**

- **Establish and implement sound forest management plans to assure that forests with their biodiversity are managed on a sustainable basis.**

Chapter 3B - Domestic Biodiversity Resources

Promote In-Situ Conservation

- **Develop a policy on introduction of exotic high yielding varieties which assures that the benefits of indigenous genetic resources are not lost to Bhutan.**

- **Survey and Inventory Crop Genetic Resources**

- **Support On-Farm Management and Improvement of Plant Genetic Resources**

- **Assist Farmers in Disaster Situations to Restore Agricultural Systems**

Promote Ex-Situ Conservation

- **Support Planned and Targeted Collecting of Plant Genetic Resources in Arable Agricultural Systems**

- **Expand Ex-Situ Conservation Activities, including Botanical Gardens, Field Genebanks and the Use of New Technologies.**

Chapter 4 - Essential Supporting Measures
Chapter 4A - Wild Biodiversity Resources

Scientific Research

- **Initiate a Major Program to Build the Scientific Knowledge Base on Bhutan's Wild Biodiversity.**

- **Undertake Research on Sustainable Use of Wild Biodiversity, including Identification of Threats, Collection of Traditional Knowledge, Needed Scientific Research, and Development of Comprehensive Management Programmes.**

Surveys and Monitoring

- **Undertake Wildlife Surveys to Obtain Adequate Ecological Information for Management within Protected Areas**

- **Conduct a National Aquatic Resources Survey, and On the Basis of the Results, Formulate Conservation Measures, Management Plans and Legislation.**

- **Design and Carry Out Monitoring of Biodiversity Status and Trends, Biological Conditions, Impacts of Human Activities, and Effect of Management Efforts.**

Databases

- **Develop and Establish A System of Biodiversity Databases.**

Land Use Planning

- **Assure that Comprehensive Land Use Planning Incorporates Biodiversity and As Necessary, Develop Enabling Legislation**

Economic Valuation of Biodiversity Resources

- **Develop Methodologies for Economic Valuation of Biodiversity Resources; Develop Local Capacity in Such Evaluation; Prepare Economic Valuation of Bhutan's Biodiversity.**

Incorporate Biodiversity in Related Sectors' Strategy and Planning

- **Assure that Biodiversity Considerations are Effectively Incorporated in Planning and Development of Forest Management Units (FMUs)**

- **Assure that Forest Management Plans are Strictly Implemented According to the Principles of Maintenance and Sustainable Use of Biodiversity**

- **Assure that Production Forests are Managed on Strict Sustainable Use Principles.**

- **Develop Ecologically Sound and Economically Viable Forest Based Industries.**

- **Accelerate Development and Implementation of the Program on Integrated Resources Management and Land Use Planning, and Assure that Biodiversity Conservation Concerns are Central to the Process.**

- **Assure that the Development of Ecotourism is Based on the Principles of Sustainability, Ecological Soundness and Cultural Acceptability.**

Strengthen the Institutional Framework Relating to Biodiversity.

- **MOA to Give Serious Consideration to Developing an Integrated National Biodiversity Programme; an Operational-Level Program and Mechanisms to Improve the Coordination, Efficiency and Effectiveness of Bhutan's Efforts in Biodiversity Conservation.**

Improve the Staff Capacity in Biodiversity Conservation and Sustainable Use: Expanding and Improving Training.

- **Develop a Realistic Long Term Vision of the Staff Which Will Be Required To Effectively Develop and Manage Bhutan's Programmes for Conservation and Sustainable Use of its Biodiversity Resources.**

- **Accelerate the Acquisition and Training of Staff within the Present Plans.**

- **Identify the Priority Needs and Seek Additional Funding for the Acquisition, Training and Recurrent Costs of That Staff.**

Assure that Biodiversity Conservation Brings Benefits to Local People.

- **Promote Social and Community Forestry Through Extension Programs**

- **Promote Proper Agro-Forestry and Agro-Silvo-Pastoral Techniques, and Build on Traditional Knowledge to Improve the Sustainable Benefits Local People Obtain from Biodiversity.**

Strengthen Biodiversity in Education and Awareness.

- **Review the Present Status of Biodiversity at the Various Levels of Formal and Non-Formal Education and the Religious Sector, and Develop New Programs and Materials as Necessary.**

Encourage and Augment International Cooperation in Biodiversity Conservation and Sustainable Use

- **Plan, Obtain Funding, and Carry Out a Policy and Technical Exchange on Biodiversity with Costa Rica.**

- **Actively Explore Possibilities for Debt for Nature Swaps**

- **Pursue Active Follow Up of the Biodiversity Action Plan with the Donor Community.**

Recognizing the Critical Importance Population in Biodiversity Conservation and Sustainable Use.

- **Incorporate Considerations of Population Growth and Movement in Biodiversity Planning.**

- **Provide all Possible Support to the RGOB Programs on Family Planning.**

Chapter 4B - Domestic Biodiversity - Plant Resources

Research and Information.

- **Develop Comprehensive Information Systems for Crop Genetic Resources.**

- **Expand Characterization, Evaluation and Number of Core Collections of Plant Genetic Resources.**
- **Increase Genetic Enhancement and Genetic Base-Broadening Efforts.**
- **Promote Sustainable Agriculture through Diversification of Crop Production and Broader Diversity in Crops.**
- **Promote Development and Commercialization of Under-Utilized Crops and Species.**
- **Support Seed Production and Distribution.**
- **Develop New Markets for Local Varieties and "Diversity-Rich" Products.**
- **Develop Comprehensive Policy and, as Needed, Legislation, on Domestic as well as Wild Biodiversity, Giving Consideration to Sovereignty over Biodiversity and Importing Exotic Biodiversity.**

Chapter 4B - Domestic Biodiversity - Livestock Resources

- **Develop and Conduct an Expanded Programme on Livestock Biodiversity Resources.**
- **Develop a Comprehensive Research Program on Yaks.**
- **Develop Extension Programmes on Biodiversity in Livestock; Develop Policy Guidelines to Promote Livestock Genetic Conservation; Develop Public Awareness Programmes.**
- **Improve Strategy and Planning for Livestock Genetic Conservation.**
- **Improve Health Services at Field and Laboratory Levels.**
- **Provide Support for** Feed and Fodder Development.

TABLE OF CONTENTS

ANNEXES

BIODIVERSITY AND ITS VALUES

Biodiversity

Biodiversity is a key part of a nations's natural patrimony. The Convention on Biological Diversity defines Biological diversity as "the variability among living organisms from all sources, including, inter alia, terretrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and ecosystems." Biodiversity is generally considered in terms of ecosystem, species, and genetic diversity. Biodiversity refers to all living organisms, and thus includes both wild and domestic species, terrestrial and aquatic.

The Role and Values of Biodiversity

It has become increasingly recognized that biodiversity is absolutely basic to human survival and welfare. The role of biodiversity in human affairs--and therefore its values to mankind--can be described as ethical, cultural, aesthetic, utilitarian, and ecological. Of course, these roles are not separate one from another. For example, the ethical and aesthetic roles are combined in Bhutan's culture, and the aesthetic interest in biodiversity drives much tourism, which can play a distinctly utilitarian role in many countries.

Ethical, Cultural and Aesthetic Values

The ethical, cultural and aesthetic roles are mentioned first because in Bhutan the Buddhist religion plays such a central role in peoples' lives and their entire culture, and nature--which in this sense is essentially biodiversity--is so central to Buddhism. The basic principles are to give back to nature what has been taken away and to respect all forms of life. Thus, in Bhutan, the ethical and aesthetic roles of biodiversity are integral components of the culture. In other countries, however, they may be more separate, yet the ethical concern for biodiversity can still play a major role.

In many industrialized countries there is a dramatically different culture and one in which religion plays a much less overt role than here. Yet many peoples maintain a strong ethic about biodiversity. This ethic can be described as a conviction that it is wrong to needlessly take life, or that since humans have the technological capability to exterminate other species, they also have an ethical responsibility to avoid doing so.

This ethic can also have important economic or utilization implications. For example, because of the public's strong ethical objection to killing baby seals, the import and sale of seal skins were banned in Europe, which had important economic effects in seal-producing countries such as Canada.

The Utilitarian Values

The utilitarian value of biodiversity is great. Biodiversity provides direct products such as food, medicines and timber along with genetic materials and chemicals for agriculture, medicines and biotechnology, It can also provide the basis for economically significant tourism. In Bhutan 85 percent of the public live in rural areas and depend directly on biological resources. Food, fibre, construction materials, clothing, fuel and medicines are a few of the biodiversity products in direct daily use. The same can be said for many other peoples throughout the world. Wild species provide a significant food source for peoples on all continents. But on a global basis the genetic diversity represented by wild species is of even greater importance. The need for wild genetic material to improve and diversify domestic crops, livestock, and other agricultural products and processes is well known. This utilitarian value of biodiversity, along with the recognition of its threatened status, was one of the important motivations for the Convention on Biological Diversity.

There are increasing efforts to achieve conservation and sustainable use of biodiversity in agriculture. Beyond assuring supplies for immediate use, the rationale for conservation of agro-biodiversity is to maintain the materials for use by future generations. In the proposal for the Bhutanese Agro-Biodiversity Project (RGOB 1996) it was noted that the conservation and utilization of agro-biodiversity will contribute to three primary areas in Bhutan: sustainable development, food security, and financial benefit. While these goals and contributions were described for Bhutan, they are also valid for most other countries throughout the world.

In Bhutan an estimated 300 species of plants and animals are used for medicinal purposes in forming nearly 200 different traditional medicines. The National Institute of Traditional Medicine has developed standardized preparations of many of these medicines and is making them available through traditional medicine clinics across the country. Various herbal products are also marketed and some are exported.

But biodiversity resources also are essential and are of great economic importance to industrialized countries and to urban dwellers throughout the world. It is estimated that a key component of over 80 percent of the modern medicinal prescriptions currently filled in the industrialized nations originally derived from wild biodiversity. New uses are continually being found for biodiversity, and some of these are of great economic value. This point is well illustrated by the volcanic hot springs in America's Yellowstone National Park. These springs have been found to harbor a variety of curious micro-organisms. These organisms are yielding genetic material with uses which range from developing bacteria which consume toxic wastes, to providing scientific insights into the

possibilities of life on Mars. One form already has earned several hundred millions of dollars from using these genetic materials in a process to identify DNA a basic building block in the genetic make up of humans and other animals.

Bioprospecting -- the search for new genes or chemicals of value in the pharmaceutical, biotechnology, or agriculture industries -- is a rapidly growing endeavour, and one which, as the Yellowstone example shows, can have immense economic benefits. However, bioprospecting in most developing countries must involve significant international exchange of biodiversity since these countries lack the technological capacity for complete product development. In view of this, bioprospecting falls under many of the provisions of the Convention on Biological Diversity, and in particular Articles 15 and 16 on Access to Genetic Resources and Transfer of Technology. If it is very carefully approached and with the protection of the Convention, bioprospecting may offer an opportunity for substantial economic benefits.

Ecological Values

At first thought ecological values this may sound academic and detached from the day-to-day business of living. However, wild species and the ecosystems of which they are components provide a number of ecological services which are of critical importance to human welfare. Forests regulate and ameliorate climates, maintaining conditions necessary for agriculture and other human needs. Forests and other vegetation provide watersheds, assuring sustained flows of clear water. Vegetation prevents erosion, soil slumps and landslides. Plants and various animals, including micro-organisms, create and maintain soil and its structure and fertility. Healthy ecosystems recycle nutrients. Birds, insects and some bats provide pollination for agricultural crops as well as wild plants. Many wild species are predators which help to control pests. Forests and other wild ecosystems play key roles in global cycles such as those of carbon and water. Vegetation absorbs or filters many air pollutants. And of course, ecosystem biodiversity provides the essential habitats for species and genetic diversity.

Forest biodiversity provides two particularly critical ecological services for Bhutan, erosion protection and maintenance of water discharge patterns. Bhutan's steep slopes would be particularly subject to landslides and erosion without the forests, with resultant severe impacts on settlements, agriculture, and hydropower. Forest cover also smooths out water flow to and in the rivers, reducing peak wet season flows and providing continuing flow during dry seasons. Loss of watershed vegetation creates a "tin roof' effect, with sudden run off in the wet periods and minimal flow in the dry, causing damaging floods, interrupted water supplies, and significantly impacting the operation and economics of hydropower developments. These results of lost ecological services are all-too-evident in neighbouring areas where the forest biodiversity has been lost.

THE BIODIVERSITY CONSERVATION ACTION PLAN PROCESS IN BHUTAN

PREPARATION OF THE BAP

On 19th November, 1996, the Royal Government of Bhutan initiated a project funded by the UNDP/GEF to enable the RGOB to develop a National Biodiversity Conservation Strategy with prioritized Action Plans, which will serve as an overall framework to consolodate, strengthen and improve its activites and programmes to conserve and sustainably utilize the rich natural biodiversity in Bhutan. In addition this project would also enable the RGOB to prepare its first National Report on Biodiversity to the CBD Conference of Parties (CoP) in 1997, thus fulfilling Bhutan's obligation to the CBD under article 26.

The Nature Conservation Section of the Forestry services Division within the Ministry of Agriculture was given the responsibility for coordinating the development of the National Biodiversity Conservation Strategy and Action Plan (BAP). This was because the Forestry services Division is the main governmental agency responsible for the execution of biodiversity conservation programmes as well as overseeing and enforcing measures to conserve and sustainably utilize the biodiversity resources of Bhutan.

Core Team ("Focal Persons")

A core team was formed comprising of

- Mr. T N Acharya (Crop and Livestock Division),
- Mr. Karma Tsering (Research Extension and Irrigation Division)
- Mr. Tenzing Dhendup(Research Extension and Irrigation Division)
- Ms. Durga D Sharma (NCS, Forestry Services Division)
- Mrs.Deki Yonten (NCS, FSD)

Each Person played a key role in developing the BAP. This was a nearly full time assignment from mid-January to end June, 1997.

Task Force

Individuals from other Ministries, NGOs and the UNDP were also nominated as members of a Task Force, which served as a steering committee and acted as a forum for consultation, discussion, review, analysis, and coordination for the development of the Strategy and Action Plan. The Task Force Members were:

- Kunzang Norbhu, Planning Ministry
- Karma Nyedrup, National Environment Commission
- Dorji Thinley, National Institute of Traditional Medicine
- Ugen P Norbhu, World Wildlife Fund
- Kunzang Yonten, Royal Society for the Protection of Nature
- Thinley Wangchuk, Ministry of Trade and Industries
- Sonam Tobgay, Tourism Authority of Bhutan

- Gyem Tshering, Bhutan Chamber of Commerce and Industries
- Chhador Wangdi, Ministry of Health and Education
- Ugen Norbhu, Ministry of Finance, NBACD.
- Tenzin Doji, United Nations Development Program
- and more from the Ministry of Agriculture

National Workshop

On January 13, 1997, a one day National Workshop was convened in Thimphu to discuss the approach to be adopted in the preparation of the National Biodiversity Conservation Strategy and Action Plan. An outline of the National Biodiversity Strategy and Action Plan prepared by the consultant Dr. L M Talbot was reviewed and Terms of References for the Coordinator, Focal Persons and Task Force Members were also discussed.

This workshop was immediately followed up with a meeting of Biodiversity Task force Members to discuss the Terms of Reference for Focal Persons as well as devise course of action and future programmes for the core team. The team was given the responsibility of identifying, collecting and reviewing existing reports and plans that should be included in or can contribute to the National Biodiversity Conservation Strategy and Action Plan to fulfil any of the requirements for the plan while avoiding unnecessary duplication or effort. One means of collecting the information required for the BAP as well was through familiarization tours through the country meeting the relevant persons.

Regional Workshops

In an effort to ensure broad participation of all stakeholders and well as encourage constructive contributions to the BAP, a series of regional workshops was held throughout the country as per the following
12-14 March, 1997: Conducted Regional Workshop in Paro
19-2 1 March, 1997: Conducted Regional Workshop in Bumthang
24- 26 March, 1997: Conducted Regional Workshop in Trashigang
The fourth workshop to be held in Sarpang was postponed as per directives received from the Government.

The workshops provided a mechanism for consensus building and information gathering, and their specific purposes were

- to provide a forum for participation for local people who use, affect, study and conserve biodiversity, in order to assure a wide participation in the BAP process
- to assure the differing needs and perceptions of people from different regions is incorporated in the BAP process
- through local participation, to seek to build understanding and support for the BAP
- to compile information from the different regions to assure that the BAP reflects differing conditions in the differing parts of the country.

Participants: To achieve the objectives the workshop organisers tried to seek the widest participation from groups using and affecting biodiversity. These included:

- representatives of the local people such as Gups, Chimis and MangiAps from each Dzongkhag,
- Divisional Forest Officers,
- District Agricultural officers
- District Animal husbdary Officers
- Dzongkhag Forest Extension Officers
- selected District Education Officers
- Research Officers from the Renewable Natural Resource Centres
- selected Dungtsos
  Lecturers from the Bhutan Forestry Institute for Forest Guards, Natural Resource Training Institute, Sherubtse College
- Project Officers,
- as well as users like sawmill owners, paper industry owners, .

Task Force Members were invited to join the core team at various stages in the tour and participate in at least one workshop. This would provide a better insight and understanding of the BAP process for the Task Force Members as well. The workshops were organized and conducted by the BAP core team comprising of the Coordinator and Focal Persons.

Workshop process

Since the objective was to both gather information as well as seek to build consensus, the workshops were structured so as to encourage a maximum local participation. The workhops were informal with no papers 'read'. Each workshop began with an explanation of the terms 'Biodiversity, Sustainable Development, the importance of conservation, the Convention on Biological Diversity and the country's obligations to the CBD. Participants were divided into four groups each dealing with

(a) Forestry,
(b) Livestock/Pastoral,
(c) Arable-Agriculture/Horticulture,
(d) Wetlands/Freshwater. Based on the recommendations by the participants during the first and second workshop two more groups were formed in the third workshop dealing with
(e) pasture and grazing and
(f) wildlife.

The group discussions which were held for two days dwelt mainly on:

- the status of biodiversity (varieties known to participants), their special significance whether religious, cultural or otherwise
- any existing threats to the biodiversity, or from the use of biodiversity
- distribution of species

- status of wild biodiversity
- uses of biodiversity, sustainability of these uses,
- existing conservation measures currently in use in any region,
- conservation action that may be required for the future
- any conflicting issues and
- recommendations to the government

The local representatives were very keen to share their knowledge with the other participants and were very forthcoming during the discussions. Many of the final presentations of the group discussions were done by the local representatives themselves. A Task force meeting was organized to present and discuss the findings of the regional workshops and discuss further actions required. There was a general consensus that the fourth workshop which was postponed should be conducted sometime after the BAP has been prepared since it was necessary both for the sake of data collection as well as for the purposes of creating awareness.

Based on the findings of the regional workshops, the Forestry Services Division nominated a small working group to discuss the issues raised and come up with solutions or actions for recommendations that came from the workshops.

In late May and June, 1997, a series of meetings of the Focal Persons and Consultant were held to review progress and compile the draft BAP on the basis of the materials collected, prepared and drafted by the Focal Persons. The draft was assembled from sections drafted by each member of the Core Group. The draft was subsequently reviewed at a meeting of the Task Force and submitted to a final National Workshop.

Final National Workshop

A final National Workshop was held on 17 June to present and discuss the Draft National Biodiversity Conservation Strategy and Action Plan. The draft was then revised in accordance with the workshop recommendations and submitted to Government for approval.

FOLLOW UP - THE BAP AS A LIVING DOCUMENT

The BAP is a living document. It is an ongoing process, not a one-time document to be noted and set aside. The BAP provides a framework for action that will enhance Bhutan's ability to ensure the productivity, diversity and integrity of its biodiversity and natural systems, and as a result, its ability as a nation to develop sustainably. However, unless it is used and implemented; unless it leads to action, it will not be successful. Further, conditions are changing. Bhutan is developing; its population is rising; knowledge and understanding about biodiversity is increasing; and the nation's ecosystems are in a dynamic state. The successful achievement of some of the goals in the BAP will

themselves change conditions. Consequently, the BAP must be a dynamic document which, itself, changes to reflect these changes.

As a result, the BAP is an ongoing process of

- defining goals and action to attain them;
- monitoring the actions to see that they are carried out;
- assessing the success of the actions, both administrative and in the field;
- determining what changes are required in the Action Plan itself;
- making those changes; and
- repeating the cycle.

Assessing the progress of implementing the BAP will require establishing goals, standards against which progress can be measured. The first-order goals would be the achievement or progress on the actions and objectives specified in the BAP. The second-order goals would involve, for example, the status and trends of key species, habitats and ecosystems -- which themselves indicate the ultimate success of the BAP process -- and these in turn would require the development of indicators and indicator criteria (see Annex). This process will be relatively crude initially, given the present state of scientific knowledge about Bhutan's biodiversity. But with time and the achievement of key goals of the BAP, the process will become significantly refined.

Experience with BAPs in other countries has shown that it is important to monitor, evaluate and revise the BAP within a year of its approval by government. Such initial reevaluation and revision will be particularly important in Bhutan's case. This is Bhutan's first effort of this type; as noted above the document was prepared from separate parts of drafts prepared by different people; and the time available was short. Consequently some areas of biodiversity have received more complete attention than others, and some, such as microflora, are not yet covered. Therefore it is anticipated that relatively significant revisions may be required at the time of the initial reevaluation and revision.

Thereafter such action should be taken annually and timed to precede each Conference of the Parties to the Convention on Biological Diversity, so that the results of the evaluation can serve as the nation's report to that conference, as required by the Convention.

If they are properly carried out the periodic evaluations of the BAP can serve as a report on the state of the nation's biodiversity. Such a report can be of great value both to the government and to the general public, and as such it can help build continued support for biodiversity conservation.

Consequently, it is envisioned that the Minister of Agriculture should: (l)Assign the responsibility and authority to conduct the periodic monitoring, evaluation and revision of the BAP; (2)Assure that the results of the evaluation and revision would serve as the

basis of Bhutan's regular reports to the Conference of the Parties to the Convention on Biological Diversity; and (3) Cause the results of the evaluation to be published as a periodic "State of Bhutan's Biodiversity" report to the nation. It would be the most efficient use of staff time and experience to assign this responsiblity to the same Core Croup and Task Force which has prepared the original BAP.

INTRODUCTION

BRIEF DESCRIPTION OF BHUTAN

The Kingdom of Bhutan is situated on the southern slopes of the Eastern Himalayas. It is landlocked between China in the north and India to the east, south and West. It covers and area of 40,076 sq. km (LUPP, 1995) and has a population of 600,000 (UNDP, 1997). Its physical feature is characterised by high-rising, rugged mountains and an intricate network of deep valleys, ravines and depressions earmarking water-courses, drainage basins, water-falls, human settlements, glacial lakes and moraine. The components of its biotic feature is as diverse as its geo-physical elements, broadened further by the consequent climatic attributes. Through this natural endowment, the Kingdom has acquired special significance at the global level with regard to biological diversity.

Bhutan is one of the least densely populated country with 85% of the people living in rural areas (NEC, 1997). Human settlement pattern is determined by the local topography and areas with agriculture and business prospects. The population is growing rapidly at an estimated rate of 3.1% per annum (NEC, 1997, Health Survey, 1994). Updated estimates of land cover based on the analysis of 1989 satellite imagery, showed that forest accounted for 72.5% (includes 8.1% of scrub forest) of land area. Cultivated area accounted for 7.8% of the land cover and includes cultivated wetland, dryland and horticulture, Tseri/Fallow rotation, mixed cultivated land and others. Table 1 shows percents of classified land cover and the proportion of arable land under different production systems.

Table 1. Land cover figures and areas under different farming systems

Land Use	Area (km^2)	%
Forest	25,787	64.4
Scrub Forest	3,258	8.1
Pasture	1,564	3.9
Agriculture	3,146	7.8
Snow & Glacier	2,989	7.5
Water Spread/ Marshy	339	0.9
Rock Outcrop	2,008	5.0

Agricultural Land	Area (km^2)	%
Cultivated Wetland	388	12.3
Dryland/Horticulture	977	31.1
Tseri/Fallow-Rotation	883	28.1
Mixed Cult. Land	840	26.7
Other	58	1.8
TOTAL	3,146	100

Other	985	2.5
TOTAL	40,076	100

The development in Bhutan is guided by the principles which emphasize the need to ensure the preservation of natural and cultural heritage, and that development from a subsistence to more modern economy proceeds on a sustainable manner. The Renewable Natural Resources (RNR) sector of the Royal Government of Bhutan (RGOB), represented by the Ministry of Agriculture (MOA), covers agriculture, livestock and forestry. Although the economy has been diversified, the RNR sector remains the single-most important sector accounting for 42.8% of the Gross Domestic Product (CSO, 1990). It is estimated that arable agriculture and horticulture production account 53% of the sector output. More than 85% of the population depend on agriculture for their livelihood.

BHUTAN'S UNIQUE APPROACH TO CONSERVATION AND DEVELOPMENT

His Majesty King Jigme Singye Wangchuck has stated that "Throughout the centuries the Bhutanese have treasured their natural environment and have looked upon it as the source of all life. This traditional reverence for nature has delivered us into the twentieth century with our environment still richly intact. We wish to continue living in harmony with nature and to pass on this rich heritage to our future generations"(RGOB, 1996). The Royal Government of Bhutan (RGOB) and its people have implemented this goal, and have set up policies and programmes which forego short term profit at the expense of long term loss of its biodiversity heritage.

According to both Buddhist and pre-Buddhist philosophies, the mountains, rivers, streams, rocks and soils of Bhutan are believed to be the domain of spirits. The Buddhist respect for all living things has led to the development and adoption of ecologically friendly strategies -- a solid foundation for a National Biodiversity Conservation Strategy. This, coupled with the Buddhist tenet that the acts of this life will be rewarded or punished in the next, provides a powerful motivational principle for sustaining Bhutan's natural resource base including its outstanding biodiversity.

In accordance with these principles, RGOB has placed primacy on conservation of Bhutan's natural resources, when formulating development and economic policies. (Paro Resolution 1990, RGOB, 1991, NEC, 1993, FSD, 1995), Cognizant of the environmental disasters in neighbouring countries as a result of development policies that largely ignored the inevitable consequences of environmental backlash in favour of quick economic returns. Bhutan has opted to pursue a cautious and environmentally friendly approach to development. This approach has been embodied within the Forest policy of Bhutan 1992. Although the policy recognizes the need for the use of forestry resources, such use will be guided by principles of sustainability . Thus, priority has been place on conservation, with purely economic benefits relegated to a secondary role.

Conservation is not a new concept to the RGOB and the people of Bhutan. A religious and culture ethos based on a philosophy that values all life forms- Buddhism- has fashioned a life-style that is very much conservation oriented (Bunting and Wangchuk, unpubl, RGOB, 1991, FSD, 1995). Bhutan had established an extensive system of protected areas, including wildlife sanctuaries and nature reserves by 1978.

Since then the RGOB has, among other actions:

a. identified and notified nine protected areas representative of Bhutan's diverse ecosystems, comprising over 26 percent of the country's land area.
b. pledged to maintain 60% of Bhutan's land under forest cover.
c. included provisions for establishing protected areas and conservation regulations in the Forest and Nature Conservation Act, 1995
d. established the nature conservation section with a mandate to oversee and manage the protected areas system and conserve Bhutan's biological diversity into the future
e. established the Bhutan Trust Fund for environmental conservation to provide a long term source of funds for conservation and related activities.

In spite of the many challenges which Bhutan faces, and the limited economic opportunities, the RGOB has made it a policy to avoid over-exploitation of its forests and minerals. The RGOB has instead chosen to forego immediate economic gains and has placed a higher priority on the conservation of natural resources. The Royal government has continued to take steps to strengthen its legislation and adopt policies which reflect the significance it places on long term conservation of Bhutan's biodiversity.

A Buddhist Perspective on Environment and Conservation.

Buddhism, the state religion of Bhutan, teaches respect for all life forms. The Buddha taught his followers to cultivate boundless love towards all beings in the manner a mother would protect her only child at the risk of her own life. Such a philosophy is the basis of the Bhutanese cultural fabric.

The four great events in the life of the Buddha took place under the trees - his birth, his enlightenment, his first teaching in the Deer Park of Saranath and his passing away. The Buddha taught to love all beings just as a tree that provides shade even to the axe-man that comes to cut it.

The crux of the Buddha's teaching is "Tendrel Gi Choe" or the interdependence among all life forms. In the continuous cycle of birth and death, there is not a single being that has not been, at one point of time or another, our mother. Therefore, the Buddha taught to respect all life forms in a manner we respect our mother.

The physical form, according to Buddhism, consists of four elements - earth, water, fire and air. There are same corresponding elements in nature which is directly linked to the elements of the physical forms. Therefore, if the elements within the life

form are to be pure, then there must necessarily be environment where the same elements can be found in their pure state.

Buddhism is all about the growth of the human mind so that it can achieve the highest level of wisdom. The stories of Buddhist saints and sages are replete with examples of how they moved to nature's wilderness once they have acquired adequate level of academic proficiency in the Dharma. It is because the profoundity of nature - its richness, its wilderness, its diversity etc. - helps to stimulate the loftiness of his own thoughts.

In the day- to- day life of the Bhutanese, certain deities such as Lha (deities of the heaven above), Tsen (deities of the mountains), "Lu (beings of the underneath world) and Sadag (deities of the land) are worshipped and evoked. The practice comes from our society's deep respect for nature and its environment. There is a fervent belief that if we pollute the heaven above, the mountains in-between and the land below, we are bound to suffer the wraths of their respective deities. So concern for environment is found deeply embedded in our beliefs and day-to-day activities.

It is because of the rich Bhutanese culture which is pro-nature backed by sound environmental policies of Royal Government and far sighted vision of His Majesty the Ring, that Bhutan is able to sustain its biodiversity-base in all its grandeur, complexity and multiplicity which in turn has immensely contributed to the happiness and well being of the people of Bhutan.

ORGANIZATION OF THE BAP

The Biodiversity Conservation Action Plan for Bhutan is organized into five chapters, The first two represent an inventory of what Bhutan has at present in terms of biodiversity and efforts to conserve it. The last three chapters represent the Action Plan proper. On the basis of the information in the first two chapters of the BAP, chapters two and three present the actions which need to be done to conserve and sustainably use the biodiversity. The last chapter presents options for actions which Bhutan can take to realize additional benefits from its biodiversity.

Chapter 1 focusses on the biodiversity itself. It provides an inventory and assessment of what is known about the biodiversity, its status and trends, its special features and significance, the threats to it, and the urgency of conservation and sustainable development.

Chapter 2 focusses on what is being done to conserve or sustainably use the biodiversity. It describes what is being done, evaluates the strengths and weaknesses and identifies what are the areas where more needs to be done to improve the situation.

Chapter 3 is the first part of the Action Plan proper. It specifies the direct actions needed for the conservation and sustainable use of the biodiversity itself, covering ex-situ and in-situ measures including protected areas, and biodiversity outside of protected areas.

Chapter 4 specifies the measures which are essential to support the direct actions described in Chapter **3.** These essential supporting actions include measures such as policy and law, institutions, research, capacity building and public awareness.

Chapter 5 presents options for actions (additional to and in more detail than those in the previous two chapters) which Bhutan can take to realize additional substantial but sustainable benefits from its biodiversity resources. The actions covered include such areas as ecotourism, bioprospecting, and carbon storage.

"Wild" and "Domestic" Biodiversity and Integration within the RGOB

Throughout the BAP the material is presented in terms of *Wild Biodiversity* and *Domestic Biodiversity.* This is done to facilitate presentation for several reasons. The Convention on Biological Divesity draws such a distinction, defining *Domestic or cultivated* species as species in which the evolutionary process has been influenced by humans to meet their needs. The RGOB administration, agencies and programmes are specific to wild or domestic biodiversity. Also, in most cases the species are different.

However, there is actually often no clear dividing line between the two. Wild relatives of domestic crop plants may have great significance to domestic agriculture. The use of wild species for purposes such as food, medicine, construction, and fuel is an integral part of the life of much of Bhutan's population. And both wild and domestic species are dependent upon the ecosystems and habitats of which they, in turn, are integral parts.

Further, this division does not reflect the integration which the RGOB has sought to accomplish through the creation of the RNR sector (see above).

CONSERVATION AND SUSTAINABLE USE

The main objectives of the Convention on Biological Diversity are the conservation of biological diversity, the sustainable use of its components, and the sharing of the benefits. Although *Conservation* is often used in the broader sense of including protection and sustainable use, in this BAP we have maintained the distinction of the Convention, with the caveat that *conservation* in the Bhutanese context does not exclude sustainable use.

There is much confusion about the definition of *Sustainable use.* In the Convention on Biological Diversity, *sustainable use* is defined as the use of components

of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

In practice there are several components of the definition of *sustainable use* which must be considered together. These include:

- **Sustainability of the yield** of a particular consumed biodiversity product, such as timber, medicinal plants, domestic crops, etc.

- **Sustainability of the ecosystem** on which the consumed biodiversity product depends, as opposted to a plantation or cropped field. That is, it may be possible to sustain timber harvest in some conifer trees but in the process the forest has been transformed from a forest ecosystem with rich biodiversity to the equivalent of a plantation with very limited biodiversity -- so there is a basic difference between sustainability of wood production and sustainability of the natural ecosystem with its Ml biodiversity and the benefits (including those of ecosystem services) which the natural ecosystems provide for humans.

- **Long term sustainability considerations.** There are long term sustainability issues which often are overlooked. It is often argued, for example, that logging only a small percentage of a forest annually has little effect in any one year and therefore is sustainable. But after some years the small percentages can add up to 100 percent, and the original, mature ecosystem is lost.

- **Lateral considerations.** As far as we know, each species plays some role in the ecosystem, and it has a set of relationships with other species. Some are predators, some are prey providing food for others, some tree or other plant species provide shelter or food for other plants and animals. Therefore, harvesting any species, plant or animal, from an ecosystem will have some effect on the other species (including threatened ones) which make up the ecosystem. Removing prey species may leave predators without natural food, so they may starve, or shift to domestic livestock. Removing “keystone species”, i.e., species which play a key role in maintaining the ecosystem, may cause the collapse of the ecosystem even though only one species was removed.

- **Sustainability of Ecosystem Services.** Sustainability of an ecosystem includes sustainability of the ecosystem services which the ecosystem provides for humans (and others). Ecosystem services include maintenance of watersheds, control of erosion, climate amelioration, provision of critical habitats for other life forms, development of soils, so the impact of use on these services is another consideration in determining the sustainability of use of any component of the ecosystem.

- **Sustainability of non-consumptive uses.** Non-consumptive uses (i.e., uses which do not remove individual species, e.g. trees, from the system) are assumed to be

sustainable because they are not believed to have an impact. However, this is not necessarily true. Tourism is an example of non-consumptive use of biodiversity, but even though tourism is non-consumptive it may have a significant impact on the biodiversity.

CHAPTER 1
THE STATUS OF BIOLOGICAL DIVERSITY IN BHUTAN

OVERVIEW OF BIOLOGICAL DIVERSITY IN BHUTAN

Bhutan has very high levels of biological diversity at the ecosystem, species and genetic levels. Bhutan's biological diversity is matched by very few countries in the world, and fewer still have taken such strong steps to conserve their biodiversity. Bhutan ranks in the top ten percent of countries with the highest species density (species richness per unit area) in the world, and it has the highest fraction of land in protected areas and the highest proportion of forest cover of any Asian country. The other countries in the region have taken less action to conserve their biodiversity and they face far greater threats to what they have left. Bhutan is one of a very few biologically diverse countries in the world which have the opportunity to maintain its biodiversity largely intact in the coming decades (Reid, 1996).

TERRESTRIAL ECOSYSTEM DIVERSITY

Bhutan has great diversity of ecosystems partly because of its location at the juncture of the Palearctic realm of the temperate Euro-Asia and the Indo-Malayan realm of the Indian sub-continent, and partly due to the country's great geological relief and climatic heterogeneity. Valleysin the inner mountsins receive less than 800 mm of precipitation, while rainfall in the lowlands is as high as 5,500 mm. The country includes a range of ecosystems from sub-tropical forests in the south at an elevation of 150 meters to mid-elevation temperate forests, to the northern alpine zone above 7,000 meters.

While there are few areas of the country which have not experienced some human activities, most ecosystems remain substantially intact. According to the latest land use survey, conducted by the Land use planning section (LUPP), MOA, the total land area under forests was 29.045 km2 or 72.5 % of the country. Out of this total, 8.1% or 3, 258 km2 have been classified as degraded forest or natural scrub forest. Coniferous forests constitute 26.5% broadleaf forests 34.3% and 0.2 % are under plantation.

The Interaction of topography, climate and human use has resulted in the development of a complex pattern of vegetation and habitat types over Bhutan. Although there are land cover maps, there is no country-wide inventory of ecosystems as such. However, it is possible to provide an idea of their range using survey information from eastern Bhutan (ranging from approximately 200 to 3,800 meters elevation) and from the Jigme Dorji National Park in the northwest (ranging from approximately 1,400 to over 5,500 meters elevation).

Eastern Bhutan:

Information on current forest cover in Eastern Bhutan, based on 1:50,000 scale SPOT imagery (1989-90), aerial photography and field verification, has been mapped at 1:50,000, 1: 100,000 and 1: 250,000 scale, and also is maintained in GIS format (LUPP 1994, Laumans 1995b). according to this information, natural forests (42.2%) cover an estimated 69.7% of Eastern Bhutan, with broad-leaved forests (4.1%) . An additional 8.2% is covered by scrub forest. Other natural cover types of importance in Eastern Bhutan are perpetual ice and snow (4/7%) natural pastures (2.4%) rock outcrops and other unvegetated areas (2.1%), and floodplains.

The land cover classification used by LUPP also provides additional detail on main species composition and crown cover of conifer forests, and on crown cover(but not species composition) of broad-leaved forests (LUPP 1994). Natural forest types occurring in Eastern Bhutan and the project FMUs can be classified in more detail as follows (based on Grierson and Long1 983) and Sargent(1985), supplemented by observations during March-May 1995

Sub-tropical forest. Largely deciduous(broad-leaved) forests, developed under a dry winter/summer monsoon climatic regime with relatively heavy rainfall (2000-5000mm/annum) and contain many tropical genera and species. Confined to low altitudes (200-1000m), primarily on the hills and in the river valleys of the south. Cleared for timber and agriculture in accessible areas.

Warm-broad-leaved forest. Contiguous to the above, but at higher altitudes(1 OOO-2000m) with lower rainfall (2300-4000mm), having fewer tropical and more temperate genera, and occurring far into the interior along deep river valleys. Often cleared to produce grazing.

Cool Broad-leaved forest. Found on moist slopes above (altitude 2000-2900m) warm broad-leaved forest, under an annual precipitation regime of 2500-5000mm. This is a mixed deciduous/evergreen forest characteristically having a dense growth of shrubs, climbers and epiphytes. Currently being logged in Korila FMU and due to its mix of species and tall growth form may be targeted for logging elsewhere.

Evergreen Oak forest. Also found on slopes above (altitude 2000-2600m) warm broad-leaved forest, but under a lower annual precipitation regime (2000-3000mm) than cool broad-leaved forest, with which it intergrades. Evergreen Castanopsis and/or Quercus species predominate. This forest type is heavily utilized for livestock grazing and for fuelwood.

Chir pine(*Pinus roxburghii*) forest. A low altitude (900-1800m) xerophytic forest type occurring in deep, dry valleys, in Eastern Bhutan primarily along the Kuri chhu and kulong/Dangmechu systems, essentially under subtropical conditions. A long dry season is characteristic of these areas, the annual precipitation of 1000-1300 m falling primarily during the summer monsoon. Chir pine forests are much influenced by human

activities, including tapping for resin, felling for timber, and frequent ground fires that are deliberately set to produce fresh grazing for livestock and to produce new lemon grass growth, which is harvested for essential oil production.. Although the pines are resistant to burning, frequent fire has severely damaged stands in some areas (e.g. eastern Korila FMU)

Blue Pine ***(Pinus walliciania)*** forest. The temperate equivalent of chir pine forest, occurring at higher altitudes (2100-3000m) and under drier conditions(700-1200mm annual precipitation), but under similar summer monsoon rainfall pattern in dry inner valleys, east to Tashigang District. Intergrades with evergreen oak forest, and higher altitudes with spruce, hemlock and fir forests. Very susceptible to fire but colonizes burned or disturbed areas.

Spruce ***(Picea)*** Forest and Hemlock ***(Tsuga dumosa)*** forest. These two forest types occur in the montane cloud forest zone between temperate broad-leaved forests and fire forests, generally at altitudes of 2700-3 100m often mixed together or with other coniferous or broad-leaved species. Hemlock forest apparently requires a higher precipitation (1300-2000mm) than spruce forest (500-1000mm), part of which is derived from mist condensation, and thus has a more luxuriant undergrowth of rhododendrons, ferns, lichens and bryophytes.

Fir(***Abies densa***) forest. This forest type is found in the highest forested ridges, between about 3 100 and 3800m. It requires relatively high precipitation (probably133+cm), part of which is obtained as condensation. Rhododendrons and other shrubs from a dense understorey. Fir forests have long selectively been felled in Eastern Bhutan for shingles. Cleared or disturbed areas of this forest type and adjacent hemlock forest revert to dense stands of bamboo, as in Khaling-Kharungla FMU where the resultant bamboo forest is now an important source of building materials.

Although nearly 70% of the area of Eastern Bhutan is currently covered by forest, or nearly 78% if scrub forest is included, a more relevant measure for the purpose of assessing the current state of biological resources would be forest condition. To our knowledge no such measures have yet been developed, although as noted above forests in Eastern Bhutan have long been used by humans and livestock, and the composition and structure of some types, notably evergreen oak forest and chir pine forest, have probably been widely influenced by this use. The 70% forest cover therefore includes significant but undocumented areas of degraded forest.

Another, indirect way of assessing the current state of forest cover is to put in the context of forest loss. If it if assumed that all the land in Eastern Bhutan except natural pastures, wetlands, perpetual ice and snow, and outcrops was once covered by forest, the previous extent of forest cover can be estimated as approximately 91% of land area. Based on these estimates, Eastern Bhutan has lost a maximum of 23% of its original forest cover via conversion to other land use/cover types.

North-western Bhutan (Jigme Dorji National Park):

Jigme Dorji National Park (JDNP) is characterized by a range of vegetation and wildlife habitats whose distribution is largely determined by elevation and aspect. Nine broad habitat types have been identified and mapped. Eight of these also represent distinct vegetation communities as described below:

Perpetual snow/glacier: Areas mostly above 5,500 meters.

Alpine scree slopes:: Areas close to snow line e.g., high passes, bases of scree slopes and loose rocks (4800 - 5500 m) characterized by very sparse (<5%) vegetation cover and resemble cold deserts in appearance. The vegetation consists of a few dwarf herbaceous plants such as species of *Draba, Corydalis, Saxifraga, Androsace, Arenaria, Lagotis,* etc; however, the rocky outcrops abound, in lichens such as *Thamnolia vermicularis, Geocarpus,* etc, and mosses.

Alpine meadows: The alpine areas, especially gentle slopes with stable soil between 4000 - 5000 m. which support species- rich herbaceous meadows. The plant communities vary according to stability of slope, aspect, moisture and degree of disturbance (e.g., overgrazing, burning, camping, and fuelwood collection). Important Plant communities of alpine areas include *Kobresia* sedge meadows, and the *Potentilla - . Geranium, Trachydium - Euphorbia stracheyi, Pedicularis - Primula - Juncus* communities. The alpine meadows.are known for a large number of valuable medicinal herbs some of which are dwindling due to over collection.

Most of the south facing alpine scrubs and adjacent meadows are heavily grazed by domestic livestock (yaks and horses) during summer. The moist meadows, interspersed by streams, are particularly preferred by yaks for grazing. The following species are typical of overgrazed alpine meadows: *Prunella vulgaris, Trollius acaulis, Primula sikkimensis, P. rosea, Carex nivalis, Rhododendron lepidotum, Senecio chyrsanthemoides, Polygonum viviparum, Plantago erosa, Taraxacum officinale, Euphrasia himalaica, Rumex nepalensis, Capsella bursapastoris, Scirpus* spp. Preferred palatable plants include *Cortia lindleyi, Trachydium roylei, Selinum vaginatum,* species of *Astragalus, Oxytropis, Polygonum, Sibbaldia, Festuca, Poa, Agropyron, Carex, Kobresia.*

Alpine Scrub: The area between timberline (ca. 3700 m) and alpine meadows (ca. 4200 m), characterized by scattered bushes of various species. Depending upon the exposure, (i.e., sunny vs. shady slopes), two distinct categories of alpine scrub vegetation can be identified in JDNP:

a). Alpine Dry Scrub: Nearly all the south and south-east facing slopes between the alpine meadows and timberline are dominated by various shrubby species such as *Ephedra gerardiana, Juniperus pseudosabina, Lonicera nzyrtillus, Rosasencea, Rhododendron lepidotum, Cotoneaster microphylla, Salix lindleyana, Chesneya*

nubigena, etc. These slopes are also preferred by domestic livestock for *grazing. 7hermopsis barbata and Rumex nepalensis* are the typical plants of overgrazed slopes.

b). Alpine Moist Scrub: All the shady moist slopes as well as valleys between 3700 - 4200 m support dense thickets of stunted trees and shrubs. Three distinct shrub communities can be identified and included in this category viz., riverine *Salix - Myricaria* scrub, dense krummholz (stunted forest) of *Rhododendron -Lonicera - Sorbus,* and Ericaceous dwarf shrub communities of bouldery areas above the kninunholz zone.

Sub-alpine forests: This zone (ca. *3300 - 3700* m) fomis one of the important ecological zones in the Himalayan mountains exhibiting characteristics of both temperate and alpine regions. These forests terminate at timberline towards the upper limit, forming its natural edge, and merges with cool temperate forests towards lower elevation. The following communities are the characteristics of sub-alpine forests:

a). Birch-rhododendron forest: Several species of *Rhododendron (R. hodgsoni, R. campanulatum, R. barbatum,* etc.), along with birch *(Betula utilize)* and occasional fir *(Abies densa)* form this community. The steeper areas with prolonged snow deposition causes the typical gnarled appearance of birch and rhododendrons.

b). Juniper woodland: Generally the south-facing subalpine slopes are dominated by juniper *(Juniperus pseudosabina)* woodland. These forests have relatively low tree species- diversity. However, the cover of mosses, shrubs and herbs is considerable. *Juniperus,* being a valuable timber and fuelwood species, gets cut and burnt frequently, thus reducing the forest cover every year. Common co-occurring species include *Rhododendron lepidotum, Gaultheria trichophylla, Phlomis spp., Thalictrum chelidonii.*

c). Fir forest: Though fir *(Abies densa)* is not a typical subalpine species, -- since it is found in association with other broadleaf and coniferous trees even at lower elevation (2500 m), -- it forms **a** considerable forest cover on northern aspect as high as the tree-line, interspersed by patches of birch, rhododendron, bamboo, etc. depending upon the canopy opening and site characteristics.

The subalpine forests also contain several rare and endangered herbs, including medicinal plants such as *Rheum australe, Aconitum* heterophylloides, *Pleurospermum angelicoides, Angelica glauca, Thalictrum* spp., etc.

Mixed conifer forest: The areas between ca. 2000-3300 m especially on rocky north facing slopes represents a mosaic of forests invariably dominated by pure or mixed conifer species. Fir, *(Abies densa),* is the most dominant at higher elevations (>2600 m). At lower elevations pure to mixed patches of hemlock *(Tsuga dumosa), Juniperus recur-vu* and spruce *(Picea spinulosa)* with varying degrees of association with broadleaf

species such as maples *(Acer caudatum, A. pectinatum, A. campbelli), Prunus. rufa, paks (Quercus spp-), Sorbus, Betula* etc. can be found. Larch, *(Larix griffithiana)*, is found mainly along ravines towards interiors of Pho Chu, Mo Chu and Pa Chu. The small patches of broadleaf species, bamboo brakes, and rhododendron thickets within the mixed conifer forests vary considerably in species richness and physiognomy, thus influencing the wildlife habitat. Large scale satellite image analysis coupled with extensive ground truth verification will be needed to map all the smaller categories described above.

Pine forests: Two species of pine, Blue pine *(Pinus waliichiana)* and Chir pine *(Pinus roxburghii),* are found in the middle elevations (1500-3000 m).

Chir Pine, which grows at lower elevations (1500-2200 m) is limited in JDNP, and is found in the lower Pho chu and Mo chu valleys. Characteristic shrubs in chir pine are *Budleja asiatica, Indigofera dosua, Rhus paniculata, Woodfordia frucosa..*

Blue pine forms extensive forests in lower westen part of JDNP (2200-3000 m). Being dry **these** forests are prone to fire and support mainly thorny species such as *Berberis spp, Prisipia utilis, Rosa sericea, Zanthoxylum armatum.* The ground vegetation is dominated by grasses.

Temperate broadleaf forests: Areas between 1400-3300 m along the major river valleys and gentle slopes, which support broadleaf forests. This belt is divisible into two zones:

a). Cool Temperate broadleaf forests: Usually above 2200 to 3200 m. These forests support a variety of broadleaf species, many of which are deciduous and include *Acer, Prunus, Sorbus, Betula ainoides, Carpinus viminea, Quercus semecarpifolia, etc.* The forests are rich in understory vegetation, such as several species of *Viburnum, Lindera, Rosa, Symplocos, Rubus, Euonymus, Rhododendron,* with occasional bamboo brakes *(Yushania maling, Y. hirsute, etc.).*

b). Warm Temuerate broadleaf forest: These forests are located in warm and moist valleys along the lower Mo Chu (1200-1500 m). Though limited in extent, these forests represent very distinct vegetation communities with characteristic evergreen elements of subtropical areas such as members of Lauraceae *(Persea, Litsea* spp.), Mdraceae *(Ficus* spp.), Euphorbiaceae *(Macaranga, Daphniphylium himalense, Bischofia javanica), Quercus glauca, Toricellia tillaeafolia, Mussaenda roxburghii, Schima wallichii, Aiangium chinense, Engelhardia spicata etc.*

Riverine vegetation: Narrow belts all along the perennial rivers and streams **(1400-4200 m) support this vegetation.** The characteristic communities are as follows:

a. Hippophae - Myricaria :	*4000-4200* m.
b. Willow scrub :	2000-3600 m.

c. *Debregeasia-Boehmeria-Ficus*. mixed: <2000 m.

Wildlife Habitats

The characteristic use of habitats by the wildlife of JDNP are given below, It is noteworthy that some species use very narrow range of habitats. For example, tigers, snow leopards, Himalayan musk deer, marmots, red panda and tragopans use a narrow range of habitat types, while others such as, common leopards, Himalayan black bear, sambar, wild boar, and wild dog use a wider range. Others, such as blue sheep and taken migrate between habitat types seasonally.

Alpine scree slopes are used only by a few mammal and bird species. Significant are blue sheep, which use these slopes for resting, particularly during summer season and snow leopards for stocking and resting.

The alpine meadows are used by snow leopards, marmots, blue sheep, Tibetan wolf and other north temperate species. The birds typical of this area include the snow pigeon, yellow billed chough, red billed chough, upland pipit, robin accentor, rufous breasted accentor, grandala, and Tibetan snow finch.

Alpine habitats are particularly important from their aesthetic, hydrological, and biological view points. Low productivity and increasing pressure from livestock in these areas warrant immediate action in terms of controlled grazing and habitat monitoring.

Alpine scrub form important habitat for blue sheep during winter. The moist alpine scrub and adjacent meadows along major river valleys are used by takin during summer. The birds characteristic to alpine scrub include red billed chough, fire tailed sun-bird, black red start, rose finches, red headed bullfinch, white winged grosbeak, and Juniper finch, although most of them are summer visitors.

Sub-alpine forests are used by a variety of manunals and birds such as Himalayan musk deer, serow, takin, blood pheasants, tragopans, and monal. Some of the rarer bird species characteristic to sub-alpine birchrhododendron forests include golden bush robin, gold crowned black finch and fire-tailed myzomis.

Mixed conifer forests occupy a considerable proportion of the habitat in JDNP, especially on steeper rocky slopes between elevations 2500 - 3300 m. The forests on south facing slopes being relatively drier are prone to fire and hence favour good grass growth which is utilized by goral and serow, as well as by domestic livestock. The shady, moist conifer forests are poorer in herbaceous and shrubby species, but are very rich in saprophytes. Most animal species use these forests as refuge during the day time.

Pine forests are rather extensive in southwestern parts of JDNP. Since these forests are close to human habitation and prone to disturbances from frequent fires, fuelwood and grass collection, wildlife abundance is low compared to other habitats.

Nevertheless, several rare species, including pheasants, partridges, and mammals such as goral, Himalayan yellow throated marten are known to occupy these habitats.

Temperate broadleaf forests covers a wide altitudinal range and support a large number of mammal and avian species. The old growth forests, with a variety of fruit-bearing trees and bamboo brakes, provides habitat for Himalayan black bear, red panda, squirrels, sambar, wild pig, barking deer, tiger, common leopard, and kaleej pheasant. This zone is also rich in oak species, most of which are highly preferred by local people for firewood and agricultural implements.

Riverine vegetation not only checks bank erosion but also provides critical habitat for several animal species. The alpine willow and *Hippophue - Myricaria* scrub, for example, serves as habitat for lynx and takin, and the lower riparian acts as dispersal corridors for tigers. Thus, the riverine forest habitat is of high conservation significance because; a) it acts as a habitat corridor for several species of wildlife, and b) it protects the river banks from erosion.

Species richness in various vegetation types:

T'here is a considerable amount of variation in the species richness both within and between habitat types. While a detailed analysis of plant species diversity and distribution is yet to be done, the following table (Table 2.20) shows a general trend of tree, shrub, and herbaceous species richness in various habitat types.

Table 2.20 : Average number of species per transect in various habitat types of JDNP (N = 3 transacts of 10 plots each).
WBL= Warm Temperate B/L, CBL= Cool Temp. B/L, MCF= Mixed Conifer,
SAF = Subalpine For, AS= Alpine Scrub, AM= Alpine Meadow.

	Habitat Type	Elevation Range (m)	Tree SPP	Shrub SPP	Herb SPP	Others	Total
1.	WBL	< 2000	22	18	16	14	70
2	CBL	2100-3300	13	12	10	17	52
3	MCF	2000-3500	14	16	16	13	58
4	SAF	3500-3800	4	5	30	6	45
5	AS	3 800-4200	1	l-6	46	18	81
6	AM	> 4000	0	6	38	9	52

* Others include ferns, climbers, epiphytes, etc.

The table shows that the tree and shrub species richness decreases with increase in altitude. The mixed conifer and cool temperate broadleaf forests show almost equal species richness, The striking feature of this data is a significant increase in the number of herbaceous species in alpine scrub. This is reasonable due to the removal of trees and shrubs which allows a large number of opportunistic (including weedy) species to occupy the area. The higher meadows, on the other hand, represent mainly herbs, sedges and a few grasses. Their number also declines with increase in altitude.

AQUATIC ECOSYSTEM DIVERSITY

Bhutan has different forms of aquatic habitats scattered throughout the country. A large number of high altitude lakes and the major river systems originate from the high Himalayas - a renewable water source. The waters from these rivers and lakes traverse from the northern mountainous region to the southern lowlands. The tremendous difference of altitude and the climatic contrast from north to south exhibits a wide variation of ecological conditions ranging from glacial or freezing lakes and streams to torrential cold waters of mountainous and hill region and slow flowing to stagnant eutrophic warm waters of lowlands. The fishes have also adapted to the diversified ecological conditions by establishing different forms, developing different feeding habits and also developing special organs to get attached on rocks or to absorb atmospheric oxygen to respire.

Bhutan's aquatic habitats are found throughout the various ecological zones. They range from glacial origin, perennial torrential rivers to seasonal rivulets or streams, high altitude lakes and springs to lowland lakes, swamps and marshy lands of river flood plains to paddy fields to manmade reservoirs to village ponds. In the near future a greater area of water surface is expected to be added from the implementation of a series of hydropower, irrigation and aquaculture development projects.

River System

Though this section is supposed to deal with the wetlands/freshwater there was no clear-cut demarkation with agriculture and forestry because both these activities also deal with the wetlands. This section made some effort to include the wetlands also in the discussions during the workshops.

Bhutan has a vast inland resources in the form of rivers and lakes. The Manas river system with a total length of 3200 km is the principal drainage followed by Sunkosh river (1810 km), Wang chu (610 km) and Amo chu (310 km). Besides these, Mangde chu, Badanadi and Jhumri chu (Dhansiri) are the other rivers which contribute to the overall drainages of the country. Barring Amo chu, Badanadi and Jhumri chu the principal tributaries of these river system are as follows:-

Sl.No.	RIVER SYSTEM	TRIBUTARIES
1	Manas river	1. Kholung chu 2. Tawang chu 3. Amrichu 4. Sheri chu 5. Kuri chu
2	Sunkosh river	1. Pho chu 2. Mo chu 3. Dang chu 4. Daga chu
3	Wang chu	1. Wang chu 2. Paro chu 3. Haa chu
4	Mangde chu	1. Chumey chu 2. Chamkhar chu 3. Tang chu 4. Mangde chu 5. Chendebji chu
5	Amo chu	--
6	Badanadi	--
7	Jhumri chu (Dhansiri	--

Lakes

A number of small and medium sized lakes are scattered throughout the country. All the lakes have not yet been surveyed both for its area, location and the flora and fauna. Studies need to be conducted for flora and fauna of the lakes. It is expected to find many endemic species of both flora and fauna of Bhutan.

Man-Made Reservoirs

There are only a few reservoirs in the country and the prominent one being the diversion dam for the Chhukha Hydropower. Not much of work has been done either to access its flora and fauna or to culture fish in the water body. Many more reservoirs are expected to be made in the near future as quite a number of hydro powers and irrigation facilities are either in the process of construction or included in the plan.

Government policy requireing mandatory environmental impact assessments with special consideration for biodiversity in the proposed power facilities is needed.

Village Ponds

Numerous village ponds are scattered all through the southern belt of the country and many more are expected to come up with the development plans to enhance the aquaculture production.

Irrigated Paddy Fields

The staple food of Bhutan being rice there are a lot of paddy fields scattered all over the country. Most of the paddy fields are filled with water for at least a few months during the monsoon. Traditional as well as modem irrigation system presently covers a considerable area of paddy field under irrigation.

Marshy Land

Besides the rivers, lakes and reservoirs it is also estimated that marshy lands in the form of depressions and water logged area constitute a considerable area in the country. Such aquatic habitats are rich in biota and also serve as good habitat for resident as well as migratory birds, reptiles, amphibians and fishes.

AGRO-ECOSYSTEM DIVERSITY (also see below under DOMESTIC BIODIVERSITY for a more complete discussion)

The country can be classified into agro-ecological zones based on the agro-climatic condition determined by altitudes, rain fall and the topography within three broad geographical zones: the Southern Foothills, the Inner Himalayas, and the High Himalayas.

The altitude of the country varies from around 150 m.s.l in the south to about 7500 m.s.l in the main Himalayan range. Based on this topography Bhutan has perhaps the greatest climatic diversity of any country of its size in the world. It ranges from hot and sub-tropical conditions in the south to perpetual ice and snow in the north. The central of inner Himalayan belt contains the major forested area of the country and enjoys temperate climate and vegetation. The vegetation also shows great variation depending on climate, topography, altitude, aspects and soils.

Livestock and associated farming systems differ from one agro-ecological zone to the other based on altitude, temperature and rainfall distribution.

There is great influence by the combined effect of climate, physiography and demographic pattern on agricultural activities.

a) Temperate zone

This zone covers cultivated area in high altitude (2500-4000m) with low rainfall, so dryland farming is mostly done. Livestock system is operated by nomadic yak herder. In this zone, livestock raising forms a predominant feature of the farming system. In particular, a small but distinct population of pastoralists maintain herds of yak and sheep on summer alpine pasture migrating down to about 3000 m before the snowline during winter. Horses, donkeys/mules and dogs also form part livestock living in this eco-system.

b) Warm Temperate zone

This zone falls between 1800-2500 meters sea level. Temperatures are slightly higher than temperate zone, although winter frost still occurs. This zone used semi-nomadic Siri and Mithun herders, who often have family links with the lower zone. They also keep pigs, poultry, dogs, cats horses and small ruminants. After the harvest of the crop cattle are allowed to graze on the crop stubble. Rice straw is used as winter fodder for the cattle. For a certain period during winter, feeding of crop-residues is the only alternative. However, due to severity of the climate at this elevation, majority of the farmers migrate to lower altitude in the south.

c) Dry Subtropical Zone

In this zone, temperature is comparatively higher than the other two temperate zones. Cattle are tethered on the paddy land and maize field after harvest mostly for manure. All other forms of domestic bio-diversity are found here.

To fertilise the field, cattle are tethered after maize harvest.

d) Humid and Wet tropical zone

These zones fall within 150-1200 meters above sea level altitudes and have excellent areas for crop cultivation. Fodder is scarce here. Hence, the cattle are tethered in cropping areas prior to preparation.

Livestock rearing in these zones is normally stationary. Cattle are kept for milk production and draught power. As these lands are mostly arable, the FYM or cattle manure is the ingredient of compost fertilizer to be used in the field.

Due to scarcity of fodder, maize fodder grown prior to rice and crop residues, which are mostly straw, are the fodder fed to cattle during winter. All other forms of domestic bio-diversity are present here.

SPECIES DIVERSITY -- WILD BIODIVERSITY

Plants

Bhutan has a very diverse flora with affinities to southeast Asia (mainly tropical taxa), China/Japan (temperate taxa), Tibet, the Euro-Siberian region, and the Arctic/alpine areas of Europe and Asia, and to a very limited extent to the floras of India and Sri Lanka (Grierson and Long 1983). Of the known 5,446 species of vascular plants, as many as 750 are endemic to the Eastern Himalayas and 50 or more are endemic to Bhutan itself (Grierson and Long 1983; Myers 1988; Sherpa et al, 1991; Yonzon 1992; FAO 1994).

No comprehensive description of the Bhutan flora is available yet, although the first five of ten planned parts of the Bhutan Flora Project have been completed (Grierson and Long 1983, 1984, 1987). The flora includes 50 or more species of rhododendrons and numerous species of economic value, including valuable timber trees, medicinal, aromatic, horticultural and ornamental plants and very many species that provide essential non-timber products to rural users (Grierson and Long 1983; UNIDO 1994; Dorji 1995). The Bhutanese flora is considered to be of great scientific value, both because of its biodiversity and because of its relatively good state of preservation compared to adjacent Himalayan areas (Grierson and Long 1983), although many taxa are now considered to be nationally threatened (WCMC 1995; Appendix 7)

Birds

Although Bhutan's avifauna is still poorly known, around 770 species have to date been recorded (MacKinnon 1991, RGOB, 1996). The avifauna includes both Indomalayan (tropical) and Palearctic (temperate) elements. Approximately 73% of the known species are resident. The remainder are summer visitors that breed in Bhutan but winter elsewhere, winter visitors that breed further north, passage migrants or vagrants (Inskipp 1995). Most of the resident species are altitudinal migrants (Inskipp and Inskipp n.d) that move between higher altitude breeding areas and lower altitude wintering areas.

Bhutan may support significant populations of at least 119 species whose breeding ranges are restricted to the area encompassing the Himalayas, northeastern India, northern Southeast Asia and southwestern China (Inskipp et al 1993). At least 12 of Bhutan's bird species are considered to be globally threatened (WCMC/IUCN 1994; Appendix 7) and 11 have worldwide breeding ranges of less than 50,000km2 (ICBP 1992), putting them at risk from any significant loss. Bhutan's temperate and subtropical broad-leaved forests are particularly important for bird conservation, as a high proportion of the area of these forest types remaining on the South subcontinent lies in Bhutan. The low altitude broad-leaved forests in the extreme south of the country support a particularly high diversity of bird species (Inskipp et al, 1993)

Mammals

Although Bhutan contains important populations of a number of mammal species of international conservation significance, including a wide variety of the large carnivores and herbivores that often provide a focus for conservation efforts (WCMC/IUCN 1994; appendix 7), in general the mammalian fauna remains poorly known. The National

Conservation Plan for Bhutan (Mackinnon 1991) provides a provisional list of 178 species based on predicted occurrence, including 24 internationally threatened species and 64 species that may be nationally endangered; however it needs to be emphasized that this is a provisional list and not a list of known species. A subsequent list of 145 species produced by Yonzon (1992) included 74 species (mostly shrews, bats and rodents) that are suspected but not yet confirmed to occur in Bhutan.

The mammal fauna consists of both Indomalayan and Palearctic elements, which overlap in the temperate, largely forested zone. Several important species occurring in eastern Bhutan (e.g. elephant, gaur, wild buffalo) are confined to the far south, while others (e.g. tiger, leopard, Himalayan black bear, wild dog) range more widely and are found in a variety of forest types.

Reptiles and Amphibians

The herpetofauna of Bhutan is poorly documented but is is considered to be rich, probably including a tropical/subtropical element in the south (MacKinnon 1991). MacKinnon et al (1994) provide a list of 15 reptiles and three amphibians for Manas national park, a small part of which extends into the east in the subtropical zone. Threatened species include the Gharial *Gavialis gangeticus,* the Indian python *Python molurus* and the yellow monitor lizard *Varanus flavescens* (MacKinnon et al, 1994; WCMW/IUCN 1994)

There is very little information on these taxa. Nevertheless the broadleaf forests seem to have rich amphibian and reptile fauna as evidenced by several types of tadpoles and snakes seen during field surveys. Tadpoles were even found in alpine lakes to the south of Tse thso La at 4300m (Wikramanayake 1995, JDNP). Most species seen could not be identified due to the lack of appropriate field guides and unfamiliarity with the herpetofauna of this area.

Fish

Very little fisheries work has been done in Bhutan, and no comprehensive list of fishes occurring in Bhutanese waters is available. Dubey (1978, cited by Tamang 1993) collected 42 species, primarily from western and central Bhutan, as part of an FAO fisheries project in 1976 and an additional two species were collected in connection with surveys for the Wangdi Hydroelectric Project in western Bhutan in 1992. Tamang (1993) developed a more extensive list (197 species) based on species occurring elsewhere in the Himalayas and their foothills (Meghalaya, Auranachal Pradesh, Nepal, Sikkim), but the occurrence of all of the same species in Bhutan is highly speculative. Mackinnon et al (1994) provide a list of species for Manas National park.

The 44 species confirmed as occurring in Bhutan are listed in Appendix 6, along with an indication of their altitudinal distribution and status. An additional 49 species that have ranges bordering Bhutan on both the east and the west also are included as they are

likely to occur in Bhutanese waters, although this requires confirmation. Additional survey work will very likely confirm the occurrence of many of most of these latter species, as well as the presence of a number of other species.

It is noteworthy that in Bhutan fish species richness probably varies considerably with altitude with by far the greatest number of species occurring at low altitudes and very few expected to occur above 2000m. This is in agreement with the general observation that in the Himalayas fish populations are confined primarily to the major rivers and their immediate tributaries, and are absent from many small streams due to extensive waterfalls and other barriers. Nevertheless, many of the fish species expected to occur in Bhutan are adapted to turbulent and swift-flowing stream habitats(Tamang 1993). In addition, a number of species are widely distributed across a range of elevations and/or are seasonal migrants.

Virtually nothing is known regarding the conservation status of Bhutan' fish populations although given that fishing pressure is very light, and that water pollution or other forms of habitat degradation are not major problems in Bhutan, fish populations would be expected to be in good condition. Three of the (unconfirmed) species listed in Appendix 6 have ranges that are confined to the Eastern Himalayas, and Bhutan may provide regionally important habitat and harbor regionally important populations of these species, especially as habitat degradation is becoming a serious problem in virtually all of the Eastern Himalayas outside of Bhutan.

Invertebrates

The invertebrate fauna is poorly known, although a start has been made in cataloguing the butterflies. Bhutan is considered to have an rich butterfly fauna, including some rare species (MacKinnon 1991); Yonzon(1992) lists 50 species as occurring in Bhutan, based on literature review and field studies, of which 28 are endemic to the Eastern Himalayas and other are rare or uncommon. At least four species are considered to be internationally threatened (WCMC/IUCN 1994; Appendix 7). Butterflies have been used as a indicator species (including as indicators of habitat condition) in rapid biological inventories elsewhere (e.g. Davenport et al 1994; Howard and Viskanic 1994) and it would be useful to develop additional data on butterfly distribution, abundance and habitat associations in Bhutan (Salter).

SPECIAL FEATURES OF BHUTAN'S BIODIVERSITY

Ecological and Evolutionary Features

The Eastern Himalayas, within which Bhutan lies, is considered to be one of the ecological wonders of the world. The country straddles two biogeographical realms: the Palearctic realm of the temperate Euro-Asia and the Indo-malayan realm of the Indian

Sub-continent. The result is a nation rich in biodiversity with its natural forest cover(72%) and the traditional highly integrated farming systems largely intact.

Bhutan has devoted over 26% of the total land area to an extensive protected areas systems reflecting the strong biodiversity conservation policy and the ethic of the people. The extensive protected area system in Bhutan stretches from the sub-tropics in the south, temperate in the central interior, to the alpine zone in the north. This protected area system serves as a unique system of in-situ conservation of biodiversity.

High Richness of Biodiversity and Endemism

Animals such as the tiger, one-horned rhinoceros, Asiatic water buffalo, pygmy hog and the rare golden langur exist in the lush tropical forests of the south. The snow leopard, blue sheep, and the takin are found in the cool forests and alpine meadows of the north. Within Bhutan's borders, one can find over 60% of the endemic species of the eastern Himalayan region. There are over 165 species of animals (mammals), and more than 770 species of birds that have been identified. In addition, Bhutan's rich flora comprises 5,446 known species of vascular plants, including over 50 species of Rhododendron, and over 300 species of medicinal plants, mostly alpine, that are used in traditional herbal medicine.

As a result, Bhutan has been declared as one of ten global 'hotspots' for the conservation of biological diversity. Many ecologists believe that Bhutan represents the last best chance for conservation in the Eastern Himalayas, a region considered of critical importance to the global efforts to conserve biological diversity (MOA).

Regional and Global Importance of Bhutan's Wild Biodiversity

Plants:

Several plant species are of high conservation value; e.g. the Himalayan yew (*Taxus baccata),* an important alpine fungus (C*ordyceps sinensis*) which commands a high price in the international market. *Podophyllum hexandrum, Aconitum* spp., *Delphinium* spp., *Herminium* spp., *Pleurospermum* spp, *Gentiana* spp, *Corydalis* spp., *Parnassia* spp., *polygonatum* spp., for their valuable alkaloides and various medicinal properties; species of *Allium* spp., *Fritillaria* spp., *Lilium* spp., as wild gene pools for future crops research; *Rheum nobile*, *Pterocephalus hooker?., Aster* spp., *Senecio* spp, *Saussurea* spp., *Rhododendron* spp., *Geranium* spp., *Meconopsis., Epilobium* spp., *Anemone* spp., and *Potentilla pedicularis,* as potential horticultural crops of ornamental value; *Circaester agrestis, Triosteum himalayanum, helwingia himalaica, Diapensia himalaica, Corylopsis himalayana* as rare endemic species for Bhutan.

Several plant species listed under schedule I of Bhutan's Forest and Nature Conservation Act, 1995 are also from the alpine and sub-alpine regions and have very specific micro-habitat requirements. For instance, the threatened species *Podophyllum hexandrum* (Himalayan May Apple) grows only among Berberis-Juniperis shrubberies in rocky areas, and frequent fires and systematic removal of shrubs from such areas may cause the local extinction of this species. Another e.g is *Circaeaster agrestis,* a rare plant that grows only under rock shelters and caverns.

Hence there is a need to identify the populations or rare plants and their micro-habitat in order to protect and monitor them. These micro habitats include, glacial moraines, marsh meadows, stream courses, moist rocks and seeps, caves and caverns, etc. (JDNP)

Mammals

Several species of mammals are globally or regionally threatened and some are listed in Schedule I of the Forest and Nature Conservation Act, 1995. These include several which can be considered as 'flagship' species such as Takin, Blue sheep, Snow leopard, Tiger and Red Panda.

Other species of conservation importance for reasons of threat and /or their ecological roles as significant predators or prey are leopard, wild dog, musk deer, sambar, barking deer, goral, serow, marmot, and pika.

Several species of mammals are habitat specialists and thus have restricted range distributions. For instance, blue sheep use alpine meadows for grazing, and venture into alpine scree in the ridge tops above the meadows. During winter, blue sheep migrate down into the alpine scrub habitat. Takin follow the blue sheep migratory pattern but remain in one habitat category below, by migrating into alpine scrub in summer and down to the sub-alpine and cool temperate broadleaf forests in the winter. During winter, takin populations can be found around Gasa, Tashithang, and Bayla, and in summer around Lingshi, Lunana and Tsharijathang.

The distribution of snow leopard is restricted to the higher elevations, such as alpine scree and meadows.

Musk deer usually found in moist sub-alpine forests, overlaps with the Red panda, which inhabit old-growth mixed conifer and temperate forests with heavy moss cover on trees and bamboo undergrowth.

Other mammals restricted to higher elevations include the marmot, which is found in localized colonies in the alpine meadows, and Pika which is distribute from the sub-alpine forests to alpine meadow. Both these species likely form an important base for many carnivores, such as foxes, martens, weasels, snow leopards and predatory birds (JDNP).

Birds:

Several birds that are globally and/or regionally threatened occur throughout the country. Some are listed in schedule I of the Bhutan Forest and Nature Conservation Act, 1995.

The number of bird species which may have internationally significant breeding populations in Bhutan, arranged according to ecosystem type:

Warm broadleaved forests		19
Cool broadleaved forests		35
Mixed coniferous/broadleaved forests		31
Blue pine forests		6
Subalpine forests		
Fir		45
Spruce	10	
Juniper	10	
Alpine scrub		9
Alpine meadows		4
Wetland (river, marsh, pool)	0	
Cultivation around villages		1

DOMESTIC BIODIVERSITY - PLANTS

The traditional, self sustained farming system integrates crop production, livestock production and use of forest products. The wide range of climate and altitude has allowed the Bhutanese inhabitants who come from different ethnic backgrounds to use a variety of crops and vegetables. This diversity in crop species surpasses anything one would expect considering Bhutan's small size.

Despite its relatively small size, Bhutan is very varied both in terms of climate and, to a lesser extend, soils. Bhutan's landscape rises from an altitude of 150 meters above sea level in the southern foothills to over 7,000 meters along the northern border. Climatic zones are tampered by elevation and rainfall, and so climatic types often coincides with topographic zones (Table 2). This dramatic elevation gradients account for its diverse flora and fauna, the species richness further enhanced through its relative isolation from other parts of the continent. Through a long process of natural and human selection, a wide array of crops and of varieties within crop species exists, sometimes hidden in remote areas. Many of the native crops as well as those which have been introduced into Bhutan long time ago possess significant genetic diversity and are ecologically well adapted to the specific requirements of the local environment.

Table 2. Description of the six Major Agro-ecological Zones'.

Agro-ecological Zone	Altitude m.a.s.l.	Temperature °C			Rainfall (mm)
		Monthly Max	Monthly Mean	Mean Annual	
Alpine (AL)	3600 -4600 Hight	12.0	-0.9	5.5	<650
Cool Temperate (CT)	2600 -3600 High	22.3	0.1	9.9	650-850
Warm Temperate (WT)	1800 -2600 High	26.3	0.1	12.5	650-850
Dry Sub-tropical (DST)	1200 -1800 Mid	28.7	3.0	17.2	850-1200
Humid Sub-tropical (HST)	600-1200 Mid	33.0	4.6	19.5	1200 -2500
Wet Sub-tropical (WST)	150-600 Low	34.6	11.6	23.6	2500 -5500

[1] RNR Research Strategy and Plan Document (May, 1992).

The Himalayan ecosystem which includes Bhutan has diverse biodiversity values of national and global significance. One of the world's ten global biodiversity hotspots, the Eastern Himalayas include Bhutan which is squarely placed at the intersection of three world centers of diversity of cultivated plants. With over 70% forest cover, Bhutan is known to harbor approximately 7,000 species of vascular plants. Many of these include fruits, vegetables and cereal crops in Bhutan that are either native, invasive, ecological escapes or introduced long time ago that they have developed unique genetic, morphological and ecological characteristics. The country's diverse flora includes numerous economically important plants: timber trees, medicinal herb, industrial plants, horticultural and agricultural crops.

The natural forest and the traditional integrated farming systems remain largely intact. Bhutan not only has a wide diversity of plant genetic resources but also has a large number of endemics- both cultivated and wild species. Thus Bhutan, least developed in economic term, plays an important role in conserving the global biodiversity in general, and the biodiversity of the Eastern Himalayas in particular.

Today there is a global awareness concerning the urgency and importance of the conservating biodiversity and the sustainable use of the biological resources in terms of their roles in the survival of the human species. In Bhutan, farming has remained largely at the subsistence level. Apart from the integration of the three sub-sectors in the farming systems, a special characteristic typical of Bhutan is its tremendous diversity in its landscape and ecosystems. The need to maintain high level of self-reliance and the variation dictated by climate and other environmental factors has broadened the scope for biodiversity in the agricultural systems.

It is often stated that only 30 crop species feed the world. These are crops which provide 95% of the dietary energy (calories) or protein, Based on the extent of cultivation and their contribution to the daily diet of the rural population, maize. rice, millet, wheat and buckwheat are the predominant agricultural crops of Bhutan (Table 3). Horticulture crops are mainly grown with commercial objectives in mind. There is no definitive list of staple or important crop. Nonetheless, the listing in the table does constitute a range of crops, which include different crop groups, species with different breeding systems, and crops of temperate and tropical origin. There are many other species that are important to large numbers of people at sub-national levels as suppliers of other dietary factors (protein, fat, vitamins and minerals, etc.). A crop-wise review on the state of diversity for some major staple food crops are provided.

Table 3. Area and production figure figures of major agricultural and horticultural crops in Bhutan (LUPP, 1995)

Crop Species	Area ('000 Ac)	Production (MT)	Yield (kg/Ac)
Rice	111.406	107,877	968
Potato	13.914	43,325	3,113
Wheat	23.642	10,747	454
Buckwheat	18.013	6,443	357
Mustard	11.816	3,686	311
Barley	10.887	4,849	455
Maize	137.072	75,380	549
Millet	25.498	9,159	359
Vegetables	14.802	22,257	1,503
Legumes	4.070	2,098	515
Chili	1.688	887	525
Ginger	2.817	4,503	1,598
Orange	19.866	77,031	3,877
Apple	4.858	9,266	1,907
Cardamom	17.23 1	3,980	230
Arecanut	0.277	1,073	3,870

Maize

Maize is the most important field crop in terms of the area under cultivation. No information is available on how and when it was introduced and distributed in the country. The presence of maize had been noted by Bogyle during his visit to Bhutan in 1774 (Markham, 1876). Some even hypothesised that maize might have been in this region even prior to the discovery of the new world. The advent of maritime exploration, especially the opening of communication between the old and new world, and the trade links between Europe and East Indies are most plausible elucidation to the entry of maize into Bhutan,

Today, maize is grown throughout the country up to an altitude of 2900m (Rodder & Gurung, 1990), with main growing area concentrated in Eastern Bhutan at altitudes below 2500m. It is grown in areas without irrigation facilities and on unterraced slopes.

Local maize includes dent, flint and popcorn types planted almost throughout the year, and cropped twice in some low lying areas. Generally, maize is intercropped or relay-cropped with beans, soyabean, vigna spp., potato, taro, sweet potato, amaranth, chenopodium and pumpkin.

The farmers' varieties or landraces contain high level of genetic diversity visually distinctive in their morphological make-up. Therefore, the farmers have names for them and different landraces are understood to differ in adaptation to microclimates, soil types, time of seeding, date of maturity, height, nutritive value, socio-economic use and other properties. The inherent variation within landraces of maize may be high since it is a cross-pollinated species.

The RNRRCs in Bumthang and Khangma are currently involved in collecting, characterisation and evaluation of high altitude (>1800m) local maize cultivars for use in crop improvement programme. Large scale exotic introduction has been curtailed to avoid marginalizing the traditional varieties. Nonetheless, a high yielding variety Suwan 1 was released as Yangtsipa in 1992. By 1993, this variety has spread to over 30% of the maize area in Eastern Bhutan. Studies on the adoption rate and success indicated that over 90% of the households were either growing Yangtsipa as a sole variety or in combination with a local variety (RNRRC-Bajo, 1996). This HYV is said to have an yield advantage of 20% over landraces. Two more varieties, Palmirah 8529 (white) and Suwan 8528 (yellow) are pending release.This is definitely a case for concern from the conservation perspective since the situation leads to widespread replacement of diverse local varieties by homogeneous modern varieties.

Rice

Rice is the preferred staple food and often consumed three times a day. The landraces in general have medium to high amylose and a low gelatinization temperature (Chettri, 1990). In Bhutan rice is grown from 300m to about 2600m in altitude. Rice is cultivated in terraces and about 90% of the rice fields are irrigated following a rice-fallow or rice-another field crop system of farming. It is estimated that landraces cover about 95% of the total rice growing area in the country (Roder, 1990). The number of farmers' varieties in the field is tremendous. Traditionally, rice landraces are assorted into two groups: Bjakaap (white pericarp) and Bjamaap (red pericarp). Within these groupings, local farmers distinguish several varieties with discrete indigenous names that relate to certain unique morphological characteristics or ascribing special socio-cultural attributes. The diversity in rice ecotypes and morphotypes, and the genotypic variation within these constitute invaluable genetic resources for the breeding work. The present knowledge across the whole spectrum of genetic variation in rice in Bhutan is minimal. Bhutan lies within the region considered to be the primary centre of origin and diversity for rice. New variations may be evolving all the time through continued geneflow between crops and their wild relatives. Thus it will be difficult to achieve comprehensive and exhaustive information on rice, but proper inventory and documentation must be maintained to facilitate conservation and use.

To illustrate the extent of diversity in rice, the farmers from five gewogs in the eastern part of the country grow in total 16 rice landraces (Chhetri & Schouten, 1995). The concentration of landraces at the country level will, therefore, be very high. These varieties deserve concerted attention since they confer several benefits that the HYVs cannot provide toward the fulfilment of a farmer's multiple needs.

Throughout the subsequent years since the establishment of the Centre for Agriculture Research and Development (CARD) in 1982, the introduction and evaluation of HYVs has gained intense momentum in the pursuit for domestic food security. From 5000 or more introduced lines, seven improved HYVs have been recommended since 1988 for general cultivation in the mid and low altitude environments. A small scale shuttle breeding programme is implemented to develop varieties suited to the high altitude areas (>1800m). More than 100 crosses were made between local varieties and HYVs generating 100 bulk populations and over 2500 pedigree lines. Some of them are undergoing screening for resistance to rice blast and cold tolerance at Gaynekha.

The RNRRC-Bajo in collaboration with other RNRRCs has embarked on a nation-wide exploration and collecting of traditional rice germplasm. Systematic followup leading to utilization is constrained by the lack of storage facilities and associated infrastructure. There is only one reality in the field, and that is to acknowledge the fact that solutions to many problems of rice farming in Bhutan are inherent in these landraces.

Wheat

Wheat is the third most important cereal crop after rice and maize in terms of production. No records on the introduction of wheat to Bhutan are available. Nakao & Nishiokha (1984) speculated that it might have been introduced from Tibet. Records by early visitors (Markham, 1876; Kuloey, 1865) suggest that wheat cultivation as second crop after paddy was more important in the last century than it is today (Roder, 1990). There are several factors contributing to the depression in wheat cultivation in Bhutan. Certain element of social bias restricted its wide-scale acceptance as a staple food; and often, does not contribute directly to the alimentary needs. The transition from a subsistence and barter economy to market economy has brought forth radical change in the approach to agriculture development. Low grain yields and subsequently low returns to investment, and cheap import from India were considered to be the main reasons for stagnant wheat cultivation (Mann & Hobbs, 1988).

Wheat landraces are the most threatened cereal food species in the country. Many village elders throughout the wheat growing area relate nostalgic account of local varieties they grew for varoius purposes. Most of these landraces, according to them, have disappeared from the field as they are progressively being replaced by exotic wheat varieties (or Jaga-Kaa as they call these improved varieties). It is likely that few of them may still be surviving in the very remote areas far removed from the present network of seed distribution system. Immediate and effective action must take precedence of all

debate on priority issues to save the remaining populations of wheat landraces maintained in the periphery of its gazetted provenance by few insipid but enterprising farmers.

The common borderwith India and the prospect of monetary income heralded the demise of wheat landraces in Bhutan. Since wheat is secondary as a staple crop, farmers have been complacent of the entry of Indian improved wheat into the country through formal system or farmer-driven seed acquisition and exchange system. Under the formal agriculture development programmes, the landraces were further neglected with public resources concentrated into the introduction and identification of improved varieties like Sonalika. As a product of formal breeding work, such cultivars are genetically uniform with narrow genetic base. As a result, problems like the stripe rust epidemic in 1986 and 1987 began to emerge. Sonalika became susceptible and consequently two more introduced varieties: Bajo Ka 1 and Bajo Ka 2 were released as rust resistant..... but for how long? It has been noted at the First Field Crop Co-ordination Workshop that almost all area under wheat in the rice-wheat system is under the improved varieties. This roughly accounts for more than 60% of the total area under wheat cultivation.

Wheat is grown in almost all the different agro-ecological regions of the country, right from 300m to locations above 3000m, as the main crop or second crop after maize, rice and potato; and in rotation with buckwheat at higher altitudes. Wheat is also grown as winter fodder at elevation up to 2500m, and for haymaking at elevations of 3500-4000m (Roder & Gurung, 1990).

Buckwheat

Buckwheat is an important food for the non-rice-growing areas at elevations above 2500m (Roder, 1995). Both bitter and sweet buckwheat species are grown. Owing to its short growing period, the crop can be accommodated under various cropping patterns. While it may be the only crop for high altitude farmers, it can be grown as second crop after potato, wheat or barley up to 2900m of altitude. Traditionally, buckwheat was the major crop in grassland shifting cultivation systems in regions from 2500m to 3400m. The duration of fallow period in these systems generally increased with altitude such that fallow of 15 years were common above 3000m.

So far one local variety of bitter buckwheat and two local varieties of sweet buckwheat has been recorded under cultivation. It may be possible to have enormous diversity within these landraces. In fact the farmers do discriminate between morphotypes found under different agr-ecosystems. These buckwheat landraces are most prominent in Bumthang and Haa districts.

Buckwheat production has not receded like wheat under the competition from surrogate crop species and improved varieties within. Research in the introduction and evaluation of improved varieties is at the initial phase. The traditional seed exchange and distribution methods are still intact, thereby preserving the available diversity and

contributing to the enrichment of germplasm by assenting to parallel but mutual human involvement and natural evolution.

DOMESTIC BIODIVERSITY - ANIMALS

Diversity of species, breeds and sub-breeds

The main livestock in diierent regions of Bhutan are cattle, yaks, poultry, pigs, equines, sheep and dogs. Goats, buffalo and cat are other domestic livestock but the former two are found in lower valleys or parts of Southern Bhutan. So far following breeds and sub-breeds of domestic livestock have been recorded in Bhutan.

Species	Type	Main Breeds	Sub Breeds
Cattle	Local	**3**	**9**
	Exotic	2	6
Yak		1	**9**
Pigs	Local	**3**	
	Exotic	4	4
Poultry	Local	4	
	Exotic	2	
Horses	Local	4	
	Exotic	1	1
	Donkey	1	5
Sheep	Local	1	**2**
	Improved	2	4
Dogs	**Local**	**7**	
Goats	**Local**	1	?
Buffalo		?	?
Cats	**Local**	**?**	**?**

Domestic Breeds and Sub-Breeds

a) Yak

Yaks are the integral part of the pastoral system and are the most important in terms of domestic biodiversity in Bhutan. They are herded mainly in Thimphu, Trashigang, Haa, Paro, Punakha, Wangdue and Bumthang Dzongkhags (districts) in the northern areas of the country with thin populations of pastoral groups. The yak act as the capital in themselves thus the need to have large number of these animals are justified from the economic point of view. Barter system of trade still exist in some areas.

Brokpa (yak pastoralists mainly in eastern Bhutan) are entirely dependent upon herds of yaks without having cultivable land holdings. Most of the Brokpa do not have permanent

habitations but spend their entire year in crude shelters or yak hair tents tending their animals in a transhumance migratory pattern that follows fodder availability through the season often covering large distances.

The population of yaks was about 30,241 in 1992, mostly concentrated in the districts in upper temperate to alpine zone of Tashigang, Gasa, Haa and Paro. Taking the national average of 0.47 yaks per households, Gasa and Thimphu have the highest relative density of > 5 per households.

The yaks of Bhutan generally appear smaller than those of regions. In summer yaks graze in pastures up to 5000 m and remain there until late October when they begin their descent to lower altitudes to elevations of 2500 m. In spring when the weather turns warmer, yaks once again start the cycle of movement to higher elevation grazing lands. Yak herders may be having as many as 20 different pastures that are only grazed for a week or a month or more in other situations. In some places , there are also tenant herders who pay 10 to 15 kg of butter per year for each milking animal and rest of the excess butter, cheese, hair and wool kept for themselves.

In some case yak and *dzom* (the female progeny of *Langu* and yak) herds are kept together for two to three months in the summer but usually keep them separate at other times. Some households with fewer animals may combine their animals with others to form one herd.

The dzom herds usually leave to lower elevation winter grazing lands in late September or early October and are kept there till mid of May. In late May the herds are moved up, usually reaching the highest elevation alpine grazing lands in July where they usually remain until late August. Yaks are crossed with Golengs or Langus to get different blood lines.

The average annual production of a yak cow is about 25 kg of butter and 30 kg of cheese while that of a zom is 30 kg of butter, and 40 kg of cheese. Butter and cheese are either consumed by the herders and exchanged for rice or sold in the market.

The long hair and wool produced by yaks is vital to the herders' existence. The long hair is cut in early summer. The fine inner wool of the yak is obtained at the same time by plucking it out. The inner wool is used for making clothing and the long hair is used for making ropes, pack strips, bags, blankets and tents. This wool and hair is not sold but spun and woven by herders for their own use. The average hair and wool production from one yak is reported to be 1 to 1.5 kg and about 2 kg respectively. Hides from animals that have been slaughtered or have died from natural causes are used as carpets and are also tanned for making leather straps and ropes.

Some yaks are also slaughtered for meat. Yaks can fetch Nu:6000 to 10000 depending on their size. Yaks are also exchanged with rice. There is great demand for meat and yak tail throughout the country.

b) Mithun

The **Mithun (*Bos frontalis*)** is the domestic form of Gaur. It is indigenous to parts of India (Assam & Arunachal Pradesh), Burma and Bangladesh. These animals are big and strong, have a typical dorsal ridge on the crest of the shoulder, a flat forehead and big horns with an enormous base.

In order to meet the demand and create continual source of genome there are two Mithun breeding farms producing more than 20 pure Mithun bulls which are distributed among the farmers for crossbreeding with Siri (***Nublang in Bhutan, Bos indicus***). ***The*** F1 generation obtained after mating Mithun (male) with Siri breed (female) is the most prized animal. The males, ***Jatsha, are very*** huge and powerful and are excellent draught animal when compared to the indigenous bulls, but is sterile. The females ***(Jutsham)*** population are very good milk producers having relatively higher fat percentage in the milk. They are preferred for easy maintenance in difficult terrain of Bhutan. They are superior in feeding on steep hills/slopes and for grazing on native grass and tree leaves. The interesting feature is all the male progenies are sterile.

Mithun Breeding practice with the farmers to produce Jatshamin which is superior productively compared to either of their parents:

		Mithun_ X Siri_ 100%
	⇓	
F1		**Jatshamin 50M X Siri_ Siri Blood SOS**
	⇓	
F2		**Yankumin 25M X Siri_ Siri Blood 75S**
	⇓	
F3		**Deobam 12.5M X Siri_ Siri Blood 87.58**
	⇓	
F4		**Deotha 6.25M X Siri_ Siri Blood 93.758**
	⇓	
F5		**Thabamin 3.125M X Siri_ Siri Blood 96.8758**
	⇓	
F6		**Thabazing1.5625MX Mithun_ 100% Siri Blood 98.4375**
	⇓	
F7		**Jatsham & Jatsha Siri Blood 49.215**

The **F1 male** (Jatshas) although excellent for draught propose are considered infertile and therefore can not be used for breeding. Hence, future research will be focused on producing a stable Mithun breed, where by inter-se mating can be made possible avoiding the disadvantages of very long traditional back-crossing system for getting jatshas. Preliminary research has shown that there are jatshas which are fertile as well which will be able to produce progenies with all normal characters. This research work is expected to turn out quite costly. Priorities include:

studies on different methods of collection of semen from mithuns. Initial trial has not been very satisfactory in view of the several techniques available these days.

continue studies on infertility problem in Jatshas

tri-hybridisation studies using Mithun, jersey and Indigenous breed. The first phase of the activity has already begun in one of the research farms.

studies on disease resistance as the Mithun crosses are relatively resistant to many of the common diseases affecting the ordinary cattle and buffaloes.

c) Siri or local cattle

Nublang origin is linked with the western Bhutan legendary lake-Nob Tshonapata, located on the western mountain ranges of proper Haa and above Nakha village of Sombe Gewog. It is said that the Tsomen had given a breeding bull to a kind Nor-pen from Nakha village who had given her a night shelter in his herd camp and our present Nublang is the offspring from the Tsolang.

In Bhutan this animal is by far the most trend setting and important animal. Most of the farmers keep this breed for milk, draught and for crossbreeding with Mithun to produce Mithun crosses. The later use is one of the foremost purposes in the Northern and Eastern part of the country. Although the low milk production, late age of maturity, delayed conception, impaired fertility and long calving interval are some common algeny of our indigenous breeds, they become good asset for some of the productive traits and hetero-genesity particularly disease resistance, foraging ability, traction capacity and butter fat production. The Nublang population accounts for a density of 3.82/household with highest number in Chukha, Bumthang, Haa and Wangduephodrang. With the continuous use of this breed for crossbreeding, pure stock of Nublang is becoming scarcer due to inbreeding and degeneration.

This breed is localised to conditions in the subtropical zone although it is prevalent from alpine to lower sub tropical. It migrates to higher areas during summer and low lying zone (warmer zones winter). It is known that it likes the deciduous vegetation and warm climate where it produces best.

d) **Sheep**

Sheep (*Ovis* ties) rearing tracts of Bhutan are the temperate zones, above 1800 masl covering Wangdue, Bumthang, Tongsa and Trashigang where concentration is above 3 sheep per household. Sheep are mostly reared along with yaks. The local adult sheep of Bhutan (Tibetan type) has average 65 cm height at withers, length 70 cm from shoulder point to pin bone, girth 75 - 100 cm and weighs 25 to 50 kg. The average wool yield in two shearing is 0.750 kg to 1.5 kg which is course.

The economic importance of sheep in the sheep rearing areas is only for wool and not for meat. Thus in view of the rural economy, it contributes in reality only 50% of what the animal by itself can offer to the rural community. It is very important for mountain people as the wool is used for making yarns and clothing. Sheep are mostly reared together with yaks. Some sheep are separately reared in lower altitudes.

Local sheep, having coarse wool, is the most predominant among the farmers. Others are the crossbred of Merino and Comeback exotic breeds introduced for production of finer wool. The local ones are very good for Bhutanese terrain while the crossbred are good yielder of lambs, wool and have bigger body size.

The population of sheep in Bhutan is about 25000 at the moment.

e) Poultry

Poultry (*Gallus domesticus*) keeping is very common among the permanent settlements of rural life in Bhutan. It is mostly kept for meeting the household demands of eggs , although it is also meant for chicken in some pockets of the country.

Although many types of poultry birds are found in Bhutan (yet to be surveyed) the common type is the one with single and pea comb. These are of white, buff, red, spangled and striped coloured types.

In addition to indigenous breed (descendant of Red Jungle Fowl), there are two exotic breeds of poultry in use in the country namely: Rhode Island Red (RIR) and White Leg Horn(WLH). The indigenous breed is good for scavenging and production, broody habits, and disease resistance. The RIR is an exotic dual purpose breed while the WLH is very good for egg laying.

Poultry keeping is predominantly a integrated practice among the crop farmers. In Bhutan the highest relative density per house hold is in the districts of Chukha, Dagana, Tsirang, Zhemgang, Mongar and Lhuntse (more than 3 birds per household) averaging to 2.5 birds per house hold in the country. The population of poultry has fairly remained static over the years.

f) Pig

The pig is predominantly present in central valleys of Phochu-Mochu, Western Dzongkhags and east. Average pig holding is about 0.8 in the country with Wangdue Dzongkhag among the highest, 1.5 per house holds.

In addition to local pig there are also cross-breds of exotic breeds. Local breed is mostly left free to scavenge. It has tough skin, jaw and small tapering body with rough bristles. The crossbred are mostly of Duroc breed, Saddle back breed and Jersey breeds. These are very high yielding animals in terms of piglet production, body size and breeding efficiency.

g) Horses

Horses play very important role for transportation in areas where road transport is not available. The districts of Gasa, Bumthang, Haa, Trashigang and Zhemgang have highest density of horses.

The local (Tibetan type) horse has been used to cross breed with the exotic Haflinger breed, the popular Austrian breed, known for its higher load bearing capacity and is supposed to be very good for higher altitude and difficult terrain.

h) **Dogs**

Dogs are the most common forms of domestic bio-diversity. For the yak and sheep herders it is very important for security and protection against wild animals. They are also significant from the point of disease transmission

I) Buffaloes and goats:

Buffaloes are kept by the fanners for milk and draft purpose in the southern tracts of the country. Not much efforts have been put to do any further work on this livestock, although it is believed that it is a descendant of riverine type. Goats are also significant in terms of their use as meat. There is a considerable section of community which depends on goat for emergency cash. Not much information is available on goats. It is however believed that the type must be Black Bengal and Assam because of the contiguous land mass.

Genetic Diversity of Livestock

Sub-breeds & inter-breeds of livestock

Yak XLangu	Yak X BS	Langu X YAK	Mithun XNublang	Yuta X Donkey	Local pig X Exotic
Zo/Zom	Zo/ Zom	Zomo	Jatsham/Jatsha	Yuta X HF	Dogs Gokhi XSakhi
Toimo/Toila		Golengmo	Yangkum/Yangka	Donkey X HF	DogsDamkhi Xapsoo
Premo/Prela		Bjomo	Dyobam/ Dyob		
Gar		KoiKyo	Dyothram/Dyothra		
Chuk			or Drangbams		
		Shingkyo	(Thabamin &		
			Thabazing)		
		Taglangma			
			BS Jatsham/Jatsha		
			Dyobam/Jatsham		
			Dyothram/ Jatsham		
			Yangkum/Menchi		
			Nublang X Jersey		
			or BS		

THREATS TO BHUTAN'S BIODIVERSITY

Overview

Despite the RGOB's efforts directed to nature conservation, however the on-ground situation is beset with problems. Threats to the ecological integrity of habitat and the species within them stem from several sources including overgrazing, illegal hunting, unsustainable farming, agricultural and logging practises; uncontrolled extraction of non-, timber forest products, unsound road building practises, introduction of exotic species, *inter alia* (FMP, 1991, FSD, 1994).

It is considered that the main environmental problems in eastern and much of the rest of Bhutan stem from improper or poorly regulated land use, exacerbated by the increasing human population. These problems include soil erosion on unterraced, permanently cultivated lands; shifting cultivation; intensive livestock grazing, both in natural grasslands/alpine areas and under forest cover; harvesting of fuelwood for urban use, much of which is concentrated along the national road system; and forest fires (Dorji 1993; World Bank 1993, NEC 1994, Dorji 1995). Intensive livestock grazing under broad-leaved forest cover has removed much of the undergrowth and has probably been a

major influence on current forest composition in oak, chir pine forests, as villagers frequently burn extensive areas to promote the growth of lemon grass, which is used both for grazing and the extraction of essential oils. Although the chir pine is fire resistant, frequent fires has resulted in a stunted, open forest, frequently with eroded soils and a depauperate understorey, in many areas.

In Bhutan, biodiversity is a matter of everyday necessity. All Bhutanese people, especially in the rural areas, depend on the biological resources in one way or the other on a daily basis. This interdependency is so strong that a breakdown in one link can create a chain of disorders- with disastrous effects on human well-being.

Main Types of Threats

Habitat Destruction, Degradation and Fragmentation, which results in the loss of biomes, ecosystems and wildlife species which depend on the habitats particularly in the tropical and sub-tropical zones of the south and the temperate zones of the interior.

Disruption of ecological processes that support life, including disruption of the **ecological services (e.g.,** watersheds, erosion control, climate amelioration) essential to human welfare.

Overexploitation - Direct Killing, Collection, Harvest - which leads to attrition or loss of plant and animal species.

Competition - for Space, Habitat, Food and Other Resources - and other emerging threats primarily caused by the **rapid growth of human population** and urban centers, and by **introduction of exotic species** associated with agriculture, forestry and fisheries.

Replacement of traditional crops and livestock by commercial varieties

Direct and Underlying Causes of Threats

Human Population Increase. Bhutan's 3.1 percent per annum rate of population increase puts ever increasing pressure on the country's fragile environment and natural resource base.

Overgrazing by Domestic Livestock, both in range and pasture areas where it leads to attrition or loss of species, reduction of productivity, and erosion; and in forest areas where it leads to loss of reproduction of forest species and to changes in vegetation composition.

Fuelwood Collection. This is exacerbated by the increasing population and its reliance on wood for fuel. It occurs wherever there is human habitation but it is especially notable around population centers including permanent military posts. The total demand for wood and wood products in terms of volume is dominated by fuelwood demand. The total consumption of fuelwood is estimated at 1,3 18,700 cum of which the household consumption is about 89%. The consumption is estimated to grow up to 2,146,200 cum by the end of 2012/13. The use of other fuels is rather small, only about 3% of the total fuelwood consumption.

Logging. While the general policies are environmentally oriented, the implementation or interpretation of the policies in the field may lead to loss of biodiversity (Dick and Yonten, 1995), and may have unexpected environmental impacts such as causing the bark beetle outbreak (Chhetri, n.d.).

Shifting Cultivation

Forest Fires, which are mostly if not entirely caused by humans.

Overexploitation of plants and animals, especially through collection (e.g., of medicinal plants), poaching, and heavy use (e.g., of tree species for roofing shingles).

Inadequate Resource Management which in turn is caused by inadequacies in policy, legal and institutional arrangements, information and staffing.

Inadequate Implementation of Policy and Legislation, and inadequate legal system which promotes unsustainable exploitation of biodiversity resources.

Limited Institutional Systems that promote unsustainable exploitation particularly because of fragmentation of responsibilities involving biodiversity, inadequate coordination between the government units involved, and inadequate authority to achieve biodiversity conservation.

Personnel Capacity. Extremely limited numbers of trained personnel in the field of biodiversity conservation represents a major factor limiting the nation's ability to improve and maintain biodiversity conservation.

Exotic Species, especially those associated with agriculture, forestry and fisheries.

Pollution, primarily of water in the vicinity of urban areas

Inadequate Data and Information on Biodiversity and its Use, and inefficient use of the information that does exist.

Inadequate Economic Valuation of Biodiversity Resources, especially the natural resource pricing policies which do not reflect the true values of the resources involved.

Inadequate Return of Benefits to the Affected Public from Use and Conservation of Biodiversity, which is partly a result of inequity inownership and access to natural resources, and partly failure to develop programs to bring benefits to the people involved.

Inadequate Public Awareness and Support for Conservation, which stems in part from the previous two causes.

Threats from Outside National Borders, which primarily involve transborder poaching of medicinal plants, and poaching of larger mammals, especially along the southern border.

Threats to Aquatic Biodiversitv

Many of the same threats affect aquatic biodiversity. The main threats involve habitat destruction, over exploitation, competition and introduction of exotic species in the same habitat. The principal causes of the threats include the following:

Ever Increasing Population

The population growth of Bhutan is rather quite high at 3.1% per annum. This ever increasing population has a great impact on deteriorating environment by means of rapid deforestation and uncontrolled urbanization. The resultant sedimentation and pollution impacts aquatic biodiversity.

Irrigation and Hydropower

Development projects related to water resources like irrigation and hydropower are vital to enhance the irrigation facility for increased food production and to provide hydropower for industrialization. Mostly such projects are monologue type with their own objectives and do not give serious consideration to small animals like fish and other aquatic animals, their biodiversity and habitats. A cross dam on a river or stream without any provision of a fish ladder impedes the movement of the fish either upstream or downstream. The hindrances in fish migration result in poor or no breeding and ultimately causes depletion of the fish population. So far no detailed information on the adverse effects of a cross dam and the effectiveness of providing a fish ladder is not available as no such studies has yet been undertaken because there is only one dam in the country. It is a thing of concern for the fact that many more dams are either under construction or are in the plans of the country. However, hearing things and reading of the effects of these structures over a river or a stream one can get enough information on the adverse effects of these structures.

Road Construction

Road construction projects are of special importance in facilitating communication within the country. On the other hand the roads makes it more accessible for people to reach the most interior parts of the country and it becomes very difficult on the part of the conservationists to keep proper tract of the biodiversity of these places. The road construction unit requires a lot of workforce to be employed and whenever they are camped near **a** river or a stream they are very much known for the depletion of the flora and fauna and especially that of the fish population.

Introduction of Transgenic Fish species

The introduction of the exotic fish species for enhanced production per unit water area in a shorter period by use of fast growing fish species to obtain higher economic benefits. For instance, the introduction of the Brown Trout (*Salmo trutta fario)* in the cold water regions in the western parts of the country has had bad effects on the indigenous fish, the Asla *(Schizothorax spp.).* It is believed that this has become a voracious competitor to the indigenous fish and above all it is believed that this exotic fish, being carnivore in its feeding habits, forages on the young ones of the indigenous fish. The group of fish brought into the country for the purpose of culturing in the village ponds for their high food value have been restricted to only ponds for the time being and they have not been released into the natural waters. They are the Common Carp *(Cyprinus carpio),* the three Chinese Carps: *Ctenopharyngodon idella, Hypophthalmitchthys molitrix,* and *Aristichthys nobilis;* the three Indian Major Carps: *Catla catla, Labeo rohita* and *Chirrinus mirgala.* The Gold fish (*Carassius carassius)* in some of the water bodies of the country and due its ability to breed and thrive in worst conditions that the closed water become over saturated that they have started showing signs of stunting.

Industrial Pollution

Presently there is not much of industries in the country and the effect of the industrial pollution is very nominal. However, concern is there about the small cottage industries and the vehicle repair workshops from where the wastes like oil spillage directly goes into the water bodies which in the long run is going to deplete the fish fauna.

Lack of Awareness

Lack of awareness amongst the mass of the people threaten the inland fish fauna and their habitats.

Threats to Domestic Biodiversity -- Plants

In Bhutan, specialized forms of crop production has evolved as a result of its geography and climate, but the production systems have been sustainable and capable of

meeting most of the food needs. Agriculture is estimated to account for 40% of the gross national product and 90% of the employment. It is essentially a family based farming system, where entire household members are involved. At the same time, there are a number of critical issues facing Bhutanese agriculture in the years ahead. The drive to attain food self sufficiency using modern concepts of green revolution is causing severe erosion of the plant genetic diversity. The population and animal pressure, and the cropping of marginal lands could lead to a dramatic degradation of rangelands causing the loss of much of potentially useful plant germplasm. Replacement of landraces and folk varieties of indigenous and peasant agriculture with elite cultivars could result in the genetic erosion. What is left is vulnerable to high input agriculture with genetically similar stands of plants. The narrowness of the genetic base could pose greater risk of crop failure as occurred in the epidemics of wheat stem rust of 1954 and southern corn blight of 1970 in the US. The Irish potato famine in the 1840s is a classic example of genetic vulnerability. Rapid and wholesale destruction due to social disruptions and relentless exploitation of natural resources presents an even worse scenario of uncalculated genetic wipe-out. The woman-folk of the rural communities will be the hardest hit in the event of any such calamity because of their closer interaction with the natural resources in the daily running of the household to ensure family food security.

In Bhutan, the importance of protecting traditional crops, wild relatives and wild collected forms of economic uses is just being realized. Conserving landraces has so far been a de facto investment by the traditional farmers under a very diverse environmental conditions. The MOA's role has always been geared towards agriculture development through increased productivity, land use intensification and alleviation of biotic and abiotic stresses. In the process, high yielding varieties of many crop species have been introduced into the country. Many local crop and landraces are being replaced by these HYVS, and in extreme cases, traditional germplasms are so rare that they are in danger of extinction. The general perception is why bother to maintain inferior material when better options are within reach. Traditional crop genetic resources are the product of generations of farmers' experience with informal research and experimentation taking into account the socioeconomic, cultural and environmental concerns that influence their vocation. Therefore, they are well suited to the prevailing conditions and serve multiple purposes of fulfilling basic needs. Also, improved varieties coming out of the formal breeding systems originate from such locally developed landraces. Given the immense diversity in geophysical elements and the resulting agro-ecosystems in the country, these landraces hold great potential to contribute profitably to the national system of crop development.

Threats to Domestic Biodiversity - Livestock

The information gathered from the discussion across the country suggests that main threats for most of livestock species are deterioration of original breed due to non systematic breeding and human habitation. Yaks and sheep which are mostly grazing in the alpine pasture, are believed by some to compete with the wild animals like blue sheep, but the overgrazing in these areas is probably more due to of patterns of domestic

livestock grazing than any possible competition with wild species. There is also fragmentation of families and herds which contributes to degradation of grazing land.

In the case of Mithun and Siri cattle, inbreeding and deterioration of breed seems to be very apparent. The two species are the basic genetic material for production of suitable animal for milk and draft. Mithun is not the native animal. Hence there should be a continual source of its supply. On the other hand Siri is the base genome for all the crossbreeding. Due to the economic competition more and more farmers are going for cross bred or pure bred exotic breed for higher production and thereby better income.

In the case of pigs and poultry these are mostly reared in the lower valleys and agricultural belts, Some of the indigenous pig breeds have not been identified yet while some poultry breeds have been feared to be extinct already. For the pig breeds the exotics are normally taken by farmers for fattening because of their ability to put fast weight. There are also no piggery development programmes locally available.

There is also a threat to dilution of breeds because of the infiltration of animals from across the border due to the proximity of the habitat.

THE URGENCY OF BIODIVERSITY CONSERVATION AND THE NEED **FOR SUSTAINABLE DEVELOPMENT**

Bhutan is at crossroads, where development has accelerated and we are faced with many difficult issues with relation to development, and associated demographic changes. It is clear that Bhutan's conservation of biological diversity must become an integral component of economic development(DT)

Threats to the continued integrity of Bhutans natural resource base are increasingly being felt from a variety of 'developmental' sources including infrastructural construction, industrial expansion, increasing urbanization, and the growth of foreign tourism.

In addition, Bhutan is having to deal with the compromising land-use management practices that are an inevitable result of the steady increase in the country's population. Though Bhutan's population density is low, the constraining fact is that land available for cultivation in the country is very limited. Expansion of the agricultural sector is therefore limited (NIX).

Over 85% of Bhutan's population practice subsistence farming, relying on an integrated system of crops, livestock and small-scale forest management, with the country currently meeting 66% of its food needs.

The limited amount of arable land, the nature of the terrain which makes intensification difficult, a high population growth rate (3.1% per year) and the increase in urban non-farm communities are some of the constraints face.

Forestry Sector: The biggest challenge for the forestry sector is to keep up with the overall economic growth rate and thus maintain its share of production. This is , however, not the only challenge. Another one is the support to other sectors.

The load and pressure from agriculture and animal husbandry is not going to ease up, even if the value added share of those two subsectors is going down. One must bear in mind that even these sectors are still growing. The key linkage that requires forestry's attention is the supply of animal feed. The previous estimate has been that 30% of animal feed comes from forests. There are regional studies which indicate that the portion could be up to two thirds of fodder requirements.

Arable Agrobiodiversity: Agricultural biodiversity is the surest insurance against disasters provoked by biotic and environmental anomalies. Therefore, the future in food security lies with the conservation and sustainable utilization of the rich diversity in native or naturalized plant genetic resources. Much of the local germplasm falls within the primary general of corresponding elite varieties. The transfer of and breeding desirable traits from landraces into such materials should be possible in most cases. To some extent, the presence of local forms in the proximity of cultivars could induce natural introgression thus broadening the genetic base of a particular crop.

- At the government level, society should be interested in plant genetic conservation to provide the information necessary for long-term sustainability and advancement, not just profitability over a 10 to 20 years time horizon.

- The nurturing and advancement of the Green Revolution has been an important event in human history, but it is equally important that scientific basis for conservation be developed in order to ensure the sustainability of this advance.

- The public sector interest in genetic resources is substantial because they are a critical input into agriculture, and scientific agriculture is a necessary condition for social viability. It must be channeled to safeguard the global values of genetic diversity since it is the informational and insurance values of bio-diversity which should motivate the public interest in and investment in the conservation of genetic resources for food and agriculture. A scientifically constructed conservation plan must be built upon the foundations of these sorts of values. The *PGRP* program, with the support of SDA-PGR project, will have the national mandate to implement the plan conforming to the national objectives and pragmatic strategies.

- The diversity in genetic resources will encourage the creation of a strong national plant breeding and crop improvement capability to the international standard. The *PGRP* will play an important part through the conservation and dissemination of germplasm for breeding purposes.

- Bhutan has ratified the Convention on Biological Diversity (CBD) on 25th August 1995. The Sustainable Development Agreement with Netherlands and other bilateral and international contracts bind the country to take necessary steps in fulfilling its share in the preservation of biodiversity and environment.

- The greater dependence on few plant species, about 20-30 in the national context, creates the need to conserve the native genetic resources. Agriculture for food production is the basis for sustenance and a primary source of income for the rural communities. Women play a critical role in this profession, and comparatively more dependent on the plant genetic resources than men. Under any production systems, women are intimately associated with crops they cultivate, and thus are more informed of the crop genetic potential and the compelling environmental determinants. It is more difficult for the rural women to get employment outside the farm life. Their freedom and security are thus closely linked with the genetic value of the crop resources. Food and agriculture programs will have to be sustainable and productive in order to reinforce their rights to self-determination and equality in the society. Their indigenous knowledge should be incorporated into modern technologies and the local crop genepools need to be conserved to the effect of enhancing their livelihood and protecting their socio-economic status.

CHAPTER 2
DESCRIPTION AND ASSESSMENT OF BIODIVERSI'IY CONSERVATION EFFORTS IN BHUTAN

2a. WILD BIODIVERSITY

IN-SITU CONSERVATION EFFORTS

Protected Area Svstem

A total of 26.23 % of the country has been declared as protected. This is a total of 10,5 13 square miles as follows:

EXISTING PROTECTED AREA SYSTEM

NAME	AREA(sq km)
Torsa Strict Nature Reserve	644.00
Jigme Dorji National Park	4200.00
Black Mountain National Park	1400.00
Thrumshingla National Park	768.00
Royal Manas National Park	1000.00
Saktend Wildlife Sanctuary	650.00
Bomdiling Wildlife Sanctuary	1300.00
Phibsoo Wildlife Sanctuary	278.00
Khaling/Neoli Sanctuary	273.00
TOTAL	10,513.00

Source: Nature Conservation section, Forestry Services Division, 1995, Thimphu

In-situ conservation of flora and fauna including the wild relatives of domesticated species is the ultimate objective of these conservation areas. By the end of 1997, management plans for three national parks, the Royal Manas National Park, The Jigme Dorji National Park and the Black Mountain National Park will have been prepared. During the 8th five year plan management plans for four additional areas (Bomdiling Wildlife Sanctuary, Thrumshingla National Park, Khaling Wildlife Sanctuary and the Sakteng Wildlife Sanctuary) will be completed.

Three park manager have already been posted to the first three parks, and another has been earmarked for the Bomdiling Wildlife Sanctuary.

Long term Objectives of Protected Areas

- to protect a large, contigous natural area containing the range of ecosystems in each protected area in a way that will allow natural processes of succession and evolution to continue with only minimal human influence. Minimal management interventions will target the protection of valuable biodiversity and important river catchments, but only if and when necessary;

- to maintain the current diversity of habitats in the protected areas so that the full range of biodiversity can be maintained. In the event of local extinctions, reintroductions may be undertaken but no exotic species will be introduced;

- to provide specific protection to endemic and endangered species contained in the protected areas;

- to provide suitable, tested management to increase the viability of specific endemic and endangered species provided such management is confined to small areas not exceeding 5% of the park area; and

- to encourage the undertaking of biological research which will improve management, and on the evolution and ecological features of the ecosystem, provided these activities do not damage the environment or threaten endangered species.

Park Policies:

In general the policy for the management of the parks are as follows:

- put highest emphasis on protecting the ecological integrity of its ecosystems;

- ecosystem protection;

- use the park for visitation, education and research;

- to ensure that Bhutanese nationals legally settled within the park boundary prior to its establishment are entitled to remain within the park and use its resources within the parameters prescribed in the management plan;

- to provide preferential employment opportunities to local people in the park within the context of the Royal Government's Royal Civil Service Commission regulations of employment;

- apply a strict policy to prevent new settlers or settlements within the park or its buffer zones;

- to protect endemic and endangered species of Bhutan;

- to encourage and foster the traditions, culture and customs of the people living in the park, and the practise of these traditions and customs; and

- to encourage the sustainable use of natural resources in the park by the local people.

Zones in the protected areas

To accommodate the needs, aspirations and the rights of the people living within and around the park, and to accommodate the timber needs of the local communities, the park has been zoned to include enclave, buffer, and multiple use zones, as follows:

Core zone: This section will be fully protected and closed for all human-related activities except regulated research, monitoring programs and staff patrolling.

Administrative zone: These areas will contain the park headquarters, warden and guard post and other infrastructure related to management and district administration. Visitor facilities, such as tourist lodges, information centres etc. will also be permitted in these zones.

Seasonal grazing zone: Grazing of livestock will be permitted in this zone, but habitat enrichment programmes that include introduction of exotic species will not be permitted.

Enclave zone: This will define the bounds of settlements, agricultural lands, pasture lands, communal forests and orchards within the park boundary. However, land use and resource use within enclaves will be subjected to restrictions as defined by park management policy. The zoning process will consider land area necessary to accommodate sustainable land and resource use practices for the communities.

Buffer zone: The area within a distance of 3-5 km from the park boundaries will comprise the buffer zone. As policy, the buffer zone will come under the purview of the territorial divisions, and not under park management. But park management will coordinate with the respective territorial administrations to ensure that human activities do not have adverse impacts on the park. Any major developments within the buffer zone will be subject to screening by park management and EIA's.

Multiple use zones: These zones will be used to facilitate sustainable extraction of timber and other forest products, regulated tourism and recreation, limited grazing, research, reforestation and habitat management (JDNP).

National Parks, Reserves and Sanctuaries

Torsa Strict Nature Reserve (644 sq.km)

This reserve protects the westernmost temperate forest of the country from broadleaf forests to alpine parks and including the small lakes of Sinchuhmgpa. The area has no human habitation and is a security area near the Chinese border. Management as a Strict Nature Reserve will have no negative impact on local people or other planned developments for the area.

Jigme Dorii National Park

The park consists of only the western end of the former enormous wildlife sanctuary, but the border has been brought considerably further south to increase the range of habitats through conifer forests to upper broadleaf formations. This is necessary because many of the important animals for which the reserve was established move down to these altitudes in the winter- the takin, snow leopard, blue sheep, deer, pheasants etc. This area protects some of the most spectacular scenery in Bhutan including great glaciers, deep alpine lakes and the highest peaks in the Kingdom. There are many species, endangered or extinct elsewhere in the world, that exist in relative abundance in the Park. There are also intact habitats to the south between the southern boundary which extends down to the Royal Manas National Park, which allows for a continous chain of mostly protected habitats which extend down the Royal Manas in the south.

The park area has a heavily populated enclave in Gasa area up the Mochu valley and some high altitude seasonal grazing areas in the Lingshi, Laya and Lunana areas. These areas are zoned as intensive use zones. The area has high potential for trekking tourism.

Current situation. JDNP is presently managed by a JDNP Park management. A park manager was appointed in 1995. Under him is a park warden stationed at the Park headquarters in Gasa who assists in management and supervision of areas within Gasa Dzongkhag. Three park guards and five village forest guards assist the Gasa warden. A warden is posted at Lingshi Warden post, and looks after areas within Thimphu dzongkhag. Two park guards and four village forest guards assist him. In Paro, a warden has been posted at the Soe warden post with two park guards stationed at the Soe Guard post look after the park areas within that area. Two village forest guards assist them (JDNP, 1996).

Black Mountain National Park

This covers a wide range of habitat types from permanent ice on the peak of Dorshingla 4925m, alpine lakes and pasture, conifer and broadleaf forests. The reserve will constitute the largest and richest temperate forest nature reserve in the entire Himalayas. Furthermore the park can be linked with the Royal Manas National Park by means of a corridor extension to Manas. This would constitute a unique natural heritage reserve spanning the entire gradient from tropical duars to permanent icefields. The combined park would certainly merit World Heritage site Status under the UNESCO

World Heritage programme. surveys have already revealed 449 species of birds in this combined area - more than any other reserve in Asia.

The park contains almost no permanent residents. There are a few small farms along the borders of the park along the Mangde Chu river, in the lower Hara river and along the parks southern border. These areas will be zoned into a buffer zone. A larger human settlement in the Nubi area will be enclaved and left out of the reserve boundaries. The only major use currently made of this area is the grazing of large number of yaks in summer on the northern alpine areas of the park. This area will be zoned as seasonal grazing area with no loss of rights to local people except that they will be banned from further cutting the forest to extend the natural grazing area, which they currently do.

Thrumshingla National Park

This is the second major temperate park in Bhutan and contains some spectacular scenic views, beautiful forests form alpine to sub-tropical broadleaf It also contains some protected examples of chir pine forest. The soil of the area is particularly fragile, rendering it quite unsuitable for logging or other development but it has excellent tourism potential with a good wildlife trail from the Ura valley right down to the Bumthang valley. The small town of Sengor in the middle of the park will be enclaved as an intensive use zone.

Kulong Chu Wildlife Sanctuary

The alpine-tundra zone of Bhutan is split by the Kuru chu Valley. The Eastern section has some species differences. This sanctuary protects an example of the eastern section. Shou and Argai were formerly reported from here. Shou is still reported from adjacent parts of Aurnachal Pradesh (India) where an adjacent reserve is also planned. The sparsely populated Koma Chu Valley will be enclaved as an intensive-use buffer zone.

Sakteng Wildlife Sanctuary

The area is designed to protect the easternmost example of the temperate systems of Bhutan where some endemic species are found such as the eastern Blue pine, Black-rumped magpie and many species found only in the east of the country. The area is said to form part of a transfrontier reserve with a planned national park in India
The populated valley and town of Sakteng will be enclaved as an intensive-use zone.

Royal Manas National Park

This park is the conservation showpiece of Bhutan and lies adjacent to the Manas Reserve of Assam which contains more endangered species of wildlife than any other Indian reserve. The park is formed by combining the existing Manas Wildlife Reserve with the existing Namygel Wangchuk Reserve. In addition it is proposed to add a forest corridor northwards as far as the Geylegphug to Zhemgang highway where the reserve will become adjacent to the Black Mountain National Park.The reason for this is to

provide a continous gradation of protected habitat from tropical duars all the way to permanent ice. This would be a unique conservation achievement for the Himalayas.

Manas is the only Park in Bhutan where Rhinoceros may occur. The Park contains more significant species than any other in Bhutan and already 362 species of birds have been confirmed in the park area. When linked with the Black mountain the combined area already has a total of 449 species of birds confirmed. Small settlements around the park boundary and in a few small enclaves have been zoned as intensive-use buffer zones.

Khaling-Neoli Wildlife Sanctuary (273 sa. km)

This Reserve consists of the existing reserves of Khaling and Neoli. It is planned to combine the two areas and revise the boundaries retaining the same size.
The Reserve is important for elephant, gaur, and other tropical wildlife and may be the only locality in Bhutan where Pygmy Hog and Hispid hare occur. Both are known from the Khaling reserve on the Assam side of the border with which this reserve will form a transfrontier reserve.

Phibsoo Wildlife Sanctuary (278 sq.km)

This sanctuary is important for tropical fauna such as elephant, gaur, and golden langur. It is the only reserve in Bhutan to have Chital deer. In addition, it is the only remaining natural Sal forest in Bhutan. No revision of the boundaries are necessary.

Conservation Areas

The six following areas are nominated as Conservation Areas. Such areas are multiple use areas and do not need to be under the management of the Nature Conservation Section but each requires some special regulations to ensure the protection of local species of conservation importance.

Name	Dzongkhag	Special values
Docchu la	Thimphu	endemic rhododendrons, birds, Red panda
Pele la	Wangduephodrang	scenery, langurs, Red panda, birds
Yutong la	Trongsa	scenery, pine forests, birds
Durtsachu	Bumthang	hot springs, geology, scenery.

QUALIFIED STAFF AND CAPACITY BUILDING

NCS Staffing

The conservation sector has been substantially impeded in its activities by several constraints, including:

- a shortage of well-trained practitioners, both at the institutional and the implementation level;
- a weak institutional structure;
- lack of field-level understanding of the purposes of protected areas and of management techniques appropriate for the individual areas;
- heavy pressure from adjoining land use practises and local populations; and
- lack of long term management plans resulting in adhoc project implementation, lack of required data for management plan preparation and a lack of international support (FMP 1991, RGOB, FSD, 1995).

Due to lack of manpower instead of forming 5 units as per the recommendations from the NCS strategy (FSD, 1995). Instead there are three units in NCS namely the
a. the administrative unit;
b. the survey and GIS unit; and
c. the management planning and extension unit.

Actual and planned levels of staffing in the three priority national parks are presented in Chapter 4 below.

CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY OUTSIDE OF PROTECTED AREAS

Integrated Conservation and Development Program (ICDP)

The objective of the ICDP is to integrate conservation and development programs within and around protected areas i.e buffer and enclave zone development.

For each protected area priority ICDP projects and requirements will be identified. The primary objective of ICDPs are to ensure the long-term conservation of the natural resources of the protected area and to bring sustainable and economic development to the local community. These will also provide immediate benefits to the local people living in and around protected areas.

For this purpose park managers need to know the resource use and their impacts by different communities, identify the problems and key stake holders.(e.g Dzongkhag Administration, local community). Seeking their participation assess the needs and linkages between conservation and development activities and then decide where various development activities are appropriate in relation to conservation.

For these programs funding sources, implementing agencies, and coordinating bodies need to be identified. The NCS will monitor and evaluate the progress of these

activities. The capacity within NCS needs to be strengthened to identify community needs and facilitate the development of ICDPs.

Aquatic Biodiversity

For the present the only conservation effort outside of protected areas (where no fishing is allowed) is the strict vigilance over the issuance of fishing licenses and monitoring that the regulations are strictly followed.

EX-SITU CONSERVATION EFFORTS

Other than the National Herbarium, described elsewhere, there is not yet any national ex-situ program for biodiversity.

STATUS OF KNOWLEDGE ABOUT BIODIVERSITY

Existing Information About Ecosystems and Species

All of the potential avenues for both expanding economic benefits from biodiversity and better ensuring its conservation are currently constrained by the shortage of basic scientific knowledge about the identity, status, and distribution of species and genetic resources in the country, the status and distribution of habitats, the ecological requirements of various species, and the ecological functioning of ecosystems.

Basic ecological and systematic information on Bhutan's biodiversity is limited. Surveys of birds and plants are the most complete, with a fairly extensive plant inventory conducted in the 1970s and a 10-volume *Flora of Bhutan* about half published(Grierson and Long, 1983). More recent survey work has been undertaken by the NCS in conjunction with the development of management plans for the Royal Manas and Jigme Dorji National Parks, but these have involved relatively limited collecting and inventory. There are no baseline data which would permit determinations of status and trends in plants and animals, and there are very few (or virtually no) data from Bhutan on the ecology or ecological requirements even of key species. Bhutan has few if any trained taxonomists or ecologists working for the government

In Bhutan, the number of described plants and vertebrates amounts to about three percent of the total number of species estimated to exist (Reid, 1996). Bhutan is thus among the most poorly known countries in the world from the standpoint of its biodiversity.

Traditional Knowledge about Biodiversity and its Use

The only systematic investigation into traditional knowledge about biodiversity is being undertaken by the National Institute for Traditional Medicine involving the uses of medicinal plants. Because the majority of the Bhutanese live in such close relationship with biodiversity, there undoubtedly is a substantial reservoir of traditional knowledge. Some of this information surfaced at the BAP Workshops where government representatives were impressed by the local knowledge of biodiversity. This is another area where systematic research should be undertaken as soon as possible, to ensure that information is not lost which may be of great importance to conservation and especially to the development of regimes of sustainable use for the country's biodiversity.

Databases

Efforts have been made at the NCS to establish databases with biological and socio-economic information in and around Royal Manas national park, Jigme Dorji national park, Black Mountain national park, Phibsoo wildlife sanctuary and Bomdeling wildlife sanctuary. However, it is becoming apparent that these databases cannot be established and maintained until there is a trained database manager along with computers that are solely dedicated to these databases and their management. The databases should contain data from biological and socio-economic surveys, patrol monitoring programs, research and structured monitoring programs, ICDP and community-related programs, infrastructure developments in the parks, any other information relevant to protected area management, species distributions etc. Databases should be designed carefully to serve specific needs and to assure maximum utility (taking into account issues of standardization, etc.).

The Netherlands-SNV cooperative program in the Black Mountains National Park is developing a biodiversity database for that area which, it is hoped, can be extended elsewhere in the country.

Monitoring

A Monitoring system for park management programs, ICDP programs, forestry activities as well as the status of biodiversity outside the protected areas is lacking and needs to be developed.

POLICY AND LEGISLATION RELATED TO BIODIVERSITY

Direct Biodiversity Policy and Legislation

The overall policy objectives of the RGOB for Biodiversity are that:

- Biodiversity issues will be integrated into the economic development plans and programmes;

- Special attention will be given to support parks and protected areas and effective buffer zones management; and

- Information on biological diversity will be developed for sustainable utilization and conservation.

Bhutan's policies on biodiversity parallel those of the Convention of Biological Diversity, particularly those which specify that:

- Conservation of biological diversity is a priority national objective;

- Any use of biodiversity components must be sustainable; and

- There should be fair and equitable sharing of the benefits arising out of biological resources.

Most direct biodiversity legislation comes under the Forest Legislation. At present the majority of Bhutan's environmental legislation concerns the conservation of forests and the protection of wildlife and wildlife habitat. Among the most prominent of these are The Forest and Nature Conservation Act, 1995 which provides legal context to the protection to the country's biodiversity. It provides a framework for the establishment and management of protected areas, social forestry and species conservation. The National Plant Quarantine Act, 1993, provides legal measure to control the movement of diseases, insects and other pests of economic importance (MOA).

At the present moment the rules and regulations supporting the Forest and Nature Conservation Act are under review and will be approved within 1997.

Forest rules and regulations are regularly updated to improve and better enforce forest conservation policies. These rules, however, still allow the Bhutanese people to practise their traditional use of forest products. A few examples are:

Medicinal plants

- The 1974 National Forest Policy categorises medicinal plants and herbs as resources yet to be fully exploited. Hence the policy specifies that these resources be surveyed for efficient management and use.

- May **25, 198%** The Director of Forests approved a proposal to 1) ban exports of medicinal plants, and 2) establish joint efforts by the Department of Forests and the National Institute of Traditional Medicine (NITM) to both collect and cultivate medicinal plants. Otherwise the responsibility for their cultivation lies with REID.

Resin

- April 3, 1985; Revised rules on resin tapping from chirpine (*Pinus roxburghii*) were approved.

Natural dyes

- January 4, 1980: The Royal government waived royalties and sales taxes on the collection and sale of lac and waste products therefrom. This was to revive the dying art of lac cultivation and associated activities. No monopoly is now permitted.

- September 8, 1985: exports of vegetable dyes were curtailed. These are now for domestic use only.

Bamboo and Cane

- November 7, 1978: the government decided that villagers in the Phontsholing could henceforth collect bamboo and cane without paying taxes or royalties. This is to encourage the production of handicrafts for sale and domestic use.

- May 7, 1979: Mongar and Zhemgang villagers were granted permission to transport 'bangchungs', 'palangs' (both traditional bamboo containers) and other products made of bamboo or cane anywhere, as long as they are for gifts, and not for sale.

- September 2, 1984: To encourage handicraft production, the government allowed Dhrumjar (Mempa) Trongsa villagers to collect bamboo and cane for sale or domestic use without paying taxes or royalties.

Other forest products

No legislation, rules or regulations have yet been enacted for essential oils, mushrooms and other forest products.(NWFP of Bhutan).

National and Sectoral Policy and Legislation which Mav Affect Biodiversity

There are Master Plans for the development of important sectors along with numerous by-laws and acts. Examples include:

- Bhutan Land Act
- Bhutan Forest Act
- Watershed Management and Social Conservation Act
- Mining Act
- Plant Quarantine Act
- Forest and Nature Conservation Act
- Bhutan Power Master Plan

- Horticulture Master Plan
- Bhutan Forest Master Plan
- Land Use Master Plan
- National Pasture Policy
- National Irrigation Policy
- Livestock Development Policy and Strategy
- Arable Agricultural Development Policy and Strategy
- Forestry Subsector Development Policy and Strategy
- Afforestation Strategy

These and others have the potential to impact biodiversity negatively or to assist in its conservation, depending on how much attention is given to issues of biodiversity conservation.

Forest Policy

Of all the sectors in Bhutan, forestry is the most directly involved with wild biodiversity.

Over the last decade the Royal Government of Bhutan has come to recognize that if its forest estate was not to go through a process of deterioration similar to some of its neighbours, a systematic forest management program would have to be put in place based on a balancing of conservation and economic development goals through long term, sustainable, multipurpose forest management. This has been the focus of revised forest policy drafted in 1991. The primary goal of the new policy is to ensure conservation of the environment, and only thereafter aim at derivation of economic benefits from the forest as a rationally managed resource. The major objectives of the 1991 Forest policy of Bhutan are:

1. protect the land, its forests, soil and water resources and biodiversity against degradation and the improvement of degraded forest land areas;
2. contribute food, water, energy and other resources by coordinating the interaction between forestry and farming systems;
3. meet long term needs for wood and other forest products through sustainable forest management; and
4. contribute to the growth of national and local economies through the development of export opportunities for forest products, fully developed, efficient and integrated forest-based industries and employment and job-training opportunities.

Within these policy guidelines, there is a set of General Principles for biodiversity conservation in forest management in Bhutan, as follows:

1. National forest policy and planning should recognize biodiversity conservation as a major development goal;

2. A national system of protected areas should be established that is representative of all ecological zones and types, and protect areas of high biodversity and endemism and rare or endangered species and associations;
3. Protected areas should be linked by corridors of natural forest and surrounded by buffer zones;
4. The greatest proportion of the country's natural forest areas should be dedicated to multi-use, multi-purpose management where biodiversity conservation is one of the major management objectives;
5. Riparian areas should be reserved, accorded special management status and encorporated into a network of continously-connected biodiversity reserves withint he working forest providing both horizontal and vertical ecological linkages through the landscape;
6. Silvicultural systems should conserve biodiversity composition, structure and function, and thus be based as closely as possible on natural ecosystem disturbance patterns;
7. In order to retain the full range of natural forest age classes, portions of the working forest should be managed under very long felling cycles, while others should be reserved in perpetuity and incorporated into the ecological network (re 5 above)
8. The distribution of logged and unlogged areas should be managed to maintain ecological corridors and prevent ecological fragmentation;
9. Within felling coupes, "keystone" biodiversity assets with important ecological functions, such as wildlife food and habitat trees, snags and coarse woody debris, should be retained in both harvesting and stand tending operations; and
10. Biodiverstiy status of forest management areas should be assessed at regular intervals (5-10 years) through comprehensive surveys and between these major censuses there should be annual monitoring of easily-identifiable indicator species.

Tourism Policy

The RGOB recognizes the negative impacts which unregulated or excessive tourism can have on a nation's culture and biodiversity. Experience in neighboring countries has emphasized this key point. Consequently, government has set a policy of limiting the total numbers of tourists and is seeking to implement this policy by imposing a relatively high blanket fee for all tourists other than Indians.

With respect to tourism policy directed toward biodiversity, in the protected areas, especially JDNP which has a number of tourists trekking through the park, the tourism policy is as follows:

- Tourism and visitation will be allowed within the park, but will be secondary in priority to nature conservation and the needs to protect the ecosystem and the need to prevent adverse effects on the social, cultural and traditional integrity of the local communities;

- Tourism practices will be based on the principle of sustainability, they must be environmentally and ecologically friendly, and socially and culturally acceptable;

- Tourism and tourists will be confined to designated visitor zones;

- Tour operators will be held accountable for violation of park rules by visitors and guides, and will be fines and/or their licenses revoked under the regulations of the Tourism Authority of Bhutan; and

- A park-entry fee will be charged form foreign visitors. Bhutanese will be allowed free access. The fee will be used for local development and park management (JDNP).

Education Policy in the National Parks

The parks will be used as a tool towards educating the public and school children to the country's natural aspects; the need for conservation of biological diversity; and on Bhutan's conservation policy and philosophy.

The parks will be used to generate and foster an appreciation for the natural beauty of Bhutan.

Park management will, through awareness programmes, encourage park use by Bhutanese nationals to promote broader support and appreciation for the national parks system., conservation, public education, and to instill an appreciation for Bhutan's natural beauty(JDNP).

Environmental Impact Assessment (EIA)

In 1993 NEC published the first environmental impackt assessment (EIA) guidelines for Bhutan. Since then NEC in collaboration with line ministries and other interested organizations has worked steadily to improve and institutionalize the EIA process. In September 1996 NEC with assistance from the Asian Development Bank undertook a major revision of the EIA process, which culminated in the release of two draft documents in May, 1997.

The first, "*Institutionalizing and Strengthening of the Environmental Assessment Process in Bhutan*" contains sections which include the following:

1. A revised EIA process for Bhutan, including a proposed legal basis for EIA implementation, an institutional structure for EIA implementation, and an analysis of the training and institutional strengthening requirements to implement RGOB environment policies effectively;

2. A proposed mechanism for environmental permitting, monitoring and enforcement; and

3. Environmental quality objectives and guidelines, which are intended to provide guidance both for evaluating new projects and the performance of existing operations.

A companion document, ***"Environmental Assessment Sectoral Guidelines"*** was also released in draft form. It describes potential environmental problems commonly associated with activities in the following sectors:

- hydropower;
- power transmission lines;
- forestry;
- highways and roads;
- mining and mineral processing; and
- new and existing industries.

A section on Strategic Environmental Assessments (SEA) was also included in the second document. It emphasizes the importance of incorporating environmental assessments at an early stage of planning and policy development, rather than at the projecgt level when mitigation options are frequently limited.

ECONOMIC VALUATION OF BIODIVERSITY

There has been very little attempt to develop an economic valuation of biodiversity in Bhutan. There are some economic data on timber, especially on export. There are also some gross figures on tourism, with estimates of the number of tourists coming for biodiversity reasons. However, economic valuation of biodiversity in particular, and resource or environmental economics in general remains an area where work is badly needed. This is considered an particularly important need in view of the direct reliance of most of the population on biodiversity and its critical importance to the nation as a whole.

STRATEGY AND PLANNING RELATING TO BIODIVERSITY - PROCESSES AND RESULTS

The RGOB's general strategy for biodiversity conservation is as follows:

Give priority to the following areas within the Convention on Biological Diversity:
(i) conservation and sustainable use of biodiversity;
(ii) identification and monitoring of biodiversity;
(iii) in-situ conservation;
(iv) research and training;
(v) access to genetic resources; and
(vi) provision of financial resources.

(I) conservation and sustainable use of biodiversity through:
a. identifying important components of biodiversity;
b. monitoring activities that pose threats to biodiversity; and
c. where possible establishing protected areas.

(ii) identification and monitoring of biodiversity through:
a. identifying and monitoring components of biological diversity important for conservation and sustainable use;
b. identifying and monitoring process and activities having, or likely to have, significant adverse impacts on the conservation and sustainable use of biodiversity; and
c. maintaining and organizing data derived from identification and monitoring activities.

(iii)support in-situ conservation through:
a. developing guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity; and
b. rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species, inter alia, through the implementation of plans or other management strategies.

(iv) support research and training through:
a. establishing scientific and technical education and training for the identification, conservation and sustainable use of biological diversity and its components; and
b. promoting and encouraging research which contributes to the conservation and sustainable use of biological diversity.

(v) provision of financial resources to enable Bhutan to meet the agreed full incremental costs implementing measures which fulfill the obligation of this convention. and

(vi) provision of support to control access to genetic resources through human resource development in the field of environmental legislation (MOA).

Development Planning (Five Year Plans, etc)

Sector Planning (Forestry, Agriculture, Power, etc.)

Strategies (Environmental Strategy, etc.)

INTEGRATION OF BIODIVERSITY CONSIDERATIONS INTO OTHER SECTORS

Biodiversity is impacted by virtually all sectors of the RGOB, but there is relatively little integration of biodiversity conservation into most of these sectors other than those of the MOA.. For example, the primary RGOB responsibility for forest industry

development is assigned to the MTI. The MOA/FSD mandate in forest industries is limited to assuring the sustainable production of raw materials on which rational industrial development can be planned. The department therefore, implements those aspects of forestry development related to harvesting and supply of timber and other forest products on a sustainable basis.

Some of the issues are:

- development of favourable circumstance, and business and institutional environment for the wood industry, including ensuring availability of raw materials on a sustainable basis, and
- development of appropriate home and cottage industries to add value to basic forest products in order to support local community based economies and improve rural livelihoods.

Land use planning: In the past opportunities to improve land use allocations and resource use intensity for maximum sustained yield were largely ignored. This has perhaps not been too serious problem in the past due to the low popluation and largely subsistence economy. However, the marked changes now occurring in demography and economy make land use planning an essential requisite for sound and sustained development. To guide the RNR sector-al development, land use planning has been considered essential for some time now, as a means by which an effective synthesis of available land resources and optimum land utilization can be achieved. Land use planning is taken here at different scale and degree of detail as required, present land utilization in terms of different economic functions, and evaluation of land productivity and capability and land classification at different scales and for different purposes including soil and water conservation. The LUPP of the MOA is responsible for coordinating land use and planning activities within the MOA.

The primary objective is to promote appropriate land use through adequate land evaluation for multiple use of forest resources. The program also assists in developing a system of related activities of forestry use, nature conservation, management of critical watersheds, as well as in developing guidelines for area management to achieve specific land use objectives.

Hydropower electricity generation in Bhutan is increasingly becoming synonymous to economic development because its immediate impact on the country's balance of payment and down stream development activities. This is the largest contributor to the country's exchequer. However, these figures can change drastically if the catchments of the hydroelectric dams are not protected. Implementation of proper watershed management plans including biological diversity conservation programmes can contribute to the sustainability of this very important source of income for the country.

Maintenance of forest covered catchment areas is required to keep them in such shape that the hydroelectric production is not harmed due to siltation resulting from erosion upstream. In economic terms an even more important requirement is the

maintenance of the regulatory capacity of the watersheds in such a way that the run-off characteristics of the rivers originating in these areas area not harmed by making them more flood prone and less reserving for the dry season.

Protected areas have always acted as a source of germplasm for agricultural and livestock development. For instance, 'Jatsham' one of the most important livestock for the farmer is a cross between the Gaur and the local cow. Similarly yaks have also been domesticated from the wild. This is also true for many varieties of agricultural crops which have been developed from the varieties in the wild.

INSTITUTIONAL FRAMEWORK

Central Government Institutions and Functions Related to Biodiversity

The overall decision making bodies of the RGOB are National Evironment Commission (NEC), Planning Commission, and the Royal Civil Service Commission. All the heads of ministries are the member of these commissions and all important policies and plans have to be endorsed by these apex bodies.

The National Environment Commission secretariat (NEC) is the focal body in Bhutan that takes part in the international dialogues on Biodiversity. REID, CLSD and FSD are the operational technical divisions under the Ministry of Agriculture (MOA) which are responsible for the conservation of their respective resources. At the implementation level, it is the Ministry of Agriculture, the RNR sector of RGOB, which is responsible for the conservation of biodiversity.

The MOA is responsible for the promotion of the Renewable Natural Resource Sector Development, The RNR sector encompasses arable agriculture, horticulture, animal husbandry and forestry. Attached to the ministry headquarters are two support divisions (the administrative and finance division and the planning and Policy division) as well as the Natural Resources training institute at Lobeysa. There are four RNR Research centres in the country with each having a primary focus relevant to the region in which they are located.

The REID (Research, Extension and Irrigation Division): This division is responsible for promoting innovation and development at the farm level. The division operates through four RNR research centre, the Dzongkhag RNR offices and 183 agricultural and 160 animal husbandry extension centres in the gewogs. In addition the REID is also responsible for the supply of pesticides, development of regulatory measures to ensure their minimum use in Bhutanese Agriculture, and development of appropriate technology.

The CLSD (Crop and Livestock Division). This division is responsible for animal health, livestock breeding and input of supply services. Under the division are the

Agricultural machinery centre (AMC) and the Royal Veterinary Epidemiological center, four regional veterinary laboratories (RVLs) and two satellite laboratories, a vaccine production center, nine livestock breeding farms and forty two artificial insemination centers.

The FSD(Forestry Services Division): This division is responsible for the sustainable management of forest and protected areas. The division operates through ten territorial forest divisions and also manages nine protected areas. During the 7th five year plan , a social forestry and forestry extension programme was initiated with the appointment of forest extension officers to each Dzongkhag.

The NCS (Nature Conservation Section) which was made a section within the Forestry Services Division during the reorganization of the forestry subsector under the Ministry of Agriculture has the following mandates: a) formulate nature conservation policy for FSD; b) develop and implement management plans for protected areas; c) identify potential protected areas and; d) prioritize inputs from conservation related agencies (Jones 1994, FSD, 1995).

The Bhutan Trust Fund

The Bhutan trust fund was established in 1991 as an endowment to provide long term funds for conservation activities in Bhutan. Its principle activities consist of developing a national system of protected areas, building institutional capacity for conservation of Bhutan's biological diversity; institutionalizing the protected areas management by establishing a repository for biodiversity for biodiversity information, implementing protected areas management plans etc; and mobilizing donor support for the Trust fund.

The objectives of the Trust Fund are:

a. revising the protected areas system, establishing new Protected Areas, and developing and implementing management plans;
b. providing institutional support to environmental organization and training natural resource professionals like the NEC, FSD and RSPN;
c. training foresters, ecologists, natural resource managers, and environmental professionals;
d. surveying Bhutan's biological resources and developing a natural resource database;
e. designing and implementing Integrated Conservation and Development Projects (ICDP); and
f. promoting environmental education in schools and through public awareness campaigns,

The National Institute for Traditional Medicine (NITM)

Traditional medicine is still practised throughout Bhutan, with its more than 300 species of medicinal plants. The NITM is a well organised institute staffed with traditional and western trained doctors. The Institute regularly collects plants to produce medicine as per formulae cited in ancient medical scriptures. The NITM combines traditional medicine with acupuncture to treat all types of diseases.

Medicinal plants are vulnerable to overexploitation. For example, it is known that in the olden days at least two plants, ruta (*saussurea lappa*) and manu *(Innula helenium*), were cultivated and marketed in the Bumthang valley. Today many people do not even remember what these plants look like. A remnant of manu however, has been found and is being cultivated by at least one family (NWFP). Recognizing this, the NITM has a programme for research on, and propagation of medicinal plants.

Upon request by NITM to collect medicinal plants, the FSD issues permits on a case- by case basis. The location for collection and quantity to be collected are to be specified in the permits. But often the collection of the permitted quantity is not possible as the required species is not available in adequate volume.NITM shows samples of the medicinal plants to local labourers, who are then requested to collect and bring in the required quantity of each species. The collector are paid on daily basis, or sometimes contracted under lump-sum agreements. It is virtually impossible, however for the scant core of technicians to reach every collection area for screening. In most cases meeting the collection target is more important for the collectors than is scientific harvesting on a sustainable basis. Lacking technical directives and proper guidelines, this is to be expected. This is the probable reason why some species have decreased by almost 50% over the past 20-25 years in localities, where they once grew abundantly (NWFP).

Generally alpine plants flower in August, which coincides with the NITM's team's collection schedule for herbal plants. At this time, even the fruits from the earlier flowering plants are not yet ripe or mature enough fot their seeds to be shed. For many herbs, the whole plants are collected, including both flowers and fruit. This method of collection reduces the chances for regeneration and hence threatens the very existence of some species. If such methods continue, some species may become extinct (NWFP).

Local Institutions and Functions
Issues of Coordination, Authority and Responsibility

Training Programs

The curriculum of the Bhutan Forestry Institute of the FSD has been revised to include wildlife management, protected areas management and biodiversity conservation. Every year the BFI trains forest guard who are recruited by the various sections of the FSD.

The Natural Resources Training Institute provides three years training in the fields of Animal science, Agriculture and Forestry. Also refresher courses for in-service RNR staff are conducted on a yearly basis.

The NCS conducts training programs for protected area surveys and monitoring techniques for protected area staff as well as territorial field staff.

EDUCATION AND PUBLIC AWARENESS

During the 6th Five Year Plan the RGOB accorded further recognition to the role of communities in forestry development. In order to support and facilitate the participatory forestry development the government drew up and adopted a set of social forestry rules. These cover model concepts in participatory development and utilization, including private forestry, community forestry and lease forests.

Initial efforts led to the establishment of June 2nd as a 'Social Forestry Day' held annually involving the planting of trees around households and public institutions such as community schools. However, the greatest success has been planting at schools. Initially social forestry schemes sought to encourage community participation as a primary means for afforestation of degraded lands in the vicinity of rural villages. The community forestry programmes aim to motivate and educate user groups to build confidence for improved management of forest resources.

Some of the activities of this program are:

- identification of user groups;
- motivation and education including organization of field training on tree planting for communities;
- organization of public meetings regarding participatory forestry and study of problems of communities; and
- participate in discussions about policy guidelines and rules related to social forestry.

A more holistic participatory programme involving farmers, researchers, and extensionists combining conservation/protection (in situ and ex situ)aspects with development/management aspects (introductions, selection, improvement, breeding, multipilcation, cultivation etc.) will be the key programme in the implementation of the National Biodiversity Strategy and Action plan.

The Nature Study Centre established in Khebethang by the FSD with assistance from the WWF is still in its infancy. Among its many objectives include: improving conservation field education for Bhutanese secondary schools., BFI, NRTI, RIM, Sherubtse college, and other training centres as well as providing a hub for information dissemination about Bhutan through workshops, seminars, publications, public debate and school curricula.

The Royal Society for the Protection of Nature has been the most active organisation with regard to improving public awareness and education. In the last 9 years, the RSPN has established a network of school nature clubs, and several research projects including some on fuelwood consumption, water quality, eco-tourism as well as workshops on environmental issues for village headmen and representatives of the National Assembly. It also addresses a wide variety of conservation issues, using a variety of educational methods; public meetings, magazines, debates, seminars and workshops.

INTERNATIONAL COOPERATION IN BIODIVERSITY CONSERVATION

International Agreements and Programmes

The Royal government of Bhutan recognizes the importance of cooperating with nations at the international fora to bring about biodiversity conservation and sustainable use. In keeping with this policy of the royal government, Bhutan signed the Convention of Biological Diversity at the United Nations Conference on Environment and Development , "Earth Summit".

In signing the convention on Biological diversity in Rio De Janeiro in 1992 and the ratification of this convention by the national assembly at the 73rd assembly Bhutan has accepted its global commitment to preserve the country's wealth of Biodiversity. Bhutan also recognizes the importance of the part of the convention which assigns sovereign countries rights to genetic resources.

Bhutan has also signed the Framework Convention on Climate Change at the Earth Summit, and the National Assembly ratified the convention in 1995.

Multilateral and Bilateral Cooseration on Biodiversitv

Biodiversity is an important area for development cooperation between Bhutan and both multilateral and bilateral donors. A few of the projects focussed on or relating closely to biodiversity are:

- Biodiversity Strategy and Action Plan, UNDP and GEF;
- A series of environmentally related projects of the UNDP;
- Sustainable Development Cooperation between the Netherlands and Bhutan, where biodiversity has been considered one of the priority areas for cooperation;
- Assistance to NEC by DANIDA;
- Assistance to NITM by the EU;
- Assistance to NEC with the EIA process, by the ADB;
- Integrated Forest Management Projects with Austria, Germany, FAO , the World Bank, and others;
- Biodiversity conservation in Black Mountains National Park with the Netherlands-SNV;

- The Bhutan Trust Fund for Environmental Conservation, whose donors include the GEF, Finland, the Netherlands, World Wildlife Fund, Norway, Denmark, and Switzerland;
- Forest Resources Management and Institutional Development project(UNDP)
- Assistance in the Integrated Horticulture Master plan(UNDP)
- Assistance in the Integrated Horticulture Development Programme (UNDP)
- Punakha -Wangdi Valley development project(UNDP)
- Integrated warm water fisheries project (UNDP)
- Technical Assistance Programme to the First Eastern Zone Agricultural Project (UNDP)
- Assistance to essential oil development project (UNDP)
- Integrated forest management project in Ura, Bumthang (supported by Austria)
- Tourism development (Austria)
- Assistance to the LUPP (DANIDA)
- Assistance to the NITM (European Community)
- Development of a National Re-afforestation strategy (FAO & Japanese Government)
- Punakha-Wangdue- Gasa Integrated Forest Management project (Germany-GTZ)
- Integrated Forest development project (Switzerland-helvetas)
- Food processing (natural resources use) (Switzerland-Helvetas)
- manufacture of energy-efficient wood stoves (Switzerland -Helvetas)
- Assistance to NRTI (Switzerland -Helvetas)
- Assistance tot he Irrigation section of MOA (Netherlands- SNV and Save the Children- USA)

Biodiversity Cooperation with International NGOs

World Wildlife Fund (WWF) - Bhutan Program is the principal international NGO which has assisted Bhutan with biodiversity for many years. WWF (jointly, WWF-US and WWF-International) has provided important support for biodiversity conservation since 1977, including training programs and other efforts to expand staff capabilities, surveys and inventories of biodiversity, assistance to national park development, and institutional support. The principal objectives of WWF-Bhutan are:

1. strengthen protected areas management by providing financial and technical support for preparing and implementing management plans, initially in Royal Manas and Jigme Dorji National parks;

2. providing institutional support to the NCS, FSD, RSPN, RNSC, Sherubtse college and other conservation projects; and

3. providing support for research grants and fellowships to young scientists and professionals in the conservation sector.

Several of the current WWF projects include:

- Assistance to FSD, MOA(WWF);
- Assistance to Sherubtse College (WWF);
- Assistance to RSPN (WWF); and
- Assistance to NWAB (WWF).

Other international NGOs have had a much more limited involvement with biodiversity in Bhutan. The World Resources Institute (WRI) of Washington D.C. has provided personnel to assist with development of Bhutan's National Environmental Strategy and with a study of biodiversity policy options (Reid, 1996). The Snow Leopard Trust has assisted WWF with training in field survey techniques.

2b. DOMESTIC BIODIVERSITY

AGRO-BIODIVERSITY CONSERVATION EFFORTS

Bhutan's agricultural system is in an initial phase of modernization. Bhutanese farmers primarily cultivate the traditional crop varieties and also depend upon forest resources for their subsistent livelihood. The major crops traditionally cultivated in the country are maize, rice, wheat, barley, buckwheat, potato, apple, cardamom, oranges and a wide range of minor crops including amaranths, sorghum, millets, etc., vegetables, pulses and oilseeds. Few modem varieties of the major crops are being cultivated. In some cases, the area planted with modern varieties is increasing.

In-Situ Conservation and Sustainable Use

Guided by the national policy, about 36% of the forest area (2.9 million ha) are declared as National Parks/Protected areas and it accounts for 26% of the land area of the kingdom. It is against the global standard of **12%** desired for each country. There is a total of nine parks and protected areas which are evenly distributed across the country. In situ conservation of wild relatives of domesticated species, however, is not yet integrated into the natural protected area system.

In situ conservation is the continuing maintenance of a plant population within the ecological community of which it forms a part as well as in the environment to which it is adapted. It is applied to wild progenitors of crop plants, forest trees and wild fauna. But it includes conservation of existing landraces of crops as well as the artificial regeneration of folk varieties or obsolete cultivars, whenever planting is carried out without conscious selection in the same area where seed was developed by a particular farming community. However, no initiative in resources and time has been set aside to encourage this to happen at the national level.

Subsistence farming based on traditional culture practiced by local farmers has preserved diversity in field and vegetable crops. Indigenous agroforestry is an integrated approach to land use that is characterized by the deliberate maintenance of trees and other woody perennials in fields and pastures used for construction purposes, simple tools, firewood, medicine, livestock feed and human food. Home gardens or kitchen gardens hold indigenous germplasm in the form of folk varieties or obsolete cultivars, land races and rare species that thrive side by side and are preserved. These living genebanks provide a considerable amount of species diversity and to an extent, genetic diversity as well.

Local farmers still maintain land races and continue to grow them even when they experiment with and adopt some modem HYVs. The reasons for this practice are as diverse as the crops themselves; and on several accounts based on storage properties, nutritional and processing quality, cooking ease, secondary produces, and historical and cultural reasons such as dietary diversity, the use of folk varieties in traditional foods **or** religious ceremonies and filling of unique market niches. There are agronomic reasons too, such as better adaptation to traditional intercropping systems, early or late maturity, or greater resistance to local biotic and abiotic stresses. Yield stability in areas with unpredictable seasons is also a consideration in farmers retaining land races in addition to planting improved varieties.

The factors that promote in situ conservation in the Bhutanese farming communities are the fragmentation of land holdings, marginal agricultural conditions associated with heavily leached, steeping mountain slopes and heterogeneous soils, economic isolation, cultural values and preference for diversity.

The Horticulture research station under the RNRRC-West has good collection of fruits and nuts. The collection serves multipurpose roles for the researchers, students, trainees, extensionists and farmers in the country. In good sense, the collection is self supporting financially by combining conservation activities with revenue from fruit production for the export and domestic processing markets.

Ex-Situ Efforts

Ex situ conservation implies conservation of germplasm outside the natural habitat of the plant concerned. In crops, this is the form of samples of seeds stored at subzero temperatures in airtight containers, tissue cultures in glass vials, or complete plants in field genebanks where seeds are recalcitrant or cannot be dried and frozen for storing in a genebank. For the farmers it means saving up their own seeds for next season. To the present, almost all external funding is expended on ecosystem conservation without any consideration for sustaining and enhancing ex situ conservation. This, despite the latter having laid the groundwork for expertise applied with some modification to in situ work and to a system that will sustain the food security of the world. Therefore, in situ methods must not detract from the overwhelming need for more effective ex situ conservation programs for crop species.

Bhutan believes that preserving and strengthening the natural resource base is central to a sustainable development process. However, in the absence of the national capability to assume conservation and utilization activities on a concerted scale, the ex situ needs have not been put into proper perspective. So far, limited formal germplasm collection has been undertaken in Bhutan. An IPGRI mission to Bhutan in 198 1 collected 483 samples of food plants, legumes and vegetables. The mission noted serious threat to indigenous wheat and rice varieties. In 1983, a joint RGOB-IRRI mission collected 184 traditional rice varieties from high and medium altitude rice growing areas, but most remote areas were not visited (Pradhan, 1996). Recently, the RNRRC-Bajo with support from IRRI, has collected 154 samples of cultivated rice from 68 villages located from 400m to 2500m altitude, and traversing about three quarters of the country's rice growing regions (Chettri, 1997).

Extensive collection of ornamental plants from Bhutan have been recorded. Grierson and Long (1983) listed 163 horticultural species introduced to other countries from Bhutan. Among others, the list included 52 rhododendron, 34 primula and 8 Meconopsis species (Pradhan, 1996).

The country has no medium to long-term storage facility yet. There is concern that loss due to inaction could become expensive; and no time should be wasted in collecting germplasm of major food crops before farming communities succumb to the pressure of population growth, migration to urban areas and a shift toward consumerism. The IPGRI in 1989 proposed the establishment of plant genetic resources units as an integral part of the agriculture research system (Engels, et al., 1990). An Agro-Biodiversity Center will be established in the 8th Five Year Plan period with the support from The Netherlands under the SDA framework. The support project will facilitate the establishment of a national genebank for crop species, and build up the national capacity to integrate the conservation of PGR with agricultural development. The on-farm management component will build on the current experiences with traditional farming systems, the indigenous germplasm exchange networks and traditional markets (REID-MOA, 1997).

Utilization

In Bhutan, agricultural development projects and programs include a component of preserving the crop diversity of agro-ecosystems anchored in the traditional farmers' rationale to utilize local resources together with their intimate knowledge of the environment. Over 90% of the area under rice, which is by far the most important food crop, is still being cultivated to local varieties (Chettri, 1997). The people are still dependent on a variety of domesticated and wild resources for staple food, fibre, cash crops, natural dye, medicinal plants and others of ethno-botanical importance. Thus, in some cases there is no clear difference in diversity between the cultivated and the natural ecosystem. A study carried out in a district revealed that farmers collect as many as 164 different plants from the forest for their livelihood (Wagner, 1994). In a similar study in a block revealed that farmers collect as many as 22 different types of mushrooms, 16 medicinal plants, 11 cash generating non-timber forest products, 14 for home utility, 6

wild fruits, 15 food plants and 8 beverages from forest (Namgyal, 1996). The NITM uses some 300 species in preparing traditional medicines.

To meet the steadily increasing demand for food and other agricultural products, Bhutan continues to introduce exotic crop varieties. The emerging private sector seed corporation and the strengthening of RNR research are expected to accelerate this process. Local varieties are still maintained by farmers for their culinary appeal, higher market prices and secondary uses, while HYVs are adopted for their yield potential and resistance to biotic and abiotic stresses. These seem to suggest that on-farm conservation of land races can be a viable proposition even though modern techniques are applied to boost yield in traditional farming practices.

Policy and Legislation Related to Biodiversity

Bhutanese people have a culture and lifestyle which are closely related to the surroundings in which they live. They have often developed sustainable methods of managing the resources they use. The national policy and strategy resolved in the proceeding "Towards Sustainable Development in Unique Environment (Planning Ministry, 1992) stressed the following needs:

- sustainable Use of natural resources, including biodiversity;
- strengthening existing institutions, including environmental impact assessment;
- promotion of conservation ethics and environmentally sound farming systems;
- community participation in the management and protection of natural resources;
- revision of the forestry policy and legislation; and
- human resource development;

The overall policy objective on biodiversity is that the conservation and utilization of biodiversity should be an integral component of economic development. The principles underlying the policy are:

- biological diversity issue will be integrated into the economic development plans and programs;
- special attention will be given to support action plans for parks and protected areas and effective buffer zone management; and
- documentation and information system will be developed for conservation and sustainable utilization of biodiversity resources.

Within the framework of the policy objectives the priority areas are:

- strengthening of institutions in the area of programs responsible for conservation and management of biological resources; and
- education and training as a conduit to effective implementation and cultivate mass support to the relevant initiatives.

Strategy and Planning Relating to Domestic Biodiversity - Processes and Results

Self-reliance, sustainability, institutional strengthening and human resource development, balance and equitable development are mentioned as objectives to be addressed during 8FYP.

Specific objectives for the RNR sector are national food security, conservation of natural resources, and sustainable economic production and enhancement of rural income. The role of the Royal Government of Bhutan in the RNR sector should be one of facilitator, extending the range of available opportunities through constructive regulatory measures, appropriate fiscal policies, provisions of infrastructure, and cost-effective research, technical support and advisory services.

During the 8FYP, governmental interventions in the RNR sector will be brought within a stronger 'Programme Framework' approach. Activities in the sector will be grouped under six principal programmes:

- management and planning services;
- farm system development;
- crop and livestock production services;
- forest management services;
- export horticulture development; and
- human resources development.

Institutional Framework, Central and Local

The NEC is the national focal point for environmental policies, and the RGOB's instrument to the undertakings under the CBD, which in turn constitutes the framework for international effort in biological diversity. The MOA and the RNR sub-sectors are responsible for the management of the bio-resources.

Bhutan has a comprehensive network of parks and protected areas, but as yet does not have a national program on the PGR for food and agriculture. In 1990, the research program of MOA drew up a proposal with expert input from NBPGR/IPGRI, but the proposal could not be operationalized due to the lack of trained nationals and limited financial support. A new proposal has been formulated in 1996 by a joint Bhutan/Dutch mission for funding under the SDA program from July 1997. The project has been endorsed by the MOA and currently being assessed for full support by the Dutch government. It shall be implemented as a national programme under the REID direction of the MOA, and will initially work on the crop genetic resources but to expand its mandate to cover domesticated animal genetic resources in future.

The Research Section of the REID of MOA is given the national mandate to deal with the PGR affairs. It operates through the four RNRRCs strategically located at the centers of four discrete agricultural ecosystems embossed through geographic isolation

and imposed upon by natural barriers. These RNRRCs each have a national mandate to coordinate the programs on forestry, livestock, field crops and horticulture. In addition, they have regional mandates to implement component activities of all the farming systems within its mandated area. These RNRRCs have projects and activities directly involving conservation and utilization of PGR. However, such activities are not performed in a coordinated and standardized manner. For example, the methodologies and approaches, and even the information databases maintained are diverse between Centers. Therefore, information exchange is constrained and protocols are not repeatable to validate technologies developed.

Training/Capacity Building/Education/Public Awareness

The actual work specifically targeting PGR conservation and use is minimal. What has been achieved so far in this direction are mere spin-offs of greater objectives. This is because first, the research program and consequently the scientific and technical capability is weak. Secondly, the development priority in real economy gave little room for agro-biodiversity education, which in turn thwarted effort to promulgate awareness among the planners, policy makers, general public and even within the scientific community itself.

At the government level, the concern for PGR is emerging. The number of nationals being trained in conservation and natural resources management courses are on the rise, with few already been absorbed into conservation programs. In the context of present socio-economic and demographic trend, the need for education and awareness on conservation and utilization of PGR must be addressed urgently.

Regional and International Collaboration and Cooperation

International cooperation in the conservation of genetic diversity at the policy level is structured through the FAO International Commission on Plant Genetic Resources (ICPGR) and the FAO International Undertaking. Until so far Bhutan chose not to participate in the FAO-Commission, but to participate in the regional and global forums and activities thereof.

On the operational level the International Plant Genetic Resources Institute (IPGRI), part of the Consultative Group on International Agricultural Research (CGIAR), co-ordinates a network of Plant Genetic Resources Programmes with the International Agricultural Research Centres (IARCs).

The Convention on Biological Diversity supersedes the FAO Undertaking and as such is binding. In the Convention, national sovereignty over biodiversity is explicitly recognized.

During the UNCED in Rio de Janeiro, Bhutan signed the Convention on Biological Diversity. The 73rd session of the National Assembly ratified the Convention and by that

the commitment of the Royal Government of Bhutan to conserve its biodiversity was further strengthened.

An Agro-Biodiversity Project will be implemented within the framework of the Sustainable Development Agreement between Bhutan and The Netherlands. Consequently the principles of sustainable development: reciprocity, equality and participation, will be built into the project. Relevant agreements reached between Bhutan and the Netherlands in the context of SDA is also taken into account. Given the objective and scope, this project should be integrated as one of the themes upon which the biodiversity strategy and action plan will expand.

At the regional level, the South Asia regional office of IPGRI has supported the national capacity development through numerous short term training on PGR research and development. However, the benefit from these training were not realized without the institutional and policy support for a national PGR program. The officials from MOA continues to participate in the regional workshops, seminars and meetings conducted by the South Asia Regional Network for PGR management.

The MOA has also good relationship with the NBPGR in New Delhi. It has provided technical assistance in germplasm collecting and seed storage management. Apart from the PGR newsletters, which are regularly distributed to individual agriculture researchers and research stations, certain publications and periodicals are also provided free of cost. The Government of India had supported a survey of forest resources in Bhutan during 1974-1980. It is still the most comprehensive forest inventory covering 29,176 km^2 or 72% of the total land area, excluding the permafrost in the north. Some 78 tree species were inventoried and the data mapped at 1:50,000 scale (Pradhan, 1996).

Access to PGR, Benefit Sharing and Realization of Farmers' Rights

In 1969, the Forestry Act was drawn up. In 1995, the act was revised and became the Forest and Nature Conservation Act. The new Act provided a regulatory mechanism for conserving and managing the forests. The National Plant Quarantine Act, 1993 provides legal measures to control the movement of diseases, insects and other pests of economic importance. However, a policy and legal system on regulating conservation and use of biological resources under agricultural systems is yet to be developed. The issuance of government circulars at occasions has so far established guidelines for regulating PGR processes. The validity of such document is limited and often over-ruled by subsequent releases. A formalized instrument through national ruling will certainly serve the best interest of the country to secure just treatment beyond its boundary.

Access to and transfer of some economically important plant species are subject to restriction, but essentially without the legal arsenal to support contextual application. Sometimes, access to and ultimate use of PGR are conditioned to facilitate the sharing of benefit, but loopholes in the current system give rise to misuse and loss of mutual trust.

The WTO has established a framework for sui generis national policy and legislation pertaining to the trade in PGR and exercise ownership rights while respecting the rights of others. As a part of the global trading community, Bhutan must consider all aspect of PGR such that access to others' resources is not restricted by imposing nonnegotiable demand on its own resources. Within this framework, there is ample opportunity to exercise it sovereign right, implement the rights of its indigenous people, and create an amenable environment for outside interests to establish themselves within the country.

LIVESTOCK BIODIVERSITY CONSERVATION EFFORTS

Bhutan's policy of self-reliance aims at achieving self sufficiency in livestock and livestock products. This sub-sector, which is traditionally centred around small, subsistence and the migratory pattern of livestock farming, is of immense importance to the country's rural economy. Over 90% of the households own cattle. Livestock rearing forms an integral part of the Bhutanese farming system in integration with crop production (provides drought power, farm yard manure), & forest (means of collecting, concentrating and breaking down large amounts of plant materials) and producing milk, butter, cheese, meat, eggs and pack animals in the higher altitude areas.

The average farm holding of an individual farmer is 0.8 ha to earn his subsistence living. Depending upon the geographic location, livestock represents a major or minor proportion of farmers' income. The livestock production system therefore, is seldom regarded as a distinct enterprise.

Livestock, particularly the grazing one, have therefore traditionally been very important part of the Agricultural production system and the economy of Bhutan. The traditional form of agriculture that has been practised in the past enabled livestock to be managed in a way that harmonised with the environment. The livestock numbers are however excess compared to the country's feed resources (About 10-12 percent of the total land area is under permanent or seasonal grazing. In general there is a shortage of fodder by about 26%). The increase in livestock numbers has led to concerns over overgrazing of grasslands and forests and therefore the environment.

In order to combat the problem of environmental degradation, a number of strategies were introduced by the Royal Government of Bhutan. Steps were initially taken to increase animal nutrition by the development of pastures. Intense effort were made to encourage farmers to sow productive species of grasses and legumes as it was believed that through the establishment of these, communal grazing land could be reduced. In addition to these strategies, the government embarked on a genetic upgrading exercise as it believed that the remaining factor limiting animal productivity in Bhutan was the genetics of its livestock.

Within the frame work of the national development strategy which is guided by the principle objectives of Self-reliance, Sustainability, Environmental Preservation, Efficiency and Decentralisation of Government, Privatisation, Institutional strengthening, Manpower Development and Regionally Balanced Development, the specific RNR sector policy objectives are:

- the sustainable development of arable Agriculture, Animal Husbandry and Forestry for the enhancement of self sufficiency in food, fodder, fuel wood, construction timber and other products;
- improvement of income, living and nutritional standards of the rural population; and
- environmental conservation, emphasising an integrated crop/livestock/forestry system's development.

Breed Conservation

The conservation of native breed of livestock (cattle and yaks in particular) are of paramount importance in livestock development programme where extensive either systematic or haphazard cross-breeding programmes are done. The risk of over-dilution of the native/indigenous blood in the long run is foreseeable under such circumstances which should be avoided by any means.

In view of the above facts, the Royal Government did in the previous five year plans identified pocket areas where good quality indigenous breeds could be found. But due to the operational problems, this strategy proved quite difficult for implementation. Therefore, the Government has now recently established "Nublang farm" in the eastern region of the country. This is a farm where only the indigenous breed is reared and bred. Studies will be done on this breed and the males will be in some cases used for upgrading of the indigenous/native population itself The priority will be on breed research itself as the country lacks true scientific data on these native breed.

The "indigenous yaks" will also be conserved. The conservation of other domestic species will also be done at the same time, particularly the pigs and sheep but as yet the strategy has not been worked out as these species are not of priority as of today.

1 The overview

a). Until about two years ago there was no method for monitoring the various species, breeds and crossbreeds. The recently launched (and is going on) "breed survey" is aimed at identifying the different species, breeds, breeding systems and sub-breeds with productivity levels. It is also imperative that either a system for taking random or stratified sample surveys is adopted as a routine or that such questionaires are included in the annual census. Clearly the latter option would provide the most up to date and regular assessment

of the situation but will involve extra time and effort every year. It is also not clear whether we require census to be taken annually as this is a costly affair.

2. It is however clear that any such survey must not only identify breeds and crossbred but also the level of crossbreeding in order that the overall strategy can be developed properly. Alongside such work, it is crucial that RGOB, with assistance as necessary, starts immediately to establish some sample recording of performance traits on a regular basis within sample villages through out the country. This is crucial to provide information on the relative performance of the different crosses so that a sustainable breeding and conservation strategy can be developed.

3. The existing breeding schemes have essentially been crossing systems with no selection system built in. Coupled to the lack of adequate recording, it is not possible to evaluate objectively either the real or the potential contribution which the breeds used can actually make. This comment, while being pointed mainly to cattle industry, applies equally well to the horse, the pig and the sheep industries and in basic terms, also to poultry.

4. Certainly, the tradition of crossing is well established within the Bhutanese cattle industry with the basic cross of Mithun with Siri (Nublang) being the major contributor both to draught (Jatsha) and butter/cheese (Jatsham). Most villagers claim that Jatsham is still preferred to the Jersey cross in many places due to greater butter output (as compared to milk).

5. The environmental impacts are now crucial to RGOB and the Ministry's responsibilities reflect this. According to observations different cattle crosses exhibit quite different characteristics in terms of grazing ability, with the traditional crosses able to gain forage from the hill and woodland while the Jersey and Brown Swiss crosses can not. While there is concern about and allegations of damage from forest grazing, for some time to come livestock has to depend upon forest grazing. The impact of pigs on environment is unlikely to become a serious problem as long as they are retained in small numbers usually with a household using domestic scraps and rice waste. The effect of Yak has to be considered as they cover large areas of land during the whole yearly cycle of movement but the major concerns must be firstly,
during the summer when overgrazing may be a problem since total number of animals is an important social criterion and secondly, during the winter when the Yak are on the lower slopes near the villages.

6. The genetic impacts of potential schemes is difficult to estimate since there is no good statistical base for present performance levels and few good records on which to base any predictions.

a. Siri cattle conservation plan

In considering the importance of Nublang for the farmers and general lack of information regarding genetic make-up of the indigenous breed of this nature, and whatever available being scanty and unreliable ,a farm has been established. This farm will be the nucleus of the activities related to Nublang breeding particularly for:

i) investigation of detailed genesis of this breed;
ii) producing, raising and supply of Nublang bulls to farmers at cost effective price; and,
iii) monitoring the performance of the bulls in the field as well as crossbreeding programme.

Some of the long term objectives of this programme will be to:

1) to study the genesis of Siri breed and make available facts for scientific adoption of conservation of the germ-plasm and to forgo degeneration through appropriate means.

2) To adopt scientifically sound crossbreeding programme by way of producing Siri bulls for distribution in the field and for semen production and cryo-preservation.

Strategy for Siri preservation

i) The centre shall purchase good quality foundation stock both male and female. Initially about 50 female and 2 males having good genotypic and phenotypic characters, will be purchased for multiplication. The stock will ultimately be raised to 150 females and 6 males along-with additional followers.

ii) All scientific measure to keep the performance efficiency to its optimum will be adopted.

iii) Systematic exchange and addition to herd, both and females shall be carried out periodically in order to prevent inbreeding. Nublang semen will be preserved side by side to create a gene bank.

iv) Proper health coverage will be done and side by side disease/parasite patterns on Nublang will be investigated and studied in collaboration with Regional Vety Laboratory in Khaling.

v) Initially Nublang will be reared under the pastoral/ranch type of management. This will be slowly transformed into intensive management system. This is to transform the habitat & husbandry into the productive system.

vi) Computerised data collection and processing will be initiated and to the extent possible external expertise will be invited for Nublang preservation logistics and techniques.

vii) Ex-situ (seman) conservation will be strengthened.

b. **Sheep conservation**

RGOB already has a breediig farm in Bhumtang where exotic breeds are maintained for ram production. This ensures the continued source of exotic genotypes, but ultimately dilutes **the local genotypes.**

In order to do away with over dilution of local genotypes, a nucleas flock oflocal sheep should be established. Schemes for selective breeding with **the** local (superior) rams should be initiated at farmers level.

The **following** should be the core activity of the programme:

breeding programmes to find a suitable breed for the village condition;

production performance (Wool, lambing, survivability etc.) of the improved sheep;

looking into methods of culling overcoming the religions sentiments; and

introduction of simple and efficient wool processing technique.

c. Yak **development strategies** in hand

Efforts are being made to introduce range-lands management practices for providing adequate fodder.

Creating marketing outlets for the yak herders.

Introduction of better animal health programme.

i) The Government still supports the yak herders by supplying yak bulls procured from Haa to other regions as they are regarded to be of superior stock. In order to avoid problems of inbreeding in yak population, exchange of yak bulls are being encouraged from one region to another region for breeding purpose.

ii)Artificial Insemination in Yaks: Introduction of AI in certain areas on trial basis. Artificial Insemination using frozen semen of Yak imported from China was carried out on a trial basis with the main objective to improve the Bhutanese yak by introducing new blood lines and to eliminate the adverse effects caused by inbreeding. Out **of 16 first inseminations carried** out,6 **progenies-5** male and 1 female were recorded. Although the phenotypic differences are not that distinct, the following slight differences were observed in the A.1 progenies:

-more hair growth on the dorsal ridge and tail;

- horns bigger in size and long;
-strong and compact limbs; and
-docility.

Further trials using frozen semen from Jersey & Tarentaise are still on. However, under the existing circumstances that there is no motorable roads to reach the yak herds and on the other hand yaks move to summer grazing land at an altitude of 5000m during the breeding season, the implementation of A.1 programme on a large scale on yaks would be very difficult.

In the longterm maintanance of genotype diversity in yaks and selective breeding schemes among the yak herders should be established. This should be linked with proper monitoring and the use and exchange of bulls.

It is also necessary to select bulls for seman production and exchange of this material in proper frequency. A nucleus farm, , basically for bull maintenance (for seman production) and to act as a focal point for studying production and socio-economic aspects, may be the best option for longterm yak develoment and maintenance.

d. Pigs and Poultry

The population of local pigs/poultry is sharply falling down. Although some steps are underway to collect local pigs and further breed them, expanding this effort should be seriously considered. A programme to produce our own grand parents from the blend of local poultry and exotic should be urgently initiated. This will ensure that the local poultry is maintained in good numbers for selective blending.

e. Mithun

Mithun is another very important cattle species for the production of crossbreeds in the country. The RGOB has two farms to produce mithans but numbers are not adequate. The present seman product on trial and its ex-situ preservation should be strengthened.

f. Horse

Attempts are underway to identify suitable horse types for the country. Once the horse is identified, a nucleus farm is required to produce the stallions in good numbers.

g. Buffalo and Goat

In view of the large shortfall in milk and meat supply, the local buffaloes and goats should also be maintained and preserved.

CHAPTER 3
ACTION PLAN: DIRECT CONSERVATION ACTIONS

3A. WILD BIODIVERSITY

IN-SITU CONSERVATION EFFORTS

PROTECTED AREA SYSTEM

Long Term Objective: Complete the establishment and management of the protected area system in Bhutan which adequately protects the full range of the nation's ecosystems and species.

Intermediate Objectives:

- To formulate and implement management plans for the protected areas in order of priority.
- To review what is known about the nation's ecosystems and species to determine whether there are additional areas which should be protected; and to initiate action to establish any additional areas which should be protected.

Action: Prepare guidelines for the preparation of management plans for protected areas to ensure that the plan incorporates management necessary to meet the objectives of the protected area system.

Action. Continue and accelerate the phased approach to preparing and implementing management plans that is currently being followed.

Management planning for protected areas must reflect the reality of the conditions within each unit (including conflicting traditional uses and existing populations) and the relationship to the surrounding (buffer) areas, land use and settlement patterns. Efforts are to be integrated as much as possible to resolve conflicting issues.

Action: Complete the review of the current protected areas to assess the full range of biodiversity, bio-physical and socio -economic situations. Each protected should be examined in terms of land use, vegetative cover, pressure from the resource use, land alternation and so on. Appropriate boundary revisions may be required. Baseline maps are to be prepared for each protected area to illustrate physiography, habitat types, land systems and other special features.
Baseline information will also be utilized for zoning of the protected area into core zones, multiple-use zones, visitor zones, seasonal grazing zones and enclave and buffer zonesTo

Management plan evaluation and revision

Action: Review and evaluate progress under the management plan every year as per the mandates outlined in the plan. National authority, local governments as well as representatives from the local communities should also be involved in the process.

Buffer Zones and Enclave Zones

Most of the current protected areas include scattered human settlements within the boundaries. The importance of sustaining economic activities for these populations runs the risk of conflicts with the environmental and conservation objectives of the protected areas and the perpetuation of ecosystems that harbor biodiversity and genetic resources.

Management objectives for buffer and enclave zones are:

- to encourage sustainable development of local communities in order to alleviate pressure on the protected areas as well as to ensure the survival of the local community way of life.
- Where possible, to provide alternate income generating methods to reduce dependency on the parks natural resources
- to maintain existing forest cover and restore degraded forests through reforestation, agroforestry, social forestry, and alternative energy projects
- to ensure that all major development acitivities proposed in the areas are sympathetic to the needs of the local people, and are planned and executed in ways that do not adversely affect the ecosystems of the park
- to strengthen the capacities of local government and community-based institutions which manage and regulate the use of natural resources
- to promote the participation and involvement of local communities in conservation and development programmes

Action: Give priority attention to the 'enclave'and 'buffer' zones surrounding designated protected areas, including the needs of existing populations within and near the areas. Give immediate priority to developing strategies to minimize the impact on such populations without adding to utilization pressures on the buffer zones.

Action: Promote participation and involvement of local communities in conservation and development and facilitate new and existing initiatives for Integrated Conservation and Development Programs within and around core zones. The success of ICDPs will depend upon the smooth interaction among implementing agencies, benefactors, institutional support, infrastructure capabilities, and current government policies regarding land-use planning and management. Therfore, during the initial phases Park management should work closely with other governmental organizations, national development agencies and extension services to facilitate and coordinate the process, and develop and implement practical workable programmes.

Promoting In Situ Conservation of Wild Crop Relatives and Wild Plants for Food Production

Assessment

Natural ecosystems hold important plant genetic resources for arable agriculture systems, including endemic and threatened wild crop relatives and wild plants for food production. Many are not managed sustainably. This genetic diversity, because of interactions which generate new biodiversity, is potentially an economically important component of natural ecosystems and cannot be maintained ex situ. Unique and particularly diverse populations of these genetic resources must be protected in situ when they are under threat. Most of the country's national parks and other protected areas, however, were established with little specific concern for the conservation of wild crop relatives and wild plants for food production. Management plans for protected and other areas are not usually broad enough to conserve genetic diversity for these species to complement other conservation approaches. Moreover, they cannot provide comprehensive geographical and biological coverage of the diversity of many species. It is thus necessary to complement the conservation in protected areas with measures aimed at conserving genetic diversity which lies outside such areas. In situ conservation implies comprehensive planning in which protection, production and genetic conservation aspects are considered and made complementary.

Long-term Objectives

To promote conservation of genetic resources of wild crop relatives and wild plants for food production in protected areas and on other lands not explicitly listed as protected areas.

Intermediate Objectives

1. To initiate planning and management practices which take into account wild crop relatives and wild plants for food production. To clearly identify which wild crop relatives and wild plants for food production need to be protected in situ. To gain knowledge of the uses of wild plants as sources of income and food.

2. To create a better understanding of the contributions of plant genetic resources in arable agriculture systems to local economies, food security, and environmental health. To improve management and planning and promote complementarity between conservation and sustainable use in parks and protected areas by, inter alia, broadening the participation of local communities in these processes.

3. To establish better communication and coordination between various institutes and organizations engaged in in situ conservation and land use management, nationally, regionally and locally. To conserve genetic diversity for these species to complement other conservation approaches.

Policy Strategy

The RGOB, subject to national legislation and with the cooperation of the relevant public sector institutes, non-governmental organizations, farmers and traditional communities living near protected areas, should:

(a) include as appropriate, among the purposes and priorities of national parks and protected areas, the conservation of plant genetic resources in arable agriculture systems, including appropriate forage species, wild relatives of crop plants and species gathered wild for food;

(b) consider integrating conservation and management of plant genetic resources in arable agriculture systems in national land use plans;

(c) support the establishment of national and local objectives for protected area management through broad based participation, involving in particular, where they are present, groups most dependent on wild plants for food production.

(d) support the creation of advisory panels at the appropriate levels, that where appropriate, involve farmers, indigenous communities, plant genetic resources scientists, local government officials, and community leaders, to guide management of protected areas, according to national rules and regulations;

(e) recognize the rights of indigenous communities to PGRFA in protected areas;

(f) recognize that women are a valuable source of information on the feasibility of in situ conservation and management practices;

(g) support indigenous and local communities efforts to manage wild crop relatives and wild plants for food production in protected areas, or where existing aboriginal or treaty rights are recognized;

(h) review existing environmental impact statement requirement to incorporate an assessment of the likely effect of the proposed activity on local biodiversity in arable agriculture systems, particularly on wild crop relatives;

(i) integrate genetic conservation objectives in the sustainable management of wild crop relatives and wild plants for food production in protected areas and other managed resource areas.

The RGOB with cooperation of the relevant national institutes, non-governmental organizations and the farming, indigenous and local communities living in non-protected areas, should seek, where possible and appropriate, to:

(a) establish conservation of wild crop-relatives and wild plants for food production as an integral component of land-use planning;

(b) encourage local communities to conserve and manage wild crop relatives and wild plants for food production, and provide for their participation in decisions relating to such local conservation and management.

As appropriate and feasible, protected area policies should promote and sustain rather than restrict those human activities that maintain and enhance genetic diversity within and among plant species. Participatory approaches to protected and related area management should also be encouraged to reconcile the sometimes conflicting goals of conservation and local livelihood security.

Capacity Development

The RGOB should, whenever possible, and as appropriate:

(a) develop a prioritized plan, particularly for those ecosystems in which high levels of diversity related to plant genetic resources in arable agriculture systems are found, and conduct national reviews to identify those management practices needed to protect the desired level of genetic diversity for wild crop-relatives and wild plants for food production;

(b) assist local communities in their efforts to identify, catalogue and manage wild crop relatives and wild foods;

(c) monitor the holdings, the distribution and diversity of wild crop relatives and wild plants for food production, integrate and link data and information from in situ conservation programmes with that of ex situ programmes and encourage private and non-governmental organizations to do likewise.

Coordination and Administration

The RGOB should, as appropriate:

(a) Link protected area planning and management with institutions responsible for the conservation and sustainable use of wild relatives of crop plants and wild plants for food production, such as centres for crop genetic resources, national crop genetic resources coordinators, and botanical gardens.

(b) designate a national focal point, as appropriate, to catalyze coordination of in situ protection programmes and liaise with other countries in the region;

(c) establish mechanisms for periodically reviewing and modifying conservation plans.

CONSERVATION OUTSIDE OF PROTECTED AREAS

Integrated Conservation and Development Projects

The Integrated Conservation and Development Projects are intended to bring development benefits to people who are inhabitants or who live in the vicinity of the protected areas. They have constructed much needed schools for local communities, introduced programmes to improve health and sanitation, and carried out activities to help the rural communities in pasture development for their livestock.

Action: Continue and expand the ICDP activities, and monitor the results.

Forest Areas

In addition to protected areas there is also a need to strengthen the protection and conservation strategies for management of all forest areas outside protected areas. There is increasing pressure on the forests to provide increasing amounts of industrial resources, building and construction timber, fuelwood, non-wood products and grazing. Recreational use for forest is also foreseen.

Long term Objectives:

- to conserve and manage forests on a sustainable basis
- to harvest forest resources within the prescription of scientific management in order to meet the local demand for forest products, promote forest-based industries (particularly those with high value-added potential), and to generate foreign exchange through export of forest products.
- To ensure ecological stability by maintaining at least 60% of the total land area under forest at all times.

Given the growing and conflicting demands and in order to reduce the risks of environmental damage, the future use of forest resources requires the careful determination of the long-term sustainable capacity of the appropriate management units. Forest use has to be based on scientific management plans, taking into account such factors as long-term growth and yield relationships, responses to silvicultural treatment and reforestation strategies.

Action: Establish sound management plans and implement them so that the forests are managed on a sustainable basis.

Management plans when developed and approved should be carefully implemented and monitored and to have the performance evaluated, particularly with respect to anticipated impacts of harvesting and other uses. Plans need to be updated on a periodic basis based on feedback from actual operational implementation.

3B. DOMESTIC BIODIVERSITY

IN-SITU CONSERVATION EFFORTS

Policy on Introducing Exotic High Yielding Varieties vs. Indigenous Species

In workshops and other fora the question has arisen of what should the nation's policy be on importing and using exotic high yielding varieties versus maintaining the indigenous species and races. Farmers naturally want to get the highest yield possible from their lands, and much agricultural effort has been directed to encouraging farmers to adopt high yielding exotics. On the, other hand, as is discussed in more detail below, most high yielding exotics represent monocultures with a relatively narrow genetic base. Consequently they are particularly vulnerable to diseases, parasites and changes in the climate and other environmental conditions, to which the indigenous species are genetically well adapted. Consequently it is essential to maintain the indigenous genetic diversity to provide the broader genetic base to assure sustainability in crop or livestock yield.

A further issue concerns the overall balance of costs and benefits for the country. For example, some exotic varieties of livestock do provide higher yields to the farmers, but because they are less well adapted to the local conditions, diseases, etc., the costs for veterinary health services (borne by the government, not the farmer) have increased greatly. When exotics are considered for import there should be an overall assessment of the costs and benefits, including the environmental ones, not simply an assessment of anticipated increased immediate yield of farm products.

Introduced exotic tree species represent another issue. While some, such as eucalyptus and some imported pines, produce fast growth, their effect on the environment is usually far from benign. In much of the world it has been found that relative to natural forest, a eucalyptus or imported pine plantation often accelerates rather than retards erosion; it is far less usable for wildlife habitat for most indigenous species; and it maintains a grossly impoverished biodiversity relative to the native forests it replaced. Therefore as a general rule, intact native forest systems should not be replaced by plantations of exotics. However, where the native forests have been lost or very greatly degraded, the exotics can provide the useful benefits of relatively quick revegetation (at least of the exotics) and wood productivity.

Therefore a rational policy would be to allow exotic high yielding species on the basis of decisions made after an assessment of the overall costs and benefits to the country. But at the same time, there should be assurance -- and as necessary, suitable programs to ensure -- that the indigenous species and varieties will not be lost.

Surveying and Inventorying Crop Genetic Resources

Assessment

Rational conservation ideally begins with the surveying and inventorying of existing resources. In order to elaborate policies and strategies for the conservation and utilization crop genetic resources, the national agricultural centers need to know what resources exist in the country. By ratifying the Convention on Biological Diversity, Bhutan has acknowledged certain needs and responsibilities concerning this subject.

Long-term Objectives

1. To identity, locate, inventory, and as feasible assess any threats to those species, ecotypes, cultivars and populations of plants relevant to food and agriculture, especially those that are of anticipated use.
2. To facilitate the development of complementary conservation strategies (e.g., weighing the need and importance of collecting for ex situ conservation and/or continued conservation in situ and national policies related to the conservation and sustainable use of plant genetic resources in arable agriculture systems.

Intermediate Objectives

1. To develop useful methodologies for surveying and inventorying plant genetic resources in arable agriculture systems.

Policy Strategy

The surveying and inventorying of plant genetic resources in arable agriculture systems should be considered as a step in the process of conservation and of reducing the rate of loss of biodiversity. Without the capacity to conserve and/or use, however, such work may have marginal utility. Thus, surveying and inventorying should ideally be linked to specific objectives and a plan, such as one for in situ conservation, or collecting, ex situ conservation, and use. Local and indigenous knowledge should be recognized as important components of surveying and inventorying activities and should be properly considered in all such efforts.

Capacity Development

The RGOD should provide and may need financial and technical support to survey and inventory plant genetic resources in arable agriculture systems, and assistance in having appropriate access to existing and planned Geographic Information System facilities and information. Training and capacity-building should be undertaken in areas such as taxonomy, population biology, ethnobotany, and eco-regional and agro-ecological surveying.

Research and Technology

Adequate support should be given to developing better methodologies for the surveying and assessment of intra- and infra-specific diversity in agroecological systems. Existing information sources should be used in research to determine to what extent wild relatives of domesticated species are already in the national parks and protected areas.

Coordination and Administration

A strong coordinating body, with policy support and high level institutional mandate must be established in the country. Strong linkages need to be established with central programmes, training institutes, regional and dzongkhag level research and extension networks and with the users of plant genetic resources in arable agriculture systems (breeders and farmers) in order to inform, direct and prioritize the entire conservation process. The national programmes and projects should collaborate in surveying and inventorying activities in order to build in-country Capacity Development.

Supporting On-Farm Management and Improvement of Plant Genetic Resources in arable agriculture systems

Assessment

The Bhutanese farmers choose to grow new cultivars for many reasons including market conditions, family food security and environmental sustainability. Unfortunately, these choices often result in significant on-farm genetic erosion. Still, in some parts of the country, the overwhelming majority of farmers, as a matter of choice or necessity, engage in de-facto conservation and development of plant genetic resources in arable agriculture systems as they select and save seed for the next planting season. These farmers typically practice low-input farming. Such farmers often lack access to new and diverse genetic materials which could be *To identify, locate, inventory, and as feasible assess any threats to those species, ecotypes,* integrated into existing crops to improve production. Historically, farmer access to a broad range of germplasm has contributed to yield increases and greater crop adaptability through farmer selection. It has also led in many cases to the rise of local seed system and local system of crop development.

Without appropriate and creative approaches, prospects of markedly increasing the productivity of low-potential and low-input farms through genetic improvements alone also would appear limited. Yet, increased productivity is important for food security and to reduce pressure on fragile environments. Neither the private sector nor public agricultural research institutions presently have the Capacity Development of serving this large, economically disadvantaged population completely. The RGOB must also seek broad-based participation to realize farmers' rights through national legislation, as appropriate.

Initiatives focusing on participatory, on-farm management and improvement of plant genetic resources in arable agriculture systems may offer the potential to reach large

numbers of farmers and promote further agricultural development. It would, of necessity, depend on farmers themselves and their decisions and build upon and make use of their on-going efforts to improve their crops through mass selection and other breeding efforts. Efforts to provide farmers greater access to appropriate genetic resources and training could assist farmers in improving various characteristics of their planting materials (such as disease or pest resistance), and in increasing food production. The REID of MOA, especially the Research and the Extension Sections should engage in projects researching and promoting on-farm management and improvement of plant genetic resources in arable agriculture systems. The Capacity Development of such projects may need to be expanded to reach maximum number of farmers across the country. In this way, the full potential of on-farm improvement may be realized.

Long-term Objectives

To better understand and improve the effectiveness of existing on-farm conservation, management, improvement, and use of plant genetic resources in arable agriculture systems. To achieve a better balance between ex situ and in situ conservation. To realize Farmers' Rights at the international, regional, and national levels. To promote the equitable sharing of benefits from plant genetic resources in arable agriculture systems as called for in the Convention on Biological Diversity. To foster the future emergence of public or private seed enterprises and cooperative concerns as an outgrowth of successful on-farm selection and breeding. To encourage traditional seed exchange and supply systems.

Intermediate Objectives

To gain greater knowledge about the dynamics, methodologies, effects, and potential of on-farm conservation and plant improvement. To establish or strengthen programmes and networks for on-farm management of farmer's varieties, wild relatives of food crops, harvested food plants and rangeland genetic resources. To extend the role of national, regional and international genebanks to include support for and provision of materials to on-farm improvement programmes. To build on-farm and garden programmes based on local systems of knowledge, institutions, and management, ensuring local participation in planning, management and evaluation.

Policy Strategy

On-farm activities are a means to improve existing practices in selected communities. They are complementary to and not a substitute for more formal varietal development and seed supply systems. Institutional flexibility will be needed in working with farming communities. No single plan or recipe is possible or advisable. Working examples must be identified of conservation and sustainable use of plant genetic resources in arable agriculture systems that support and maintain the social, economic and cultural values of local and indigenous communities and improve the quality of life.

The RGOB should consider how production, economic incentive, and other policies, as well as agricultural extension and research services might facilitate and encourage on-farm management and improvement of plant genetic resources in arable agriculture systems. Where appropriate, the RNRRCs should consider strengthening local level Capacity Development to participate in all stages of breeding, including on-farm selection and adaptation. The research system and others should incorporate gender and socio-cultural factors into the design and implementation of agricultural research on crop genetic resources activities.

Capacity Development

Adequate support should be given to farming community-based institutions and farmers' associations and groups engaged in providing practical assistance to on-farm conservation and improvement work. Considering the needs of and numbers of the farmers served, national agricultural institutes should consider identifying appropriate landraces/farmers' varieties for multiplication and/or developing new breeding populations incorporating specific characteristics into locally adapted materials for on-farm improvement activities. Step-by-step incorporation and improvement should be encouraged rather than the hasty replacement of existing on-farm diversity. As a general practice, quantities of seed and planting materials distributed should encourage research and experimentation by farmers, and not be so large as to displace normal seed supply sources or on-farm seed management.

Interdisciplinary training programmes should be developed for researcher, extension workers, contact farmers and others in facilitating and catalyzing on-farm activities, including selection and breeding techniques appropriate to supplement and improve those already used by farmers. The focus of training programmes should be to help farmers better incorporate new knowledge and technologies and indeed become better technicians, and researchers become better enablers and supporters of farmers. Training should be aimed at four different groups: scientists, technical support staff, extension agents (including NGOs), and farmers. Support for advanced degree work should include relevant work in the biological and social sciences. Training of extension agents should aim to increase their skills in crop identification, selection and breeding, and seed maintenance in order to provide the important bridge between national agricultural research staff and farmers.

Training of (and by) farmers should emphasize enhancing the identification of plant traits, selection/breeding, utilization and maintenance of local crops. It is important to develop farmers' skills in selection of plants in the vegetative state and not only after harvest. Training programmes should be designed in close collaboration with the RNRRCs and farmers and their organizations and be based on particular needs as they see them. Programmes should consider the different uses of biological resources by women and men, including women's concern for the multiple uses and processing requirements of crops.

Research and Technology

Four basic types of rigorous, multi-disciplinary scientific research are needed:

(a) ethnobotanical and socio-economic research to understand and analyze farmers' knowledge, selection/breeding, utilization, and management of plant genetic resources in arable agriculture systems, consistent with the approval of the farmers involved and with applicable requirements for protection of their knowledge and technologies;

(b) population and conservation biology to understand the structure and dynamics of genetic diversity in local landraces/farmers' varieties (including population differentiation, gene flow, degree of inbreeding, and selective pressures);

(c) crop improvement research, including research in mass selection and simple breeding as a means of increasing crop yields and reliability without significant losses of local biodiversity.

(d) research and extension studies for little known crops will be promoted, including seed production, marketing and distribution.

Scientific research should, when possible, be coupled with on-farm activities in order that the context and purpose of the work are fully appreciated. Research should assist in the monitoring, evaluation, and improvement of on-farm efforts. Research should be undertaken in a participatory and collaborative manner to foster interaction and cooperation between rural people and the staff of the REID. Other institutions must be involved appropriately whenever necessary. Methods should be developed and assistance provided for recording and linking in situ farm and garden management and conservation of plant genetic resources in arable agriculture systems with a national genebanks and the RNRRCs.

Coordination and Administration

National coordination efforts in this area should allow for and encourage local, community-level initiatives in proposing programmes. Small, grass-roots projects should receive priority in funding and support services. Priority should be placed on farmers within a technical project area promoting the maintenance of pre-existing diversity and to collaboration between communities and research institutions. Subject to satisfactory progress, programmes should be sufficiently long (10 years or more) to achieve results. Efforts should be coordinated closely with RNRRCs, the decentralized extension network and the farming communities.

Assisting Farmers In Disaster Situations to Restore Agricultural Systems

Assessment

Natural and man-made disasters pose enormous threat to agricultural development. And pose huge challenges to the resilience of agricultural systems. Often, adapted crop varieties are lost and cannot be recuperated locally. Food aid, combined with the importation of often poorly adapted seed varieties, can lower yields and keep them low for years. While addressing the immediate crisis, such practices can exacerbate hunger conditions, undermine food security and increase costs of assistance well into the future. Indigenous landraces/farmers' varieties lost during calamities can frequently be found in ex situ collections outside the affected country. Properly multiplied, such stocks can be returned to reconstitute locally adapted planting material, an essential component of sustainable agricultural systems. Partnerships are important in such efforts and can include government and non-governmental organizations.

Long- Term Objec tives

To support farmers' and rural peoples' livelihoods and sustainable agriculture options through the rehabilitation of agricultural systems based on locally adapted plant genetic resources, including the restoration of pre-existing germplasm in cases of disaster- induced loss of plant genetic resources in arable agriculture systems.

Intermediate Objectives

To establish Capacity Development to deliver seed of adapted local varieties as needed to help re-establish indigenous agricultural systems in areas affected by natural disasters, war, and civil strife.

To establish institutional responsibilities and mechanisms for the identification, acquisition, multiplication, and re-introduction of appropriate genetic materials.

Policy Strategy

The RGOB with the cooperation of relevant rural-based committees, farming communities and UN bodies and regional, intergovernmental and non-governmental organizations should establish necessary policies at all levels which will allow unhindered implementation of seed security activities in response to calamities.

To minimize genetic loss, Bhutan should ensure duplication of plant genetic resources in arable agriculture systems outside of the country, such as in genebanks of neighboring countries, and/or regional or international genebanks and crop genebank networks. Where such ex situ collections do not exist outside the country, support should be given to undertake emergency collections of local varieties as soon as possible within the country, so that they may be multiplied for immediate use and also may be conserved in national and international ex situ collections for future use.

Capacity Development

The RGOB, through the MOA should establish agreements with appropriate agencies, especially national and international agricultural research institutions, for rapid acquisition and multiplication, restoration and provision of materials. Such institutes should endeavour to ensure that their capacity is sufficient for the task. Cooperation with non-governmental and private organizations can be an important component of efforts to distribute suitably adapted germplasm into regions that are recovering from disasters. Adequate information systems must be established to identify and track appropriate germplasm for reintroduction.

The RGOB should consider making available adequate funds to set in motion the multiplication of seed and to initiate other related activities in response to emergencies, after approaching existing national and international emergency funds to determine if they could effectively plan ahead to cover action related to the restoration of plant genetic resources in arable agriculture systems after disaster situations. It should also strengthen farmers' abilities to cope with disasters by supporting the re-emergence of local seed supply networks.

Research and Technology

Previous experience should be reviewed and options developed to enhance preparedness for rescue of ex situ collections and emergency seed collecting in the context of calamities, including war, civil strife, industrial accidents, and natural disasters. These efforts could benefit from close collaboration with other countries, non-governmental and private organizations, the national, regional and international agricultural research centres (IRRI, for example) regional plant genetic resource networks (SAC, etc.) as well as relevant inter-governmental agencies such as FAO/ICGRFA/IUPGRFA, WFP, UNDP/GEF and UNEP, etc.

Coordination and Administration

This programme should be coordinated administratively by MOA in close collaboration with the national and the international agricultural research centres, regional plant genetic resources networks, donor countries and NGOs. Public awareness efforts are needed to sensitize the donor community and NGOs to the importance of adapted plant genetic resources in arable agriculture systems in relief and rehabilitation efforts and to inform them of this programme. Such efforts should also increase awareness of the need for safety duplication of materials in other countries.

EX-SITU CONSERVATION EFFORTS

Supporting Planned and Targeted Collecting of Plant Genetic Resources in the arable agriculture system

Assessment

Potential for loss and the opportunities for use are the prime motivating forces behind most collecting. The materials that are currently being conserved do not represent the total variation in plants. In Bhutan, even the major crops have not generally been well collected. Collecting of certain regional, minor, and subsistence crops is much less attended to. Past collecting missions conducted by IPGRI and IRRI with inadequate methodologies may not have successfully sampled diversity. Conditions in genebanks where these Bhutanese materials are stored may also have led to the loss of collected materials, leading to a need for recollection. In some cases, collecting is needed to rescue materials under imminent threat in situ. In others, clear utilitarian needs - for disease or pest resistance or other adaptive characteristics - make further collection warranted.

Long-term Objectives

To collect those species, ecotypes, landraces/farmers' varieties, or other cultivars, and associated information, that are under threat or are of anticipated use.

Intermediate Objec tives

To begin to fill gaps in the genetic diversity of existing collections of some crop species with well targeted and prioritized collecting.

Policy Strategy

Collecting practices should be developed with regard to the objectives and obligations set forth in the Convention on Biological Diversity, for example the right of the traditional farmers and farming communities to prior informed consent (PIC) before providing access to genetic resources and the obligations of Collecting missions, subject to the RGOB approval, to respect the knowledge of indigenous communities regarding the conservation and sustainable use of biological diversity. The collecting conditions and the actual field activities must be consistent and implemented on a mutually agreed terms.

Capacity Development

Material so collected should be deposited in facilities which have the capacity to manage them within the country, and possibly elsewhere. Where such facilities do not exist in the country, they should be developed, where desired, and in the meantime, the materials could be managed in other countries as agreed by the contracting parties. Before collecting is initiated, full consideration should be given to the ability to conserve the material collected effectively and sustainably. Training should be undertaken in scientific collecting methods for plant genetic resources in the arable agriculture system.

Coordination and Administration

Coordination, as appropriate, should take place within the country, Regional and international level coordination, as appropriate, is needed to provide linkages with ex situ collections and gap-filling and regeneration efforts. Such coordination might concern the identification of specific needs of Bhutan that could be met by plant genetic resources in the arable agriculture system in another.

Strong linkages need to be established with regional and crop networks and with the users of plant genetic resources in the arable agriculture system (breeders and farmers) in order to **inform,** direct and prioritize the entire conservation process, including surveying, inventorying and collecting.

Mechanisms need to be developed at all levels for emergency collection of plant genetic resources in the arable agriculture system. These mechanisms should make full use of and therefore should be closely linked with information and early warning systems at all levels.

As part of national plant genetic resources programme, The RGOB may designate a focal point for administering requests for collecting.

Expanding Ex Situ Conservation Activities

Assessment

The diversity of many species of plants cannot be conserved conveniently or effectively as seed. Some species are vegetatively propagated and others have "recalcitrant" seed. A
number of major staple food crops, tropical fruits, and export crops, fall into these categories. Due to technical difficulties, the conservation of genetic resources of such plants is often not given appropriate attention.

Many plants of local importance in the arable agriculture system have been virtually neglected by the government institutes for agriculture research and development. Collections are ad hoc and no coordinated efforts have been made to ensure that adequate germplasm samples are maintained for conservation and further development.

Botanical gardens, field genebanks, and the use of new technologies, including in vitro methods, could be developed more fully to complement and expand conservation of plant genetic resources in the arable agriculture system.

Long-term Objective

To conserve plant genetic resources in the arable agriculture system so that they will be available for use.

Intermediate Objectives

- To develop management strategies for ex situ conservation of vegetatively propagated and recalcitrant seeded plants, as well as for species neglected in current conservation activities.

- To promote the development and transfer of appropriate technologies for the conservation of such plants.

- To encourage and strengthen the involvement of boating gardens in the conservation of plant genetic resources in the arable agriculture system, particularly for those species for which they already have a comparative advantage.

Policy Strategy

The RGOB, IARCs, NGOs (NWAB, RSPN, etc.), and funding agencies, should provide adequate, appropriate, and balanced support for the conservation of vegetatively propagated and recalcitrant seeded plants.

Capacity Development

Botanical gardens and field genebanks should be created and strengthened, particularly in relation to their capacity to conserve species neglected by more agriculturally-related facilities. In this regard, capacity building is especially needed in Bhutan. As appropriate, genebank facilities of boating gardens might be strengthened.

Simple, low-cost botanical gardens, arboreta and field genebanks associated with colleges, schools and other institutions should, as appropriate, be established and strengthened and encouraged to promote education and public awareness.

Support should be given to training in in vitro techniques and to other new and appropriate technologies. In accordance with national and local needs and priorities, support should be given to establishing the capacity to use such technologies.

Research and Technology

Protocols should be developed for in vitro conservation and other conservation technologies for important vegetatively propagated and non-orthodox seed plants.

An assessment should be made of the conservation needs of other species in the arable agriculture system which are not adequately conserved, including a survey of

activities as a prerequisite for further planning and coordination of collecting and conservation..

Administration and Coordination

National Crop and in-country regional networks (between RNRRCs) as well as relevant outside organizations, with the support of IARCs and RNRRCs, should regularly assess the state of conservation of vegetatively propagated and non-orthodox seeded plants, and make recommendations and take action as appropriate.

Links with international botanical garden organizations (such as the International Association of Botanical Gardens and Botanical Gardens Conservation International) and those responsible for and engaged in conservation of food and agriculture species (inter alia, FAO, IPGRI and other international agriculture research centres) should be initiated and strengthened. Similar links should be made between institutions, including the private sector (such as the nursery trade), at the national level. Practical cooperation should be encouraged as a matter of priority.

CHAPTER 4
ACTION PLAN: ESSENTIAL SUPPORTING MEASURES

4A. WILD BIODIVERSITY

SCIENTIFIC RESEARCH TO IMPROVE THE STATUS OF KNOWLEDGE

RESEARCH ON BIODIVERSITY ITSELF

Building the Scientific Knowledge Base

All of the potential avenues for both expanding economic benefits from biodiversity and better ensuring its conservation are currently constrained by the shortage of basic scientific knowledge about the identity, status, and distribution of species and genetic resources in the country, the status and distribution of habitats, the ecological requirements of various species, and the ecological functioning of ecosystems. Further development of nature tourism is constrained by the lack of field guides and individuals knowledgeable about unique biodiversity within the nation. The management of protected areas is constrained by incomplete surveys of species and poor knowledge of species requirements. Marketing of herbal medicines is constrained by incomplete information on the status of wild populations of medicinal plants and information on how to cultivate threatened species. Bioprospecting is constrained by incomplete knowledge of what species are present, inability to assure potential "clients" of the validity of the taxonornic identification of a sample, inability to assure re-collection of a sample, and lack of knowledge of potential ecological role of particular species. Particularly for **a** country where the potential to enhance benefits from biodiversity is so great, there is **a** pressing need for an ambitious program to build knowledge about its biodiversity.

Recognizing both its own limited scientific capacity for biodiversity research and the economic risks that have been historically associated with foreign scientists collecting species and undertaking biological research within **a** country, Bhutan currently does not allow foreign scientists to work in the country. However, both legal and practical mechanisms now exist to enable the country to bring international scientific expertise to bear on its research needs in a manner that serves to build the country's own research capacity and to complement that capacity as needed. Bhutan is not in a unique position in this regard. Biological research -particular taxonomic and systematic research -- is necessarily a global scientific endeavor. Because species in most families are distributed widely across a region, a scientist cannot become an expert on the identification of species within a family without studying species in a variety of countries. In turn, no single country can hope to have experts capable of identifying new species in all families that might be encountered in the country. Indeed, for certain groups of organisms -such as nematodes -- only one or two experts may exist in the world.

Costa Rica has pioneered successful approaches for building its own biodiversity scientific capacity through the strategic use of foreign expertise. The basic elements of Costa Rica's approach are the following box:

Ecological Research. The country has more than a dozen ecological research stations run by the Organization of Tropical Studies -- a group of U.S. and Costa Rican Universities with an office and staff in Costa Rica. Classes are conducted at these field stations for scientists and policymakers, and scientists conduct research at the field sites. Considerable financial resources have been invested in the development of scientific infrastructure in the country and a number of Costa Rican scientists have received their training through this program.

Biodiversity Inventory. Through the National Biodiversity Institute (INBio), an inventory of the country's biodiversity is now underway. Most of the biological collecting is done by a group of "parataxonomists" -- local residents, typically with only a basic education, who have been trained by professional taxonomists to undertake field collecting and basic taxonomic identification. The parataxonomists bring their collections from their field sites to INBio once each month. There, curators identify those species that they know, and set aside others that can't be identified for study by visiting experts. Samples of all species collected are held at INBio and duplicates are sent to international collections with extensive holdings for the group of species involved. For plants, for example, duplicates are sent to Mssouri Botanical Gardens, New York Botanical Gardens, and Kew Gardens.

Taxonomic research. By virtue of the unique collection that Costa Rica is developing, international taxonon-dsts with expertise in specific groups found in Costa Rica are interested in visiting the country and studying the collection. INBio invites these scientists to the country to help their own experts identify and describe new species, and in turn, the experts use the collections for their research. The result is that the visiting experts are assisting Costa Rica build its knowledge of its own biodiversity. Where historically taxonomists collected samples for research at their home institution, INBio turns the tables, bringing taxonomists to the country to study samples where they are also able to help train local experts.

Costa Rica's approach represents one of many possible models for how Bhutan might consider developing its own research program. The country needs to work toward the creation of an extensive biodiversity research program, but this must be done relatively slowly to ensure that its own capacity is built as it begins to expand research activities. The following steps could help Bhutan expand its scientific capacity in a manner focused on building its own scientific capacity:

1) ***Invite ecological scientists to the country to undertake specified research in collaboration with local experts.***

Ecological research undertaken within the country is a low risk and high yield activity. The RGOB can issue research permits (see above) that clearly specify that material cannot be collected and removed from the country, (For any ecological research, "type" specimens of the organisms being studied would have to be collected and examined by taxonomists -- the research permit should allow such basic identification, but could also specify that the samples be returned to the country or, more likely, could require that a material transfer agreement be attached to the samples collected which precluded any future commercial use.) Researchers could be required to fonn teams with Bhutanese experts to ensure that local knowledge and capacity is strengthened through their research and to ensure that any published papers stenuning from the research are made available in Bhutan. Research like this provides a "free" service in increasing the scientific understanding of the species and ecology in the country. In addition, it begins to provide the core knowledge that can be used eventually to build an ecotourism industry or begin other economic uses of biodiversity.

*2) **Invest in the upgrading and staffing of a National Herbarium.***

Bhutan is fortunate to have an existing national herbarium despite the limited resources that it has received. The value of this collection does not seem to be well appreciated within the government. A herbarium forms the "backbone" of any effort to build scientific knowledge of the country's diversity. The herbarium, however, is seriously underfunded and understaffed. The country's collections should be held in a single herbarium and the resources provided to ensure that the samples are adequately maintained.

*3) **Explore the establishment of additional biological collections.***

In addition to the herbarium plans have already been approved for the second most essential biological collection for any country: a seedbank. The country should also begin planning for the establishment of bird, mammal, and invertebrate collections. Within a decade, Bhutan will need a national collection that can expand beyond plants to begin to cover the bulk of diversity that wfll be found in the nation.

*4) **Encourage several Bhutanese biologists to obtain doctoral training in plant and invertebrate taxonomy.***

Bhutan, like any small country, will need to rely extensively on international taxonomists as it builds its knowledge of its biodiversity. However, the value of the international expertise can be magnified if the country also has researchers with advanced training in this field. Additional Bhutanese technical expertise in this field will also contribute to the country's ability to set policies regarding the scientific exchange of information and samples.

*5) **Encourage international taxonomists to visit Bhutan and help with inventory and collections.***

The biodiversity of Bhutan is of sufficient interest that it is likely that some international taxonomists would be interested in visiting the country to work with the existing collections and undertake some field collections even if they are not allowed to remove samples from the country. This could be an intermediate step to Bhutan's entry into the international taxonon-dc scientific network. As with ecological researchers, these taxonomists could be required to obtain a research permit that explicitly prevents the transport of samples out of the country.

6) Allow exchange of biodiversity samples for non-commercial research purposes only.

Within several years of the initiation of the above steps, it should be possible for Bhutan to begin exchange of scientific samples for research purposes. Two legal instruments now minimize the risk associated with such exchanges. For **a** country like Bhutan with tremendous potential for gain from the wise management and use of its biodiversity, the "cost" to the country of not knowing more about its resources greatly exceeds any cost that might be associated with the illegal use of samples from the country. Moreover, since the great bulk of Bhutan's biodiversity can still be found in the surrounding countries the risk is somewhat of **a** moot point in any event -- any unscrupulous collectors could be obtaining samples from outside Bhutan today.

All biological material collected after the Biodiversity Convention comes into force and obtained from another county falls under the Convention's terms for ensuring prior informed consent for access to biodiversity and equitable sharing of any benefits derived from that diversity. So long as Bhutan's access legislation requires that collectors provide all information about their intended use of the material collected, then any other use (e.g., for commercial purposes) not agreed to by Bhutan when issuing the permit would be in violation of the Convention and the country could use the dispute resolution procedures provided by the Convention.

Second, Bhutan can make use of "Material Transfer Agreements" (MTAs) associated with each sample that is sent out of the country for research purposes or for incorporation in collections in other countries. A MTA is a short contract between the "supplies, and "recipient" of biological samples. The agreement in this situation would merely state that the samples are being provided for basic research purposes only. It would state that if during the course of basic research a conunerciahy valuable property or innovation is discovered, then the researcher would have to enter into a negotiation with the supplier (Bhutan) to determine an equitable sharing of benefits with the country, ownership of patent, etc. And the agreement would place stipulations on transfer of material to a third party (typically, it would simply state that the material is subject to an MTA and the terms of the agreement are binding on the third party). In practice, the likelihood of material being exchanged for taxonomic research ever being used for research of potential commercial value are extremely slim. Even so, the combination of an MTA and the protection provided by the Biodiversity Convention provides strong

protection to Bhutan in the event that it is. A model MTA for use in transfer of material for taxonomic research can be found in Putterman (1996).

7) ***Allow bioprospecting only after the country has built the knowledge base and enforcement capacity.***

If Bhutan initiates the steps listed above to build its biodiversity knowledge base, then within a decade it could be in the position to allow commercial bioprospecting. With adequate capacity to monitor and enforce regulations and enhanced information about its biodiversity, then it would be capable of expanding the potential economic benefits of its biodiversity while facing little risk associated with the transfers of biodiversity. Because other countries in the region are losing their biodiversity rapidly, however, Bhutan should recognize that the value of the biodiversity it contains will only increase with time. A cautious approach towards expanding the exploitation of biodiversity for commercial gain is thus warranted.

RESEARCH ON SUSTAINABLE USE

Use of biodiversity resources makes a major contribution to the daily way of life of Bhutan's rural population. This involves plants and animals used for medicine, food, construction, fuel and other uses. There is substantial local or traditional knowledge about the resource species and their use, but there is virtually no scientific information about it. Anecdotal information indicates that the present use in many cases is not sustainable, particularly in view of the increasing population and its growing needs. Consequently, substantially more information is needed to provide guidance to assure that local people continue to receive the benefits of use, and that the use is sustainable.

Long Term Objective: To assure that the rural people continue to receive the benefit of biodiversity resources through use which is sustainable.

Short Term Objective: To conduct surveys and research to obtain information on which to base effective sustained management of the biodiversity resources outside of protected areas.

Actions: Develop a programme to survey the uses of biodiversity resources by rural Bhutanese. Key elements of the program are:

- To identify the key species and species which are or appear to be in danger of overuse and depletion;
- To collect traditional, local knowledge about the species and their uses;
- To conduct scientific research to provide the basis for sustainable management of these resources; and
- To develop management programmes, public education, etc., to apply the knowledge gained and to achieve sustainable use for the benefit of the people.

SURVEYS AND MONITORING

Wildlife Surveys

Action. Facilitate detailed surveys of key wildlife species in the protected area. Studies should include current status of populations, distributions, habitat requirements and population trends. Once basic ecological information for the key species has been obtained, programs can be implemented to safeguard and monitor them.

Almost certainly more species exist in the protected areas than have been confirmed to date. Therefore, comprehensive surveys to confirm the presence of expected species (based on habitat type and regional distribution) as well as reptiles, amphibians, fishes and butterflies since there seems to be a dearth of information for these taxa.

Once adequate ecological information has been obtained then species and habitat montoring programmes can be initiated by park management.

Action. However, problem areas should be identified, and if adequate trend data are available, small-scale interventions and manipulative strategies can be undertaken. These may include small-scale restoration projects in degraded and disturbed habitats (tseri, landslips, areas impacted by fire etc.).

Habitat management can be facilitated by means of establishing monitoring plots in degraded areas and undertaking restoration efforts if appropriate. In areas of special concern structured monitoring programs should be initiated.

Continual monitoring is necessary to identify and follow trends and changes in biological conditions and to check whether the applied forms of management are having the desired effects. If and when they are not, changes in the management practice should be made. Several types of monitoring are involved:

Aquatic Resources Survey:

Long Term Objective: To formulate suitable national and local fishery management plans, laws, regulations and adequate conservation measures.

Short Term Objective: To develop national capabilities in planning and initiating a fisheries resources survey covering all climatic zones and river systems of Bhutan.

The implementation of the survey may require several years, and it involves training Bhutanese specialists and establishment of a national reference collection of aquatic species occurring in Bhutanese waters. However, once completed, it is expected that the survey will produce an inventory of water bodies and living aquatic resources, together with a description of their status.

Action: Initiate and conduct a national fisheries resources survey.

Action: On the basis of the survey results, formulate fishery and aquatic resources conservation measures, including fishery management plans, necessary laws and regulations.

Operational monitoring: This is the regular reporting to the Forestry Services Division on the overall operations and activities in the park.

Monitoring biological conditions: A program should be designed for monitoring biological conditions of the park. These results will serve as a primary tool for evaluating the condition of the park as well as the problems.

Monitoring human activities: Reports from routine patrolling should present a picture of human activity levels in the area.

Analysis of satellite imagery and remote-sensing data, aided by GIS will be used to monitor habitat changes and impacts in protected areas. Satellite imagery should be analysed every five years or, if feasible at more frequent intervals (2-3) years. Managers will be able to monitor and make management decisions such as;

- detecting and calculating the extent, direction, and rate of habitat change;
- providing trend information on growth and expansion of human settlements around the periphery to project and predict impacts, resource needs, and other problem areas and take preemptive actions to mitigate the potential impacts;
- detecting and identifying sites of management interest such as fires, landslips, vegetation die-offs, deforestation, enchroachments, etc. which may be missed during regualr ground patrols, but need investigation, closer monitoring and management interventions;
- range distribution of species, movements and habitat use by herds or individuals of flagship species, especially in rugged terrain
- assiting with habitat management decisions such as identifying sites for water-holes and salt-licks, locating guard posts, extra trails etc.

The small-scale monitoring should be used to complement the on-the ground information from patrol monitoring within the context of GIS. If necessary structured monitoring programs should be initiated in areas of special concern. Environmentaly detrimental activities should be studied and their impacts assessed.

DATABASES

Databases are needed to store biodiversity and related information and make them available for optimum use. NCS has identified the needs for such databases both at national park and broader levels, but it will not be able to develop, maintain and manage databases until a qualified database manager is recruited and computers dedicated to housing databases are purchased. Prior to establishment of such databases work is needed

to establish standardized procedures, structures, etc., to assure that the resulting databases will be of the maximum use.

Action: Take the necessary steps to develop and establish biodiversity databases.

STRENGTHEN POLICY AND LEGISLATION RELATED TO BIODIVERSITY

NATIONAL AND SECTORAL POLICY AND LEGISLATION WHICH MAY AFFECT BIODIVERSITY

There needs to be a greater emphasis on conservation of biodiversity in all aspects of land management. The policy of retaining 60 percent of the national territory under forest cover should be strengthened through policies and regulations that reduce the impacts of potentially destructive practices such as logging, grazing, mining, plantation or orchard agriculture, and the construction of roads and hydropower projects. In order to do this, land-use planning exercises should take place at the water-catchment level since each catchment has its own needs for water, farmland, fuel, grazing land, industries and its own requirements for hydrological protection.

Once they are completed, these comprehensive land-use plans will need to be backed up by enforceable sanctions and adequate legal authority. Presently, the Forest and Nature Conservation Act of 1995 is the only legal document that addresses any aspects of environmental degradation and biodiversity loss. But these provbisions may be inadequate in light of the complex nature of environmental issues and the immediate needs of a developing country. Appropriate legislation such as a National Environmental Protection Act and national Environmental Quality Standards therefore need to be enacted quickly to ensure that resource degraders are properly penalized and that "law abiding" resource users are encouraged and rewarded.

IMPROVE THE ECONOMIC VALUATION OF B IODIVERSITY RESOURCES

Objective: Assure that Bhutan's biodiversity resources are properly valued, within the context of modem resource- or environmental-economics, so that biodiversity resources are are accurately valued in national income accounting and in policy considerations and decisions regarding land and other resource uses. This objective was also stressed in the cooperative agreement of Bhutan, the Netherlands, Benin and Costa Rica.

Action: Initiate a project to develop methodologies for economic valuation of biodiversity resources. The methodologies initially should be applied and tested on a limited basis, and if satisfactory, they could then be applied on a broader basis. Development of local capacity in economic resource valuation should be a part of the project.

INCORPORATE BIODIVERSITY IN RELATED STRATEGY AND PLANNING

Sector Planning

Within the forestry sector, actual management on the ground is meant to be carried out within a system of Forest Management Units (FMUs). The objectives of FMUs are to balance commodity production with the maintenance of biological diversity and forest landscape stability. Existing and potential FMUs in Bhutan not only have an important biodiversity conservation function on their own, but also should provide buffers around, and genetic corridors between, the system of national protected areas. Thus FMU planning will have to look both internally and to the regional scale in its working circle designations and management prescriptions. In particular, protected area designations within FMUs will have to pay attention at the landscape level, and to the vertical and horizontal linkages between biological protection areas, watershed protection areas, and stream protection corridors. Single isolated protection working circles blocks at the FMU level will not fulfill these functions and this concept should be abandoned in favour of integrated biodiversity conservation at landscape and stand levels.

At present about 2.4 percent of the country are covered by FMUs, but it is intended to continue the process so that all direct forest management will be within the FMU system. While the objectives are environmentally sound, care must be taken to assure that the actual planning and implementation of the FMUs adhere to the objectives.

Actions:

- Assuring that the FMUs are planned for integrated biodiversity conservation rather than with single isolated working circle blocks; If they are to be effective protection areas within a FMU must be established to meet veryt specific functions, such as: critical habitat for particular wildlife species; protecting "keystone" biodiversity values (i.e. species, groups of species, habitats or abiotic factors that play a pivotal role in ecosystem processes and upon which biodiversity depends); buffer zones around nationally-established protected areas; areas which are particularly representative of the range of local ecosystems; and corridors to ensure ecological links;
- Assuring that only degraded forest areas -- and not productive mature forests -- are converted to plantations; and
- Assuring that enough mature and old-growth forest is maintained permanently to provide the necessary range of habitats and ecological stages; Without such planning, even cutting relatively small patches each year can eventually totally remove mature forest from a large area..

Long term objective : Protection of Forests, Climate, Soil, Water and Wildlife to assure successful conservation of the forest ecosystems, their genetic resources and biodiversity in Bhutan.

Immediate objective **:** To formulate a properly documented Management plan and implement for all areas.

At present there is a lack of properly documented management plan for most of the forest outside of the Protected Areas and Forest Management Units. Proper plans will have to be prepared and implemented for all areas, taking into account the specific requirements of each location.

Actions **:**

- Strict implementation of the management plans.

- Forest land will be managed in a way that soil losses and erosion are avoided and land capability maintained. Forest management systems will be developed and practised, which will improve water quality and maintain proper water balances, allowing optimum stream flow during the monsoon as well as in the dry season, maintenance of good water quality and mitigation of floods.

- Special management rules will be defined to protect critical watersheds from irreversible changes in their flora, fauna, and ecology. These rules will also cover priority watersheds, where management rules will focus on avoiding harmful effects to the people and systems downstream.

- Representative protected areas will be maintained in each ecozone in order to conserve the unique biodiversity and ecosystems of the kingdom in their natural state. The uses of these areas will include research, recreation, and appropriate local uses. The principles of selection and development of these areas will include considerations of value for alternative uses and population pressure in the area.

- The principles regarding the maintenence of biodiversity will also be applied to production forestry. This includes avoiding any drastic alteration in the composition of tree species in extensive areas. Special care should be applied in the introduction of exotic species.

Forest Production and Harvesting :

Long term objective : To ensure sustainable source of the forest resource.

Actions:

- All suitable forest areas will be put under sustainable management as production forests. Sustainability in production forests means that the annual harvest and other loss of timber does not exceed the average annual long term growth for the total area under each forest management plan, and that soil fertility does not decrease.

- The harvesting of all forest products will be done in such a way that unnecessary losses are avoided and the productivity of the forests in maintained.

- Timber harvesting will only be carried out by an organisation authorised by the government.

- The forest resources will be harvested through construction of roads and logging in a way that minimises land and forest degradation,

- Management plans will be implemented efficiently by developing economically and ecologically sound silviculture and harvesting systems.

- For full appreciation of the forest resource, the royalties and prices should reflect the true value of the wood.

Industrial Utilisation of Forest Products

Long term objective : To have ecologically sound and economically viable forest based industries

Actions:

- The Government will create a favourable environment for development of forest industries for domestic and export markets. This support will include institutional development, analysis and exploitation of market opportunities, socio-economic planning, physical infrastructure, and contributions to training, research and development, and financing.

- Based on an analysis of present and future raw material availability, and the demand and supply of wood based energy, environmentally sustainable and economically viable forest based industry will be encouraged.

- Healthy and Integrated development of efficient forest based industries requires rapid progress in the preparation of inventories and management plans, and regular and assured supply of raw materials. No new forest based industry will be established unless guarantees of the sustained availability of raw materials are established through proper forest inventories, and environmental impact assessments are undertaken.

- Appropriate home and cottage industries and further processing of primary products that will add value to the basic forest products will be encouraged in other to support the economy of the local communities and improve the standard of living of people particularly in rural areas.

STRENGTHEN INTEGRATION OF BIODIVERSITY CONSIDERATIONS IN OTHER SECTORS AND AT LOCAL LEVELS

Natural biodiversity cannot be conserved and maintained only at one level. National parks and protected areas will ultimately become mere isolated relics if thry are

left as islands in a sea of man- made ecosystems. To truly conserve a country's natural heritage, biodiversity conservation must function at a variety of scales- regional, landscape, and stand levels, and it must be integrated within the programs of all the sectors which are involved.

Regional Level

The primary role for biodiversity conservation at the regional level will be Dzongkhag integrated resource management and land use plans that integrate goals and objectives between sectors. Such plans will usually be developed through multi-party planning processes involving government, private industry and the public, resulting inland use zoning between sectors with the assignment of either management responsibility (government) or tenure(private). Common land use designations, in addition to parks and protected areas which may be created both nationally and locally, include critical (degraded) areas requiring priority attention, agriculture, forestry and native grazing, urban and industrial areas, watershed protection areas, and special conservation management areas that include protected areas buffer zones and regional biodiversity corridors. The regional landscape that emerges from such planning will be a combination of four broad land use types:

1. core protected areas;
2. "light touch management" buffer zones;
3. ecological corridors linking protected areas both horizontally and vertically; and
4. lands devoted to intensive human use.

Integrated resources and land use planning is just beginning to be applied in Eastern Bhutan. It holds the promise of rationalizing land allocation by linking it to real land capability, of slowing the processes of land and forest degradation, and of conserving Bhutan's stunning plant and animal biodiversity

Action: Accelerate development and implementation of the program on integrated resources management and land use planning, and assure that biodiversity conservation concerns are central to the process.

Ecotourism

Objective Assure that development of ecotourism is based on the principles of sustainbality, ecological soundness, and cultural acceptability.

Action. The NCS should monitor the impact of trekking (and other) visitors to the parks; work closely with the Tourism Authority of Bhutan todetermine interim allowable numbers and limit the number of visitors accordingly; and carefully plan effective management of trekking groups, as well as conduct workshops for tour operators and guides to make them aware of the park regulations, negative impacts associated with tourism, and enlisting their cooperation to alleviate and minimize the impacts. Where

necessary, to assess the impact of tourism on the habitats and wildlife, as well as local communities. Where possible to develop strategies which will ensure that the local communities become involved and benefit from tourism (see also Chapter 5).

STRENGTHEN THE INSTITUTIONAL FRAMEWORK RELATING TO BIODIVERSITY

CENTRAL GOVERNMENTAL INSTITUTIONS AND FUNCTIONS

The Concept of an Integrated National Biodiversity Programme

The National Environment Commission (NBC) is an agency for policy decisions on biodiversity and other environment-related issues in the country. It has a high level sectoral mandate to ensure the environmental concerns are incorporated in all growth and development oriented projects and programs in the country. As a national focal point for the Convention on Biological Diversity (CBD), it fulfills the national commitment to participate in the Conferences of Parties to the CBD (COPs).

At the operational level, principal responsibilities for biodiversity are divided among several units within the Ministry of Agriculture (MOA). As described in Chapter 2, these include the Forestry Services Division and under it the Nature Conservation Section, the Research, Extension and Irrigation Division which operates the four Renewable Natural Resource Research Centres and the National Herbarium, the Crop and Livestock Division, and the Land Use Planning Section within the Planning and Policy Division.

This division of responsibililties is based in part on history and in part on the distinction between domestic and wild biodiversity. However, as discussed above in the Introduction, in Bhutan there is often not a clear distinction between domestic and wild biodiversity. The wild relatives of domestic plants are of direct importance to domestic plant genetic resources. For food, medicine, construction materials, and other purposes wild plants and animals are used as integral parts of much of the Bhutanese way of life. Both wild and domestic plants and animals rely on the ecosystems of which they are integral parts. Therefore most biodiversity conservation activities affect both “wild’ and “domestic” biodiversity, and it is not possible to draw a clear administrative or operational line between them.

Throughout the world in countries where biodiversity responsibilities are fragmented between several discrete government units there are problems of coordination, goal setting, planning and cooperation which operate against the development of an effective integrated national biodiversity program. Particularly in Bhutan where there is so much overlap between the domestic and wild biodiversity, and where staff and other resources are scarce, there would appear to be many advantages (efficiency and

effectiveness among them) to establishing an integrated biodiversity conservation programme.

Longterm Objectives :

1. To identify and meet national needs through instituting rational, sustainable, effective, and equitable approaches to the conservation and use of biological resources in natural and agricultural ecosystems for the benefit of present and future generations of Bhutanese people and sustain environmental well being of the country.

2. To ensure adequate national capacity to participate in global efforts to conserve and use biodiversity resources for.food, agriculture, industry and environment; and to share in the benefits arising from their use.

Intermediate Objectives:

1. To give high priority to establishing the essential elements of an Integrated national programme; a recognized national status; appropriate policy and institutional framework including mechanisms for coordinated planning and action; and a programme strategy; benefitting from help to do so. Where appropriate, to upgrade conservation facilities at the national or regional level.

2. To improve institutioinal and sectoral linkages and strehgthen integration of institutional and community efforts.

3. To develop national capacity in the technical, managerial and policy areas of biodiversity.

Action: Within the MOA there is ongoing discussion of the proposal for some sort of an integrated National Biodiversity Programme. MOA should give serious consideration to the establishment of such an operational-level program, and mechanisms to improve the coordination, efficiency and effectiveness of Bhutan's efforts in biodiversity conservation,

IMPROVE THE STAFF CAPACITY IN BIODIVERSITY CONSERVATION AND SUSTAINABLE USE: EXPANDING AND IMPROVING TRAINING

The central importance of training in achieving sustainable improvements in biological resources conservation and use is widely accepted. At a time when financial support to many programmes is threatened, funding for training has become particularly tenuous. The dearth of well-trained personnel is evident at virtually all levels and in all scientific and technical specialties in Bhutan. Moreover, training and education programmes which combine technical training with exposure to other needed disciplines, including management, policy and legal fields, associated with biodiversity, appear not to exist very often.

Long Term Objective: Obtain adequate trained staff to effectively develop and manage Bhutan's programmes for conservation and sustainable use.

Considering the importance of the biodiversity to Bhutan, the fact that more than a quarter of the nation is in protected areas, and the needs for effective conservation and sustainable use of biodiversity outside of these areas, the total size of the staff which is needed is vastly larger than what is presently available.

Actions:

- Develop a realistic long term vision of the staff which will really be required to effectively develop and manage Bhutan's programmes for conservation and sustainable use of its biodiversity resources.

- Identify the priority needs and seek additional funding for the acquisition, training and recurrent costs of that staff.

Long Term Objectives: Obtain adequate trained staff for the establishment and management of the protected areas system in Bhutan

Intermediate objective: Obtain staff to formulate and implement management plans for the protected areas in order of priority and effectively manage them.

Presently, an acute lack of biological, physical, social and economic data of the protected areas and inadequate professional staffing continue to impede progress in completing the completion of the establishment of adequate protected areas and implementation of scientific management of those protected areas that have already been formally designated. To date Park Managers have been appointed by the FSD for the three priority parks and staffing is as follows:

	JDNP		**BMNP**		**RMNP**	
	present	**required**	**present**	**required**	**present**	**required**
Park Manager	1		1		1	
Asst. Park Manager		1		1		1
Park Warden	2	4	2	3	2	6
Dy. Park Warden		12	1	4	3	17
Park Guards	10	16	3	18	43	28
Office Assistant		1		1		1
Accountant	1	1	1			1
Steno/Typist		1		1		1
Driver		3	1	2	2	1
Risup & others	7	9		14	36	7
TOTAL	21	48	9	44	87	63

Others include mahouts, boatmen, ganshi, gardeners, chowkidars, cooks and cattle herders

Action . Considering the present situation of manpower constraints, intake of new recruits shall be done in a phased manner, but making sure that protected area manpower requirements are completed at the latest by the fifth year of implementation of the management plan. This will enable substantial progress as well as allow the target outputs to be met. The table only covers recruitment of staff to those protected areas for which park administration has already been authorized. For those protected areas that are identified as next in terms of priority such as the Bomdeling Wildife Sanctuary, Thrumshingla National Park staff recruitment has yet to be identified.

Long term objective. To **ensure** that sufficient numbers of appropriately trained personnel at all levels are available to support the biodiversity activities of the FSD as well as reduce dependence on long-term expatriate technical assistance personnel.

Action: There should be internal evaluation of the existing and required biodiversity-related manpower within each division keeping in mind the mandates and responsibilities of each section. Placement of new staff should be done according to the existing man-power constriants in each division as well as the programs and activities outlined in the 8^{th} five year plan. Recruit appropriately trained manpower by implementing realistic human resource development plans with the help of funding agencies. Ensure the appropriate placement of all trainees upon completion of training to maximise the utilization of skills knowledge acquired. Identify training needs and appropriate candidates for implementation of various programs and activities. Recognising the key role of human resource development, put heavy emphasis on formal, vocational, and on-the-job training as well as management of human resources.

ASSURE THAT BIODIVERSITY CONSERVATION BRINGS BENEFITS TO LOCAL PEOPLE

Supporting forest Use and Participation by Local People:

Long term objective : Multiple uses of the forests including production of fodder, firewood and- non-wood forest products as well as, livestock grazing, to be monitored and controlled in order to maximise their contribution to local economies, to meet the basic needs of the people in a sustainable way and at the same time to minimise the harmful effects due to indiscriminate use.

Immediate ***objective*** **:** to promote social and community forestry through extension programs

Present status : Forest practices, including social and community forestry, that improve the availability of fuelwood, fodder and other forest produce on a sustained basis for farming and local needs, are lacking currently.

Actions:

Proper agro-forestry and agro-silvo-pastoral techniques will be developed, in order to increase output and decrease the harmful effects of present farming practices, and in particular, to promote alternatives to shifting cultivation.

Traditional knowledge of the use of herbal plants and other non-wood forest products, will be encouraged and strengthened by proper research, development and an integrated approach.

Access to forest products for all Bhutanese people will be improved by creating distribution, marketing and proper monitoring systems.

The Government should encourage the users of forests to participate in the development and management of their local forests. The Government should also review the existing forestry rules and develop favourable conditions for forestry on private registered land. Finally,the Government will encourage the forest extension service, which will understand villagers forestry related problems and work with them to improve local forest management. It is important to make certain that the villagers know the rules and regulations as well as options available to them.

STRENGTHEN BIODIVERSITY IN EDUCATION AND AWARENESS

Biodiversity Conservation in Formal Education

Special environmental education programs are now in place in the formal curricula from grade 1 through 6, and there are some programs in the curricula of higher levels of education.

Action: Periodically review the effectiveness of the existing environmental education programs from the perspective of biodiversity conservation, and with NGOs (especially RSPN and WWF-Bhutan) seek to find or develop new teaching materials for all levels.

Promoting Public Awareness of the Value of Biodiversity Conservation and Use

Public awareness is the key to mobilising popular opinion and to generating and sustaining appropriate political action within the country and internationally. This is true both for the general public and for the people who live in and near protected areas and other areas critical to biodiversity conservation. The capacity to communicate the impact of biodiversity activities to key target audiences is critical to the success of any biodiversity programme. A targeted public awareness programme can promote the development of institutional linkages and collaborative mechanisms such as networks. Within the country, public awareness can facilitate efforts to involve communities and local and non-governmental organizations, thus ensuring a broader base for conservation.

Biodiversity conservation activities should strive to integrate fully public awareness into all local, national, and regional activities through support mechanisms for coordinated public awareness activities at all levels. The national policies and planning should recognize the role that public awareness can play in establishing a firm basis for sustainable biodiversity conservation and use. Public awareness should be considered in the development of all national biodiversity conservation activities.

The national strategies should identity objectives and strategies for public awareness, defining target audiences, partners and tools for public outreach. The RGOB should recognize and encourage the work of RSPN and other NGOs in raising public awareness. Adequate consideration should be give to production of public awareness materials in appropriate languages to facilitate broad use within countries.

Biodiversity conservation activities should have as appropriate a focal point for public awareness. The biodiversity workers, however, should develop the capacity to articulate the importance of the conservation goals and activities in the broader context of sustainable agriculture and development. They should be able to communicate this to all stakeholders using tools provided by public awareness specialists. RGOB could consider enlisting the help of well-known and influential people to increase access to the media and attract added attention.

It would be helpful to also draw on public awareness tools and technologies generated at the regional and international level. These tools - and the messages they convey - may have to be adapted to reflect national priorities and circumstances. However, it is likely that many of the regional and global messages will prove useful in supporting national public awareness strategies and activities. This will substantially reduce local costs. Awareness of the value of biodiversity, and of the role of scientists, farmers and communities in maintaining and improving them, should be promoted in schools at all levels, as well as in specialized agricultural research institutions and training centers like RNRRCs, NRTI, BFI, etc..

ENCOURAGE AND AUGMENT INTERNATIONAL COOPERATION IN BIODIVERSITY

TECHNICAL AND POLICY EXCHANGE WITH COSTA RICA

There are striking parallels between the biodiversity situations in Costa Rica and Bhutan. The two countries are almost identical in size, and while Costa Rica, with its largely tropical ecosystems, may have nearly twice the biological diversity of Bhutan, they are both extraordinarily species-rich for their regions. Both countries have great hydropower potential. Both have designated more than 20 percent of their area for biodiversity protection. And both have leaders who see that the most promising long-term

approach to development is through the maintenance of their forests and biodiversity, not their conversion.

Costa Rica has far more technical and management capacity related to biodiversity, because of its longer history of research in this field. Consequently, Bhutanese officials and private sector representatives could benefit immensely from a study trip to Costa Rica to observe their protected area system, the Organization for Tropical Studies, the National Biodiversity Institute (INBio), and their tourism industry. The organization, objectives and procedures of INBio, in particular, would be of significant assistance to Bhutan in the development of its own biological research capabilities. Many of Costa Rica's current activities could not be transferred directly due to the unique conditions and circumstances in Bhutan. Nevertheless, Costa Rica would provide an opportunity for Bhutanese experts and policymakers to see one potential vision for how they might develop their biodiversity.

The exchange could involve individuals from the Forest Division, Nature Conservation Section, National Herbarium, NEC, Tourism Authority, and possibly the Energy Agency. The NEC has a list of contacts on the Costa Rica side (Reid, 1995). Such a visit would require additional funding, but it might be carried out within the existing cooperative program between the Netherlands, Costa Rica and Bhutan.

ACTION: Plan, obtain the necessary funding, and carry out the exchange.

DEBT FOR NATURE SWAPS

Debt for Nature Swaps are an innovative mechanism for financing biodiversity conservation. In these arrangements a donor will either pay off or cancel Bhutan's debty in order to preserve biodiversity and the natural environment. The Gedu Wood Manufacturing Company provides an example of such an arrangement in Bhutan. Although a feasibility study conducted in the 1980s deemed that company to be both economically viable and environmentally sound, the factory proved to be unsustainab le. As a result, the RGOB refused to allow it lto expand its logging operations and closed the company in December, 1995. The Royal Government of Netherlands in a Debt for Nature Swap provided Bhutan with assistance so that the kingdom could pay off a loan to the Kuwait Fund for Economic Development in order to close down the logging operations.

Action: Actively explore other possibilities for Debt for Nature Swaps with Bhutan's present and potential donors.

PURSUE ACTIVE FOLLOW-UP OF THE BAP WITH DONOR COMMUNITY

Bhutan already has a number of donors who contribute actively to the country's environmental programs and projects. Biodiversity is a high priority for many donors.

This BAP provides a coordinated, integrated framework which identifies a number of priority areas for action which are not funded within the present RGOB plans. When it is approved, the BAP can be used as a basis for additional discussions with donors interested in biodiversity.

Action: Actively pursue support for the priority unfunded actions in the BAP with existing donors, and investigate the possibilities of additional donors who would be interested in biodiversity.

STRENGTHEN AND SUPPORT FAMILY PLANNING AND OTHER POPULATION PLANNING ACTIVITIES

The population estimated by the RGOB was 600,000 in 1996. It is very young with 43% of the total in the age-group below fifteen. The majority (85%) of the population live in rural areas although the proportion of the urban population is increasing very rapidly. The population is growing rapidly at a very high rate of 3.1 percent per annum. At this rate of growth, the population will double in 23 years, to 1,200,000 in 2019, although the population figure could reach as high as 3.34 million in 2019, if the population in 1996 was 1.67 million as estimated by the UN (UNFPA, 1996).

This population growth will significantly change the population-resource ratio. Since most land suitable for agricultural production is already under cultivation, the population-resource ratio cannot be modified by bringing new agricultural land into cultivation. These population pressures can be expected to give rise to environmental pressures that could undermine the viability of the integrated farming systems and have serious impacts on the nation's biodiversity. The accessible forest areas are already intensively exploited and in some areas, extraction rates for fuelwood and timber are approaching unsustainable levels. As agricultural land holdings become smaller and more fragmented, farming will inevitablly extend to marginal land and steeper slopes, with heightened risks of erosion and accelerated land degradation. Growing livestock herds will add to the pressures onf orest land and to the risks of soil erosion, The progressive removal of vegetation cover, especially in critical watershed areas, is already beginning to affect the hydrological balance, leading to the localized drying up of perennial streams and flash flooding.

The RGOB recognizes the threats inherant in a continued high rate of population increase and in the Eighth Five-Year Plan (starting in 1997) it has made an unequivocal committment to reducing the rate of population growth to 2.56 percent by the end of the Plan period. His Majesty King Jigme Singye Wangchuck issuede a Royal Message in 1995 urging the population to adopt family planning as a means for safeguarding the very future of the nation.

Population growth is the engine which drives most of the more serious threats to Bhutan's biodiversity. Consequently, reducing that growth must be a central and underlying requirement for achieving biodiversity conservation in the Kingdom.

Actions:

- Incorporate considerations of population growth and movement in Biodiversity planning.

- Provide all possible suppport to the RGOB programs on family planning

4B. DOMESTIC **BIODIVERSITY**

RESEARCH AND INFORMATION

1. **Constructing Comprehensive Information Systems for Crop Genetic Resources**

Many of the Country's biological resources are insufficiently and/or poorly documented relative to what should be known about them for optimal conservation, access and use. Documentation of wild relatives of crops and on-farm genetic resources located in situ is particularly poor. Derived information on where materials have been distributed, pertinent ethno-botanical information, farmer and indigenous knowledge, have not been maintained on material conserved in the herbarium and the seed stores. This situation is exacerbated due to the fact that at the national and institutional level, data management and documentation activities are given an inappropriately low priority in the allocation of funding. There is no standard procedure and systematic data recording format corroborated by the agencies and institutes concerned with biodiversity issues. In the proper format, data can be used not only to assist conservation efforts, but to "add value" to plant genetic resources for food and agriculture.

A group must be formed under the aegis of the MOA to undertake a planning study for the creation of a National Biodiversity Information Center (NBIC) with representation from within its division, other public and private sectors, NGOs and the rural based communities. This group will be responsible for setting the specific charge for a drafting committee and for reviewing work products on a regular basis. The final product will be a report that provides both a conceptual framework and a detailed account of the structure, location, and institutional setting of the NBIC and its principle tasks. Relationships between the Center and other agencies should also be addressed.

Concept of the NBIC

Currently there is no easy way for users to know what biodiversity information exists or how to get to it. When one considers the nationwide variety of locations where

biodiversity information is being collected and stored, the need for RGOB to establish a National Biodiversity Information Center (NIBIC) is compelling.

The idea of NBIC is simple: a focal point where the many parties that generate, manage, or use data on biological resources can collaborate and make decisions leading to broader access to that information. The Center will point users to sources for the data they seek, while working with funding agencies to encourage development of tools and strategies to make data more accessible. The Center will not duplicate existing databases or information, but will provide directory services for the large array of available information. It will also identify gaps where new databases are needed, and help development, transfer, and application of new technologies. Further, the Center could coordinate access to data outside the usual realm of the biological sciences.

NBIC's mission will be to provide leadership and a neutral venue to facilitate collaborative discussions about the availability of biodiversity data and information. It will also be a clearinghouse to provide knowledge of, enable access to, and facilitate the use and exchange of biodiversity data and information. NBIC's objectives will be to promote and encourage the use of well- documented biodiversity data and information; address the full scope of biodiversity from molecular data through ecosystems; connect those seeking information and data on biodiversity to those having data custody; and facilitate structured identification of and access to data pertinent to a user's needs. This will be accomplished through an interactive computer system that uses metadata (data about the data) information on geographic location, species, ecosystem, or other keywords to sort, aggregate, and/or integrate data sets, identify gaps in existing data and knowledge- and provide a forum for collaborative approaches to biodiversity information issues.

NBIC must be responsive to user needs, providing both data and information services tailored for different audiences. NBIC must also be responsive to the needs of providers, and must offer incentives and encouragement for them to offer their data on the NBIC system, It will facilitate development of metadata standards (minimum criteria for data documentation and format) and the establishment and provision of data collection and reporting protocol. Guidance on appropriate uses of data or information will also be provided. NBIC will facilitate the improvement of data set quality with a feedback system that allows comments on data quality and utility. Data custody will reside largely with primary data collectors and producers, and users will be referred to original data sources. Therefore, data holdings by NIBIC will be reduced. NBIC will use appropriate information integration and analysis technologies and promote the adoption and use of appropriate information standards.

NBIC will have a distributed structure that will function based on a consensus-building and partnership approach. The Center will serve as a convener, facilitator, and host. Center experts will move discussions along and involve key constituencies. An Advisory or Governing Board from the broad community of contributors and users will provide general direction. NBIC must establish partnerships with the other organizations,

whose activities include data and information collection and assessment of biodiversity issues.

NBIC's location should be within an integrated National Biodiversity Programme (if it is established) under the MOA. Desirable characteristics of the host institution should include strong computational and information management services support; a creative and active program in biological sciences, especially involving the use of computers in biodiversity information management; broad-based expertise or strong links to systematics, ecological research, and collections, information management, understanding of modern and historical Bhutanese collections, reasonable access to national and international transportation; and comfortable, modem facilities for conferences and Center staff

UTILIZATION OF PLANT GENETIC RESOURCES - ACTION PLAN

Expanding the Characterization, Evaluation and Number of Core Collections to Facilitate Use

Assessment

Genebank collections should enable users to respond to new challenges and opportunities. Typically, most genebank accessions have not been well characterized and evaluated, a situation that leads to the under-use of collections and failure to realise their full value, resulting in high conservation costs in relation to derived benefits.

Farmers, plant breeders and most other users are interested in having a manageable number of genotypes that possess or are likely to possess the traits needed for the crop development programme. Identification of those traits through characterization, and the establishment of core collections (a subset selected to contain the maximum available variation in a small number of accessions), are measures that can encourage greater and more efficient use of collections. Evaluation can also aid identification of germplasm of potential for more direct use by farmers.

In addition, characterization and evaluation data as well as the wise use of core collections are important in the overall efficient and effective management of collections.

Long-term Objectives

- *To increase and improve the ease of use of conserved plant genetic resources. To facilitate innovative progress in plant breeding through promoting the identification of useful accessions or their component genes for introduction into genetic enhancement and plant breeding programmes. To promote plant breeding that results in higher levels of genetic diversity in crops and agricultural systems. To identify germplasm ofpotential value for direct use by farmers in on-farm programmes.*

- ***To promote the coordination of conservation, exploration and improvement activities by targeting collecting expeditions, optimising sampling strategies, optimising regeneration methodologies, identifying gaps in collections, rationalizing collections, establishing priorities for conservation, forming core collections, and quantifying the relative effectiveness of ex situ and in situ conservation.***

Intermediate Objectives

- ***To give high priority to the development of crop specific characterization and evaluation programmes to identify accessions and genes that counter those biotic and abiotic stresses which are limiting production of those crops.***

- ***To improve the efficacy of the evaluation process by developing and adapting new technologies for reliably identifying valuable accessions and detecting valuable genes that have been identified as valuable.***

- ***To establish international core collections for crops of global importance and promote establishment of genebank-based core collections for key national crop collections*** *in national facilities.* ***To promote, improve and test methodologies and technologies for important core collections.***

Policy Strategy

The RGOB with the cooperation of the relevant UN bodies and regional, intergovernmental and non-governmental organizations, international agricultural research centres, and including the private sector, and taking into consideration views of the scientific community and farmers' organizations and their communities should:

(a) define priorities and periodically assess progress in evaluation in relation to the different needs of the various users of plant genetic resources in the arable agriculture system, with emphasis on identifying traits that counter limits to production in staple crops and of crops of national economic importance;

(b) promote collaboration and complementarity between breeders, researchers, farmers and genebanks;

(c) encourage exchange of characterization and evaluation information;

(d) note that access to plant genetic resources in the arable agriculture system is subject to applicable international agreements. In compliance with such agreements, users of plant genetic resources in the arable agriculture system should be encouraged to agree to provisions for sharing relevant evaluation data with source institutes, giving also due regard to the special needs of commercial users for appropriate confidentiality;

(e) give appropriate financial support for characterization and evaluation programmes for crop species of primary or exclusive importance to food security in their countries, given the importance of medium and long-term financing.

Crop networks and genebanks should proceed carefully to develop core collections of crops of major interest to the national systems. While core collections provide guidance on the constitution of genebank collections, they do not replace them. Genebanks should not use the existence of a core collection as an excuse for allowing conservation conditions for other accessions in the collection to deteriorate.

Capacity Development

Support should be given to begin a step-by-step, targeted characterization and evaluation programme for selected priority germplasm. The characterization and evaluation process would begin with an assessment of current information and an effort to assemble, collate, computerize, and make available existing information contained in notes, reports, punched cards, etc. Much evaluation work needs to be done in a use-oriented, site-specific manner.

The RGOB and appropriate organizations should identify institutions and individuals who may have the capacity and expertise to carry out germplasm characterization and evaluation for specific stresses and should develop a national portfolio of such expertise, including farmers in high stress areas who may perform preliminary evaluation to identify subsets of accessions that hold promise for further evaluation under more stringent scientific conditions. The cost efficiency of sub-contracting evaluation work should also be investigated as well as cooperative programmes between national programmes and the private sector.

National programme staff should receive training in germplasm characterization and evaluation techniques on a crop-specific basis. Such training should begin with crops deemed important nationally, and for which there are current or planned breeding programmes.

Support training of farmers, including women farmers, participating in on-farm evaluation programmes, in the necessary relevant skills. As their responsibilities often extend from the propagation, production and harvesting of crops to the processing, storage and preparation of foods, women's knowledge of the uses and usefulness of plants is often extensive.

Appropriate technical and financial support should be given for multiplication of core collection germplasm.

Research and Technology

Various kinds of research must be undertaken if the cost-effective use of collections is to be encouraged. This could include access to the latest technology and support for scientific research to improve characterization and evaluation techniques.

Research priorities relating to core collections include developing:

(a) improved methods of germplasm characterization using, inter alia, biochemical and molecular biological methods;

(b) improved diversity stratification procedures;

(c) methods for validating core collection selections;

(d) methods for linking core collection to the main collection (sampling strategies);

(e) improved methods of using plant genetic resources in the arable agriculture system, including targeted trait detection.

Promote national symposia of germplasm experts to discuss the many technical issues involved in developing and using core collections and to stimulate activity in this area and complementarity with other aspects of the BAP.

Coordination and Administration

Characterization and evaluation efforts should be planned and implemented with the active participation of national central programme, and local, crop-specific and regional networks. As appropriate, farmers' organizations, private companies and their associations, and others might also be involved.

Core collections should be developed with the active participation of breeders and crop networks for major crops. Work on core collections must be considered within and integrated firmly in the context of the entire effort to improve utilization.

Cooperation and exchange of information are needed, especially by genebanks that manage collections of wide species diversity without corresponding specialization among staff for all species.

There should be periodic assessments of the use of core collections to guide future work and assist in setting priorities. Such assessments should be made in conjunction with crop researchers, farmers, seed supply system (DSC) and in consultation with appropriate international agencies, institutions, and NGOs.

Increasing Genetic Enhancement and Base-Broadening Efforts

Assessment

Broadening the genetic base of crops can contribute to increasing stability and performance in crops. However, from the perspective of any individual breeder, company or institute, the costs of incorporating new and diverse germplasm into already adapted material may outweigh the benefits they could realise. Such benefits are often realised only in the long-term and accrue to society in general as well as to other plant breeders. Due to the nature of many genetic enhancement and general pre-breeding activities, international collaboration and public support are warranted.

Approaches to genetic enhancement include:

(1) introgression of useful agronomic traits identified through characterization or evaluation into locally adapted or elite material for further use in breeding programmes; and

(2) base-broadening of breeders' material through incorporation of wide genetic diversity.

Long-term Objectives

To increase food security and improve farmers' livelihoods through the development of better plant varieties. To increase the utilization of genetic resources and thereby provide incentives for their conservation. To reduce genetic uniformity in crop varieties through the utilization of wild relatives, local materials and/or modern varieties. To increase sustainability of agricultural systems and the capacity for adaptation to unexpected environmental changes.

Intermediate Objectives

To increase the genetic diversity available in breeders' populations through appropriate strategies of introgression (base-broadening).

Policy Strategy

The RGOB, private sector, community-based groups, non-government organizations and funding sources should recognize the importance of providing long-term funding and logistical support to pre-breeding, genetic enhancement and base-broadening activities.

Capacity Development

Support should be given to national agricultural systems, networks, non-government organizations, training institutes and other relevant organizations to carry out pre-breeding and genetic enhancement projects. Priority should be given to addressing problems identified by the farmers, other competent scientific bodies and institutions, and farmers' organizations.

Research and Technology

Crop development and improvement Institutions, should further develop methodologies for genetic enhancement including pre-breeding, and broadly disseminate these methodologies.

Coordination and Administration

Activities should be planned and undertaken in close collaboration with national programmes with the collaboration of crop and regional networks, other scientific bodies and institutions, and farmers' organizations. Close communication with plant breeders and other scientists in both the public and private sector should be encouraged.

Promoting Sustainable Agriculture through Diversification of Crop Production and Broader Diversity in Crops

Assessment

Many major crops are impressively uniform genetically and impressively vulnerable. Uniformity does not equate with nor necessarily lead to vulnerability. And the lack of perfect assessment and forecasting tools and methodologies means that the degree of vulnerability cannot be precisely identified. Nevertheless, it is important to monitor this situation in order to take remedial or precautionary actions when warranted.

The future agricultural systems will need to incorporate a broader range of crops including inter alia crops which produce raw material or are sources of energy. As a precaution, some actions are warranted now to encourage and facilitate the use of more diversity in breeding programmes and in the varieties and species used on farms. Innovative approaches in plant breeding for the purposes of domesticating new crops, the development of new plant varieties and the promotion of higher levels of genetic diversity in crops and on farms, such as planting mixtures of adapted varieties, are recognized as means for adding stability in agricultural systems and promoting agricultural production and food security.

Long-term Objectives

To promote sustainable agriculture and reduce genetic erosion and possible genetic vulnerability by diversifying crop production and increasing genetic diversity in crops.

Intermediate objectives

- *To review periodically genetic vulnerability in crops and encourage breeders and appropriate groups, to take mitigating action nationally and locally, as appropriate.*

- ***To promote the goal of higher levels of genetic diversity consistent with productivity increase and agronomic needs, including in crop production, plant breeding and biotechnological research and development settings.***

Policy Strategy

The RGOB and relevant organizations in cooperation with crop networks, research institutions, extension agencies, the private sector, farmers' organizations and NGOs, should:

(a) Regularly monitor genetic uniformity and assess vulnerability in crops;

(b) review policies which may affect the level of diversity in agricultural systems, and specifically the degree of genetic uniformity and vulnerability of major crops.

(c) increase heterogeneity by planting mixtures of adapted varieties and species as appropriate.

Funding agencies should be encouraged to continue to provide support to national agricultural research systems, and other relevant research bodies and NGOs, for work aimed at enhancing levels of genetic diversity in agricultural systems. The release by the international centres of unfinished varieties to national research stations for further development, including on-farm improvement, and in accordance with an appropriate strategy, is one measure which could bring higher levels of diversity, adaptation and stability to crops. The selection of high yielding landraces/farmers' varieties is another measure.

Capacity Development

The RGOB and its national agricultural research system, supported by the International Agricultural Research Centres, and other research and extension organizations should:

(a) increase their capacity to develop and use multilines, mixtures and synthetic varieties, as appropriate;

(b) increase their capacity to use integrated pest management strategies, including the use of race-non-specific (or horizontal) resistances, the pyramiding of race-specific resistances, and the strategic deployment of resistance genes;

(c) facilitate the strategic use of a range of varieties;

(d) explore and, in appropriate circumstances, make use of decentralized and "participatory" plant breeding strategies to develop plant varieties specifically adapted to local environments;

(e) make use of modern biotechnological techniques as feasible, to facilitate broadening of the genetic base of crops.

Research and Technology

Support efforts to identify those activities used in plant breeding, plant research and farming systems that foster on-farm diversity. Such research might include a review of non-homogenous farming systems such as those based on intercropping, polycropping, integrated pest management, and integrated nutrient management, for their possible wider applicability, as well as research to develop appropriate plant breeding methodologies.

Support should be encouraged for developing improved tools and methodologies for assessing genetic vulnerability and identifying, if possible, the ideal equilibria in crops between genetic uniformity and diversity consistent with practical, technical and economic considerations that sustain ecosystems,

Administration and Coordination

A committee on Genetic Resources in the arable agriculture system, or an appropriate subsidiary body, should be regularly informed of the state of diversity in collections and breeding populations of major crops of significance to the national food security. The Committee should make such information available to other relevant governmental bodies.

Promoting Development and Commercialization of Under-utilized Crops and Species

Assessment

While a small number of species provides a large proportion of the national food needs, hundreds of other species are utilised at a local level, either through cultivation or harvesting. These under-utilised species contribute substantially to household food and livelihood security; they are often managed or harvested by women. Knowledge concerning the uses and management of these species is likewise often localized and specialized. Many under-utilised plants have potential for more widespread use, and their promotion could contribute to food security, agricultural diversification, and income generation, particularly in areas where the cultivation of major crops is economically marginal. However, current programmes and projects for conservation, research and development tend to neglect these species.

Long-term Objectives

To contribute to agricultural diversification, increased food security, and improved farmers' livelihoods; to promote the conservation and sustainable management of under-utilised species and their genetic resources.

Intermediate objectives

To develop appropriate conservation strategies and sustainable management practices for under-utilised species; to improve selected species; to improve the marketing of under-u tilised crops.

Policy Strategy

The RNR sector and its national agricultural research system, with the support of the international agricultural research centres, and relevant organizations, and taking into account the views of farmers' organizations and their communities, are encouraged to promote policies consistent with the sustainable use, management and development of under-utilized species, including land use policies, as appropriate, identified as having a potential to make significant contributions to local economies and food security.

Capacity Development

Training and capacity building for scientists and extension specialists and for farmers and local communities, with particular emphasis on women, should be provided in:

(a) identifying under-utilised species with potential for increased sustainable use;

(b) developing and implementing sustainable management practices for under-utilized species of importance to food and agriculture;

(c) developing post-harvest processing methods;

(d) developing marketing methods.

Research and Technology

Research should be undertaken to:

(a) develop sustainable management practices for under-utilized species of importance to food and agriculture and their genetic resources;

(b) develop post-harvest processing and other methods to improve marketing possibilities.

Coordination and Administration

The national agricultural programmes in cooperation with international agricultural research centres, and other relevant organizations, should regularly review the status of under-utilised species in the country, to:

(a) identify possibilities for greater sustainable use;

(b) identify common research and development needs;

(c) facilitate and, as appropriate, coordinate requests for relevant financial and technical assistance.

Supporting Seed Production and Distribution

Assessment

Farmers benefit from having a wide range of seed varieties and other planting materials. Availability can be constrained by: (a) poor harvests, inadequate on-farm storage facilities, insufficient means to multiply quality seed, and (b) poor seed distribution systems. These problems can apply to seed of both local and commercially-bred varieties. Parastatal and commercial seed companies sometimes have difficulty supplying seed of varieties specifically adapted to unique and local conditions. Often they cannot offer the range of varieties, or seed of so-called "minor" crops, on which many farmers rely, because of high transaction costs and low purchasing power of farmers. There is thus a need to strengthen local capacity to produce and distribute seed of many crop varieties, including some landraces/farmers' varieties, that are useful for diverse and evolving farming systems.

Long term objectives

- *To increase the availability of good quality seed of a wider range of plant varieties.*
- *To contribute to the maximization of both agro-biodiversity andproductivity.*

Intermediate objectives

- *To improve the complementarity between governmental (or parastatal), commercial, and small scale enterprises in plant breeding, seedproduction, and seed distribution.*
- *To develop and expand viable local-level seed production and distribution mechanisms for varieties and crops important to small-scale farmers;*
- *To help make new crop varieties available to farmers. To make suitable materials that are stored ex situ available for multiplication and distribution to farmers.*

Policy Strategy

The RGOB through the RNR sector and its RNRRCs, subject to national laws and regulations as appropriate, with support from IARCs, regional cooperation programmes and others, and taking into account the views of the private sector, farmers' organizations and their communities, should:

(a) develop appropriate policies concerning governmental, commercial and informal enterprises in, seed production, and seed distribution, to help focus efforts of government supported initiatives on the varietal needs of resource-poor farmers in particular, with attention, where necessary, on the needs of women farmers. Such an approach should be complemented by encouraging the private sector to meet the needs of larger-scale, commercial farmers. Government involvement with major or minor crops that are inadequately covered by the private sector should not be precluded;

(b) provide, and promote as appropriate, an enabling environment, where such an environment does not already exist, for the development of small-scale seed enterprises, including through appropriate incentives;

(c) strengthen linkages between genebanks, plant breeding organizations, seed producers, and small-scale seed production and distribution enterprises;

(d) consider seed quality control schemes particularly those appropriate to small scale enterprises.

(e) Consider legislative measures which allow distribution and commercialization of landraces/farmers' varieties and obsolete varieties, if they meet the same distribution and commercialization criteria for disease, pests, health and the environment, as conventional or registered varieties. These measures should meet quality standards of seed distribution and commercialization, in accordance with national legislation or applicable regional agreements, as appropriate.

Capacity Development

The RGOB, subject to national laws, regulations and policies as appropriate, and in conjunction with international aid agencies, NGOs and existing seed enterprises should:

(a) encourage existing seed enterprises to improve the range and quality of planting materials they offer;

(b) provide appropriate incentives, credit schemes, etc., to facilitate the emergence of seed enterprises, paying attention as appropriate, to the needs of the small farming sector, of women and of vulnerable or marginalized groups;

(c) provide support to and strengthen farmers' organizations in order that they can more effectively express demand for their seed requirements, paying particular attention to the needs of women and of vulnerable or marginalized groups;

(d) provide training and infrastructural support to farmers in seed technology, in order to improve the physical and genetic quality of farmer-saved seed.

Research and Technology

The RGOB should:

(a) assess current incentives and disincentives as well as needs for support to seed production and distribution enterprises, including small-scale, farmer-level efforts;

(b) develop approaches to support small-scale, farmer-level seed distribution, learning from the experiences of community and small-scale seed enterprises already underway.

Coordination and Administration

National capacity for farmers to acquire appropriate seed should be regularly monitored by the government. The potential for integrating this activity into agricultural development projects should be explored.

Developing New Markets for Local Varieties and "Diversity-Rich" Products

Assessment

Increasingly, diversity is being replaced by uniformity in the agricultural market place. Changes in traditional cultures and in consumer preferences are one explanation. Concentration on productivity, the effects of advertising and the rise of consumer markets leading to stringent requirements being imposed on farmers and the inadvertent disincentives arising from legislation, policies, programmes and other institutional activities offer additional explanations. Farmers nationwide are losing once-strong incentives to provide an array of varieties. Economic and social incentives could be offered to encourage farmers who continue to grow distinct, local varieties and produce "diversity-rich" agricultural products.

A programme to assist in the creation of specialized niche markets for biodiverse food crops could act as a positive stimulus to farmers to grow landraces/farmers' varieties, obsolete varieties, and other under-utilized food crops. Such a program should include the identification and removal of systemic institutional barriers and disincentives to biodiversity conservation and production/marketing.

Long-term Objectives

Stimulate stronger demand and more reliable market mechanisms for land races/farmers' varieties and related agricultural products.

Intermediate Objectives

To encourage farm suppliers, food processors, food distributors, and retail outlets to support the creation of niche markets for diverse foods, varieties andproducts.

Policy Strategy

The RGOB should consider, and as appropriate, adopt policies in extension, training, pricing, input distribution, infrastructure development, credit and taxation which serve as incentives for crop diversification and the creation of markets for biodiverse food crops, including standards for labeling of foods which allow the highlighting of use of non-standard crop varieties. Consideration should be given to developing appropriate niche variety registration systems to permit and promote the perpetuation, trial, evaluation and commercial distribution of local, obsolete varieties and to monitoring regulations enacted for other purposes to ensure that they do not inadvertently lead to the extinction of varieties. As feasible and appropriate, institutions should be encouraged to purchase "diversity-rich" foods for internal use.

Capacity Development

Processes and activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biodiversity should be identified and their effects on crop diversification monitored.

Appropriate bodies should promote public awareness in various media and through appropriate mechanisms, such as street fairs, initiatives in schools, etc.

Coordination and Administration

National and local level coordination and administration should be most effective.

Policy Issues on Domestic Biodiversity in Bhutan

Background

The Forestry and Nature Conservation Act establishes a legal framework for the conservation, use and access of biological resources under forest and nature reserve areas. However, in the area of crop and animal genetic resources similar legal instrument is yet to

be put in place to formalize the aims and objectives of conserving, sustainable use and equitable sharing of benefit arising from their uses. Nonetheless, the utilization, access and benefit sharing mechanism for wild and natural biological resources need to be carefully enshrined in the above Act.

The Convention on Biological Diversity (CBD, Rio de Janeiro, 1992) charges national governments with full sovereignty and responsibility over biological resources on their territory. The Convention in combination with the ongoing negotiations within the GATT/TRIPS highlight the need to regulate ownership of and access to biological resources. Legal and moral ownerships and rights are now firmly entrenched in the international trade agreements.

Differentiation is needed between the various forms of biodiversity; natural biodiversity as part of natural ecosystems, agricultural biodiversity as part of agroecosystems, medicinal plants (wild and cultivated), plants being harvested in natural ecosystems (vegetables, like mushroom, etc). Secondly, it is necessary to differentiate between biological material exported from Bhutan, and access of Bhutan to biological material from other countries, notably improved varieties of crops.

The primary objective of rules and regulations are to safeguard the interests of Bhutan and those of individual citizens with rightful claims or interests. This includes access to improved varieties from other countries. Following are some general observations on various issues as a first indication to be detailed at a later date.

Sovereignty over Biological Diversity

National sovereignty over natural resources is obvious. However, prior to the CBD, biological diversity was generally considered a common good with few or no restriction to collectors, national or international. This situation has changed. Collectors are now generally required to obtain official permits. A possible course of action for Bhutan could be to declare (by law or any other form of regulation) all biodiversity within Bhutan to be national property. Access to biological diversity could be regulated by a Material Transfer Agreement (MTA) mechanism, stipulating the kind of biodiversity concerned and the conditions under which such biodiversity can be exported and used. The rights of Bhutan on sharing of benefits if such material is commercially exploited etc. must be fixed in such arrangement. Some standard MTAs could be developed for the different kinds of biological diversity (see above) and different kinds of potential uses (taxonomic research, plant breeding, pharmacology, ornamentals, etc.). Genetic resources collecting in the country may be regulated through a code of conduct for collectors.

Importing Biological Diversity

There are various reasons why Bhutan might require access to biological diversity from other countries. The most obvious one is to have access to improved varieties of crops of interest to agriculture in Bhutan. Improved varieties from CGIAR centers are

usually free without conditions. However, commercial companies generally demand some form of protection of introduced varieties. In industrial countries this is regulated by plant Breeders' Rights (PBR) legislation harmonized in the UPOV convention. There is, however, no immediate need for Bhutan to adopt a formal PBR system until such time that it decides to promote the establishment of commercial plant breeding companies as the main source of seeds for farmers. PBR enforcement may promote local plant breeding capacity, promote access to latest foreign varieties, and fulfill some prerequisites of WTO resolutions. Till such times, limited regulations focused on specific situation (so-called Sui Generis regulations) would seem appropriate. One possible solution would seem specific MTA's on individual varieties. An alternative might be to incorporate certain protection in seed legislation. That may be expressed through issuance of a form of licensing system to give certain control in the seed supply market. A seed law may be needed to formalize varietal release procedure, institutionalize seed certification and quality control scheme and advocate compliance and respect for PBR.

Regulating distribution of planting material to farmers

When seeds (or other forms of planting materials) are distributed to farmers, guarantees are required that they are true to type (i.e. the named variety), have a good level of germination, are healthy (free of pests and diseases), properties that cannot be established from the seed without appropriate tests. It is a form of "consumer protection" regulated by seed legislation. Most countries have seed testing and certification schemes to control the quality of seed produced by either the commercial sector or by government agencies. Seed testing laboratories should be independent of the seed production organization to insure objective judgment and maintain adequate operational standards. Once released to farmers, very often varieties are entered into a farmer-to-farmer distribution system. This system cannot be monitored on quality, but may not need it. In this system formal tests are replaced by social control between farmers. Tests carried out in, amongst other, Indonesia indicate that farmers are well aware of the importance of good seed and generally maintain high standards.

As in MTAs, seed legislation can be expanded to regulate use and sale of specific named varieties stipulating certain conditions. However, both with MTAs and with specific seed legislation, once seed enter into the farmer system, regulating distribution or extracting royalties on behalf of the owner of a variety becomes extremely difficult if not impossible. Hence in the case of Bhutan, an MTA should probably have to be signed between the owner of a variety and the Royal Government of Bhutan establishing central payment of agreed reasonable royalties, or transferring ownership at a certain fee. However, the government must develop measures to recuperate the fee payments from the farmers.

LIVESTOCK RESOURCES

Research, Education, Training and Services: Present, Planned - Identity Gaps.

Agricultural research in Bhutan underwent a radical review between 199 1 & 1993. The major result was the change from the previous segregated, departmental approach to an integrated Renewable natural Resources(RNR) focus that recognised the essential interaction between crops, Livestock and forestry in Bhutan's farming systems, To this end, the separate research responsibilities of the Departments of Animal Husbandry, Agriculture and Forestry **were** amalgamated into one RNR programme co-ordinated by the Research, Extension and Irrigation Division(REID) of MOA.

The guiding principle outlined in the RNR research strategy and plan document for the effectiveness and efficiency with which the small holders Bhutanese farmers are served by the RNR research programme is based on:

i)Applied and adaptive research on real problems and constraints faced by the farmers. Food security and poverty alleviation, environmental protection and bio-diversity will be the ultimate goal of the RNR research programme.

ii) More precise research priority setting focused on high potential and impact in farmers field in diverse production systems. Therefore, incorporation of the farmers concern in the research planning process will be emphasised.

iii) Judicious use of resources through project based management.

iv) Agro-ecological and socio-economic aspects of the farming systems taken into account in technology development with strong orientation towards eco-regional approach.

v) Involvement of Extension in problem diagnosis, research planning and on-farm research.

vi) Feed back regarding transferred technologies provided by research for necessary adjustment to future technologies.

vii) Integrate research into Renewable Natural Resource Management and promote technologies that:

- increase conservation and raise productivity.
- use little external outputs but increase productivity.

viii) Recognition of research and extension as two components of the same system.

The RNR research defined as the "Development Research" will make all possible efforts so that doers and users i.e. the researchers, extension agents and farmers understand each other, and in line with the national Policy, the research activities will be geared towards planned outputs. On this basis the RNR sector has outlined the following policy guideline to the RNR research programme:

i)Problem orientation-the research programme will identify the production constraints in collaboration with extension agents and work on them to contribute to the solutions of the problems.

ii) Disciplinary and Inter-disciplinary focus-research programme will promote excellence in both discipline and inter-discipline research in view of the complex nature of the production environment and resource management.

iii) Relevance -to make research recommendations relevant to farmers, right kind of technology will be developed with high degree of interaction between researchers, extension agents and the farmers.

iv) Environmental Sustainability-research programme will safeguard against the use of technologies that will hurt sustainability and environmental integrity.

v) Institutional Sustainability-the sustainability of the research programme in the long run will be seen from the need and the resources available to support the programme that is effective and efficient.

vi) Equity-the RNR programme will pay due attention for equitable returns to the farmers of less favourable environment.

Research programmes on yaks

Range-lands management for increasing the productivity of alpine pasture.

studies on yak crosses (Dzos and Dzoms).

Finding out suitable alternatives to discourage migration

studies on dairy production and processing technique.

studies on yak diseases.

Extension policy and Education:

The concept of Domestic animal genetic conservation has come to the fore in recent times only and not many are aware of it. The extension document approved by the Ministry of Agriculture reflect its environmental and bio-diversity concerns by setting one of its ultimate objective as **"to support and promote the development and use of management strategies by rural households for sustained utilisation of natural resource".** This policy objective would be attained through its subprogram - 8 - Environmental Management: the intervention objectives of which are :

To identify with specified farmers in a specified location biological resource constraint and develop with farmers strategies and approaches for addressing these constraints.

To introduce systems of biological resource management in specified locations that promote biological diversity and contribute to sustainable development.

Based on these policy guidelines Domestic Animal Genetic Conservation would be promoted through the following :

Lobbying at the ministerial and inter ministerial level.

Training of the extension agents through workshops, seminars.

awareness raising campaigns.

c. Strategy & planning and basic services

Organised livestock development began in 1960s within the broad framework of the programmes like breed improvement, dairy development, health coverage, fodder development, sheep & fisheries development, establishment of animal husbandry cum farmers training centres, Research & extension development, human resource & infrastructure development. These programmes have been pursued in successive development plans. Livestock programmes are looked after by a network of 153 livestock extension outlets located in blocks and district head quarters. With about 73650 households in 195 blocks in the country every 585 households have one LEC. These are technically supported by regional livestock farms and laboratories.

The strategies adopted are:

breed improvement with the introduction of exotic breed of cattle like Jersey & Brown Swiss. Where feasible frozen semen is used for breeding through the network of 37 Artificial Insemination centres.

dairy development by encouraging farmers to go for small and productive herd,

sheep development by introducing better breed of sheep for increasing the wool production to meet the demand of local weavers,

fisheries development in the potential areas for increasing the cash income as well as nutritional status of farmers,

strengthening of the existing animal health services for providing better coverage to the farmers for controlling and eradication of animal diseases of economic importance,

increasing the feed and fodder resources of the country by encouraging the farmers for pasture development with the better yielding types of fodder seed,

strengthening and improvement of the existing animal husbandry farms involve in the production of various types of inputs required for implementation of the development programmes in the field, and,
providing required extension services to the farmers by building up the required trained manpower strength.

d. Other services

Health Services

Animal health services are at two levels:

a) Field services:

- disease investigation and diagnosis
-animal health extension
-co-ordination of field and laboratory services
-mobile clinics and support for field staff.

This is done through the 162 Livestock Extension Centres(including 20 veterinary hospitals) who provide services in the form of treatment of animals, deworming, vaccination, local extension programs at the Dzongkhag level.

b) Laboratory services:

The laboratory services is the services given by the Regional Laboratories(there are 4 Regional Veterinary Laboratories located at Gedu, Gaylegphu, Bumthang and Khaling) with further support from the Satellite Laboratories (Phuentsholing and Deothang) and the Royal Veterinary Epidemiology Centre which is the National Referral Laboratory in the country.
The RVEC, apart from being a national referral laboratory also acts as the co-ordinating body for all the animal health programs. In view of making laboratory services accessible to all level of farmers and in different remote areas, mobile laboratory facilities has been introduced. Apart from just doing the epidemiological studies, this approach will take the diagnostic services more nearer to the farmers. More efforts will be made towards delivery of health services to small holders in view of the fact that small holders are more livestock dependant.

e. Feed and fodder development support

Traditionally, forest browsing and feeding stubble/straw and kitchen waste have been the practice in livestock rearing, Improved pastures have been introduced about a decade back. Thus native pastures, forests, improved pasture, fodder trees, crop residues and farm wastes are the main sources of nutrition to the livestock in Bhutan.

CHAPTER 5
ADDITIONAL SUSTAINABLE BENEFITS FROM BIODIVERSITY OPTIONS FOR ACTION

OVERVIEW

The previous four chapters have focussed on Bhutan's biodiversity, what is being done now and a plan of actions which should be done to conserve or sustainably use it. This chapter presents options for additional actions which Bhutan can take to realize additional substantial but sustainable benefits from its biodiversity. The following discussion is based on *"Biodiversity Policy Options for Bhutan"* (Reid, 1996).

Bhutan's development is linked to its biological diversity and natural ecosystems to an extent almost unmatched elsewhere in the world. Its biological diversity and relatively undisturbed natural ecosystems represent a unique asset that no other nation in the region enjoys. Moreover, unlike virtually any other natural asset, the value of Bhutan's biodiversity and natural ecosystems is destined to increase with time. Throughout South and Southeast Asia, biodiversity is disappearing in the face of expanding populations, expanding agriculture, and poorly planned timber harvest, As this inexorable process unfolds, the relative importance of Bhutan's biodiversity grows.

Bhutan can benefit from its diversity in three complementary ways. First, the existing natural ecosystems will provide greater benefits to local populations than any alternative uses of most of these lands -- and those benefits can be significantly enhanced through careful management. Second, the nation's biodiversity has the potential of providing significant economic returns through international trade and ecotourism. Finally, because conservation of forests and biodiversity is of international value even beyond these domestic benefits, Bhutan stands to benefit from mechanisms for resource and technology transfer established under the Framework Convention on Climate Change and the Convention on Biological Diversity.

But these potential benefits will barely be tapped without increased ***investment*** in their development. Just as a country must make human, financial, and capital investments in its mining, agriculture, or power sectors in order to expand the potential development benefits they provide, so too it must invest in its natural ecosystems and biodiversity if it is to enhance the benefits from these resources. We traditionally think of agricultural or urban landscapes as "developed lands"and natural ecosystems as "undeveloped". But this taxonomy makes little sense in a country flke Bhutan where the natural ecosystem can potentially provide far more economic and social benefits than the modified ecosystem. With the proper investment and management, all of the country's
lands will be "developed" - some for their agricultural potential, some for industrial potential, and
the vast majority -- 70 percent or more -- for their biodiversity potential.

What type of investment is needed to increase the social and economic benefits from the country's biodiversity? Overwhelmingly, the key need is investment in the gathering, creation and protection of knowledge about the biodiversity. There are few countries where the priority for biodiversity investment is so clear. For any country to increase the contribution of its biological diversity and natural ecosystems to its social and economic development, it must adhere to the principle of "save it, study it, and use it sustainaby' (WRI, 1992). Unless the natural wealth of a nation is protected (save it) it cannot contribute to development goals. Yet unless countries and local communities obtain benefits from that biodiversity (use it sustainably), there will be no incentive to protect it. And unless the country works to better understand what biodiversity it has, what role it plays in natural processes, and how its value might be enhanced, it will not be in a position to either save it or use it sustainably.

Bhutan has taken extraordinary steps to protect its natural wealth, and already is tapping that wealth for sustainable local and national economic benefit. However, it has barely begun to build the knowledge base for better managing and utilizing its diversity. The potential social and economic gains from an investment in knowledge creation related to biodiversity are thus significant. Building the needed knowledge base is presented in Chapter 4A.

ECOTOURISM

There is considerable scope for Bhutan to increase its economic gains from ecotourism without threatening that diversity. Jigme Dorji National Park is,already a tourist attraction, and Royal Manas Park will become one when conditions permit it to be reopened. But other protected areas in Bhutan could also become attractive to tourists with appropriate investment. Bhutan has many of the features of a number of different successful ecotourism destinations -- the unique high elevation trekking experiences that draw tourists to Nepal, the "charismatic megavertebrates" that draw visitors to Kenya, and the species richness and scenic beauty that draws tourists to Costa Rica. The potential for ecotourism in Bhutan could be significant. Belize, a country half the size of Bhutan, had tourism receipts of $73 million in 1993 and surveys show that over half of the tourists visiting the country participated in nature based activities. Costa Rica - only slightly larger than Bhutan -- reported 684,000 overnight visitors in 1993 who spent a total of $577 million. Tourists spend on average $148 per day in Costa Rica (Sizer, 1996). More than 50 percent of the visitors to the Costa Rica state that the national parks are their "principal reason" for visiting the country.

However, just as a high volume of tourists can destroy cultural values in a country, so to it can degrade biodiversity. Bhutan's current goal of developing high income/low volume tourism applies equally to ecotourism. If Bhutan chooses to build a more substantial ecotourism industry - and increase the country's economic gains from that industry -- it would need to consider the following investments and policy changes:

Marketing and Market Survey

If Bhutan chooses to build its ecotourism industry, it should consider conducting basic market research to determine the types of infrastructure, information, trips, and accommodations, that would be attractive to potential tourists, and to analyze tourists' "willingness to pay" to visit Bhutan. With adequate marketing of the unique attributes of Bhutan as a tourist destination, it is likely that tourists would pay even more than the current "minimun" cost of $200 per day for visiting Bhutan with little or no decline in the rate of growth of tourism, which appears to be limited largely by capacity and lack of marketing at this stage.

Currently, Bhutan is not known as an ecotourism destination -- or even, for most people as a tourism destination at all. If the RGOB, the local tour industry, and international travel agents begin to more aggressively promote this opportunity - and particularly promote the fact that the culture and biodiversity has not been degraded by excessive tourism -- then the number of people desiring to visit the country, and their willingness to pay, will grow. Promotion of the opportunities, however, must go hand-in-hand with the development of more information about biodiversity, preparation of interpretive materials, training of guides, and development of infrastructure. A marketing survey, however, could help the country to more clearly understand the potential for this sector and to identify what specific niches within the ecotourism market Bhutan might best exploit.

The country also has potential for developing a white-water rafting and kayaking tourism industry. Because the presence of such an industry creates economic and political incentives to protect water quality and water flow, it would help to protect freshwater biodiversity and would indirectly provide an incentive for maintaining the forest cover in the watershed.

Information

The unique diversity of birds and plants in Bhutan could make the country a "Mecca" for wildlife enthusiasts, particularly birdwatchers and amateur botanists. This type of tourist is low impact, tends to be in higher income brackets and thus able to pay top prices to visit unique locations, and often does not demand high-end accommodations. However, to build this type of tourism Bhutan will need to invest in further development of basic scientific information on the distribution of biodiversity in the country and then provide interpretive materials -- particularly field guides and biodiversity tour guides -- to interested visitors. World Wildlife Fund has published a short book, *Birds of Bhutan,* listing several dozen of the most common species. Ideally, though, the country should build the knowledge base that would enable the government or private (or nongovernmental) entrepreneurs to begin to develop a series of field guides to various groups of species in the country - beginning with birds, plants, and butterflies. From this knowledge base, basic information could also be published detailing the types of species that could be seen in various parts of the country. This too could be done through private entrepreneurs, although the RGOB may want to play a role in catalyzing the development of such material.

This type of published information would be useful not only for tourism but also for education within the country. Particularly as the country becomes increasingly urbanized, the connection of people with the land and biodiversity will weaken, and field guides, regional species fists or CD-roms for use in the classroom could play important roles in building awareness among schoolchildren in the country about their biodiversity.

Training

An effective ecotourism industry will require trained guides who could take visitors to specific parks or sites, know what is likely to be seen, and be able to identify the biodiversity in the region. These skills can be obtained without extensive formal education - indeed, many rural people in Bhutan probably already have considerable expertise that could be adapted to this purpose if there were prospects of employment. Currently, the large tour operators indicate that the lack of trained guides is a serious constraint to their efforts to respond to potential interest in ecotours.

Over the long-term one of the best ways to build this capacity will be as an integral part of Bhutan's efforts to build the knowledge base about its biodiversity (Chapter 4A). Parataxonomists, for example, trained to help with a biological inventory of the country, would gain the experience necessary to become effective natural history guides.

Over the short-run, it may be worthwhile for the country to encourage natural history trips by organizations that could supply their own guides with some knowledge of the region, and pair those "visiting" guides with local people who could enhance their own skills during the trip. Almost all natural history museums in Europe and North America - such as the Smithsonian Institution, American Museum of Natural History, British Museum of Natural History -- run natural history tours for members. In addition, a number of nongovernmental organizations like the Sierra Club and Audubon Society also run international tours of this sort. The Tourism Authority of Bhutan could send exploratory letters to these groups, explaining that the country's interest is to begin to build more capacity for ecotourism within the country, to explore whether the trips could be run on terms and conditions acceptable to the government. This would also serve effectively to market ecotourism opportunities in Bhutan to a wider audience.

Infrastructure

Growth in ecotourism will require additional development of infrastructure, however this type of tourism demands somewhat less infrastructure than would be the case with expanded cultural tourism. Historically, many countries built elaborate facilities ("lodges") within protected areas as a key element of developing an ecotourism industry and Bhutan could also consider this model. Most evidence suggests, however, that a superior approach is to restrict development within protected areas to facilities needed for basic management and enforcement, trails or access routes, and basic interpretive facilities in heavily used regions and to concentrate development of lodging facilities in nearby towns or villages. Development of more extensive

facilities within protected areas has typically been done by issuing long-term concessions to private developers. It has been difficult for governments to capture an equitable portion of the returns from such developments to help pay the costs of the added maintenance and enforcement requirements that expanded ecotourism requires. Often the materials needed for more elaborate facilities cannot be obtained within the country and much of the expenditures thus "leak" outside of the country. In addition, these facilities have not contributed effectively to local economic development in the region near the protected area and have often stimulated greater population growth in buffer zones.

Expansion of lodging facilities near potential ecotourism destinations is probably best left to the private sector -- as visitation grows, the incentive to build new guest houses will grow. However, the RGOB will need to ensure that the basic protected area management and enforcement capacity is developed in parallel to growing use of protected areas as ecotourism destinations.

Policy Reforms

A typical scenario for tourism development in a country like Bhutan would be the following. Even i a region with high potential attraction for tourists, like Bhutan, tourist visits would initially be small because of the lack of awareness among potential visitors and the lack of facilities (lodging etc.) even for those desiring to visit. As more information and advertising becomes available and as facilities expand, the numbe of visitors would increase, enabling still greater investment by tour operators in advertisement and greater investment in improving facilities for visitors. The improved facilities and greater promotion would then attract still more visitors. During the period of industry growth, people would visit because of the cultural or artistic attributes, scenic beauty, unique wildlife, climate, and -- uniquely -- the relative lack of tourists compared to other more heavily visited regions. As the number of visitors grows, however, some of the attractions begin to decrease in "value". Cultural features become less distinct as the tourists themselves introduce more of their own culture to the region, the experience of seeing unique wildlife or appreciating the scenic beauty is reduced in value when visitors must experience it shoulder-to-shoulder with other tourists, and the attraction of visiting a rarely-visited country disappears. Thus, as tourism grows the marginal benefit to the country of the next tourist begins to fall (the tourist is willing to pay less because the value of the experience is decreasing) and the marginal costs rise (Lindberg, 1991).

The net value to the country is maximized at the point where the distance between benefits and costs is greatest, not where the number of tourists is greatest. Yet as is always the case with open access resources (the tourism "potential" of Bhutan effectively amounts to an open access resource), continued visitation beyond the point of maximum social value still provides benefits for the individual user (and profits for the industry) and so the pressure will be for tourism to grow. The country can act in two ways to limit tourism to the level with the highest social value - either setting a quota or using fees or taxes to raise the cost curve. Many countries have established quotas for visitation to protected areas and some countries, like the Seychelles, set overall quotas for tourism to the country. (In the case of the Seychelles, the government sets limits on the number of hotel rooms, limits camping, and does not allow tourists to stay in private houses.) Under its current poficy, Bhutan has adopted the approach of

setting **a** fee (35 percent of the $200 per person per day fee -- or $70 per visitor day) which raises the total cost curve in an effort to reduce the equilibrium number of tourists,

As noted above, it would be in the country's interest to undertake a market study of the tourism potential to obtain better estimates of the willingness of tourists to pay to visit Bhutan, the potential demand that will be generated once more people become aware of the tourism possibilities in the country, and the approximate range of visitor days that will lead to the greatest social gain for the country. Under the current policy, the incentives for both local tour operators, foreign travel agents, and local hotel operators will be to increase the number of tourists visiting the country as rapidly as the capacity and market will bear. The RGOB is thus undertaking an experiment with its current $70 per day fee to see whether that cost is great enough to limit tourism to the socially optimal level. All of the private concerns will benefit from maintaining costs as low as possible (i.e., encouraging the government not to raise the current fee) and bringing as many tourists as possible to the country. There is thus a substantial risk that the level of visitation will overshoot the optimal level, and once past that level it will be extremely difficult to reverse the trend since the capital investments in hotels and other infrastructure would make reductions in tourism visits highly costly and disruptive to the private sector.

The country could substantially reduce the risk of potential overexpansion of the tourism industry by maintaining quotas on visitation and slowly expanding those quotas as the demand and capacity warrants. There are three advantages of a quota system. First, the government is in complete control of the total number of visitors, rather than relying on the estimated elasticity of demand of visitors to the fee currently in use. Second, a quota system, by limiting visitors, creates the incentive for visitors to "bid up" the price of visiting Bhutan. Individuals will be willing to pay more, knowing that there are only limited opportunities for access. In contrast, under the existing system, so long as the visitor is willing to pay the minimum "hurdle" price ($70 per day plus expenses), then the incentives are to keep costs low and number of visitors high -just the opposite of the countries goal of high value/low volume tourism. Third, a user fee results in the govenunent capturing the rent associated with the excess of benefits over costs, rather than the private sector, whereas under a quota mechanism the higher price paid by tourists visiting the country would be captured by the private sector.

The only potential cost of a quota system would be that large tour operators may be able to drive small operators out of business, thereby reducing the opportunities for small businesses and creating **a** monopoly situation in the industry. This problem could be readily solved, however, by allocating tradable "rights" to the tour operators based on the number of visitor days that they currently are selling. Each operator would thus be guaranteed at least the current business that they are doing (and the profits they would obtain for that number of visitors would increase as the visitors began to bid up the price). Any operator, however, could sell a certain number of visitor day rights (or sell all their rights) to other operators if they felt that they could earn more through the sale of the right than through the business itself

The most desirable approach would likely be to maintain the existing fee charged by the RGOB, while setting limits to the total number of tourists visiting the country and allocating tradable rights to the existing tour operators. Operators would thus have to pay the government the current $70 per visitor day fee, but then would be free to charge what the market would bear. Using this approach, the governnent could also seek to steer tourist visits to other parts of the country or to other seasons of the year through either regional quotas or limits on hotel construction in Paro and Thimphu. The government could expand the number of tourists (the quota) in future years either by allocating additional rights to the operators or auctioning off those rights to the highest bidders.

NON-TIMBER FOREST PRODUCTS

Bhutan could increase economic benefits gained from its natural forests through intensified efforts to develop non-timber forest products. With support from UNDP, a project is already underway to expand production and quality of production of lemongrass oil. Other plants have been identified as having high potential for commercial exploitation of essential oils or resins, including *Pinus roxburghii* (chirpine), *Cympopogon distans* (a separate lemongrass species), *Artemesia vulgaris*, *Gaultheria spp.* (Wintergreen), *Abies densa* (silver fir), *Aquilaria agallocha*, and various lichen species (La, 1996). The RGOB has developed a horticultural action plan as part of the process of developing the Eighth Five Year Plan to identify priorities for further development of NTFPS.

Economic benefits from medicinal plants could also be increased in Bhutan, however, it will be difficult to expand this potential market while ensuring conservation and equitable sharing of benefits. Naturally grown medicinal plants with high potential for commercial exploitation include *Taxus baccata, Swertia chirata, Piper spp., Pseudo ginseng, Illicium anisatum, Cordecep sinensis, and Picrorhiza kurooa.* Bristol-Myers Squibb, for example, approached the National Institute of Traditional Medicine inquiring about the possibility of sourcing material *(Taxus baccata)* from Bhutan for production of Taxol. (The request was denied.) And, substantial trade is now underway with two plants: *Swertia chirata* (a member of the Gentian family exported to India as a multi-purpose medicinal plant) and pepper or pipla *(Piper* spp.), sold for spice production (the fiuits) and pan (the leaves). By one estimate, sales of pipla could expand to about $50,000 per year in Eastern Bhutan (Dorji, 1995).

The conservation risks associated with trade in medicinal plants are already well appreciated in Bhutan. Poaching of medicinal species -- including in some cases by Tibetans or Indians in the border regions -- is already a problem for a number of species. If markets are developed for additional species, added pressure will be placed on the collection of wad populations and, for some species, this could threaten the populations with extinction. This has been a common outcome of active marketing of medicinal plants in other regions of the world. Major conservation problems exist for wild medicinal plants commercially marketed in Africa (Cunningham, 1993). In Southern India alone, 80 medicinal plants have been labeled threatened by IUCN (Tandon, 1996). And often, the pressure of commercial demand comes from larger

markets in other countries. In Nepal, 60-70 percent of the medicinal herbs collected in the early 1980s were exported to India (85-200 tons annually between 1972 and 1980). Merely establishing cultivation of the species involved is not a sufficient solution to the problem (and, for many species, practical methods of cultivation are not yet known and may be difficult to achieve). Even if some people cultivate the species involved, the incentive for others to collect the species
from the wild will still exist unless the cultivated product becomes so abundant that the price of the product drops to the point that benefits to wild collectors are too low.

The National Institute of Traditional Mechanism is,hoping to establish a two-tiered pricing scheme for medicinal plants -- it will pay a higher price to producers who can 'certify that their material comes from cultivation. This policy should effectively reduce pressure on wild stocks (for those species suited to cultivation) so long as the NITM is the primary purchaser of herbal products. Maintaining this exclusivity for species with clear market value, however, will be increasingly difficult as transportation infrastructure is further developed and as local conununities establish more extensive trading relationships with others in Bhutan and in neighboring countries.

Bhutan and the NITM may want to establish 'preemptive' marketing policies for different categories of medicinal plants. The most restrictive category (Category I) would be for species that are relatively rare and which could easily be threatened by overharvesting. It would allow no commercial trade and NITM would use material only from cultivated sources. Category II would allow commercial trade only if practical means of cultivation have been developed. Category III would allow commercial trade even if the species is only obtained from the wild so long as a management plan has been established by the Forest Department. For example, *Taxus* would probably fall in Category III -- with an effective management plan the species is sufficiently abundant that it would be difficult to threaten with extinction through controlled harvest.

Bhutan should also carefully examine the issue of benefit sharing with local communities and traditional healers for traditional medicines that enter into the commercial trade. Currently, benefit sharing takes place largely through employment opportunities and the involvement of traditional healers in the NITM. The Institute can be viewed to be strengthening the capacity of these individuals to achieve their public health goals -- they are an integral part of the Institute, rather than a beneficiary of the Institute's work. While not allof the traditional healers in Bhutan may be directly involved in the institute, the NITM nonetheless provides "implicit" benefit sharing to all of Bhutan's people (including other healers) by virtue of the fact that while it is using traditional knowledge it is the repaying society by making the products of that knowledge more readily available across the country. So long as products are not being developed and sold for profit, this appears to be an effective arrangement.

However, if material is introduced into commercial markets then the issue of benefit sharing becomes more important. It clearly becomes an issue if a private entrepreneur wishes to sell traditional remedies or herbal plants that may have been used by many healers in the country.

The issue would also be relevant if NITM -- even as a non-profit institution - sells material for use outside of Bhutan. In both of these cases, the individuals whose knowledge of traditional medicines "created" the product that is being marketed will not all be receiving an equitable share of the benefits from that commercial use.

If traditional products are marketed, the RGOB thus may want to consider placing a small tax on the sales of products and using the funds raised in that fashion to provide benefits to the country's traditional healers, in particular those not directly involved in NITM. Alternatively, since the initial revenues from a small tax on a new commercial product would be very small, a portion of the Bhutan Trust Fund for Environmental Conservation, say $ 10,000 per year, could be allocated to activities that support traditional healers throughout Bhutan and the revenues raised through a tax on sales of traditional medicines would go directly into the Trust Fund. A small board comprised of traditional healers from villages and those involved in NITM could have oversight over the use of funds raised through either of these mechanisms.

BIOPROSPECTING

Bioprospecting -- the search for new genes or chemicals of value in the pharmaceutical, biotechnology, or agriculture industries -- could be considered to be just a third category of Bhutan's non-timber forest products. It is presented separately here, however, because unlike the NTFPs discussed above, the development of bioprospecting in almost all developing countries must involve significant international exchange of biodiversity since they lack the technological capacity for complete product development. Bioprospecting thus falls under many of the provisions of the 1993 United Nations Convention on Biological Diversity (CBD), including in particular Articles 15 and 16 on Access to Genetic Resources and Transfer of Technology.

For any country, the only guaranteed economic opportunity provided by bioprospecting is acceleration in the development of scientific knowledge about biodiversity and the development of enhanced technological capacity for using that biodiversity. Actual economic returns of any significance are possible, but unlikely. For example, if a country exported 1000 extracts of plants to the pharmaceutical industry, the odds of any commercial product resulting are about 2 chances in I 00 (Reid et al. 1993). Even so, if a product were to make it to market -- and it was a new pharmaceutical product -- then the economic returns could be substantial. Even with only a 3% royalty (typical royalties for randomly collected material range from 1-3% while for material collected based on traditional knowledge the royalties may be slightly higher -- 5% in one case in India) a drug earning $ 10 million net annual revenues would result in a return to the source country of $300,000 per year (although these earning would not be received until about 15 years after the sample was initially evaluated due to the lengthy process of drug development).

Thus, most countries that have established bioprospecting initiatives have focused on ensuring significant short-term benefits, recognizing that the probability of obtaining royalties are slim. This does not mean that countries should forgo the opportunity for royalties, only that

every effort should be made to ensure that the arrangements are attractive even if no commercial product is developed. Bioprospecting agreements can provide greater up-front benefits through the following approaches: a) high up-front payments that cover more than just the cost of collecting materials, such as the costs of establishing the basic scientific infrastructure for identifying, locating, and recollecting species and monitoring their population size; b) enhancement of technological capacity for extraction and isolation of active chemicals and preparation of samples; c) establishment of the capacity for basic screening of compounds for potential utility as drugs or industrial products; and, d) training of scientists in chemical analysis, drug discovery, and taxonomy (Reid et al., 1995).

The two pre-conditions for an effective bioprospecting program in a country are: (1) presence of basic biological knowledge about the resource; (2) presence of effective laws regulating access to biodiversity and the capacity to enforce those laws. Neither of these preconditions are yet met in Bhutan and thus it seems unlikely that establishment of commercial bioprospecting ventures in Bhutan would be beneficial in the near term. However, within about a decade, the country could meet these pre-conditions. The RGOB may wish to maintain its policy of not allowing conunercial bioprospecting exploration, but establish the groundwork for commercial bioprospecting over the next decade. The "groundwork" required is largely the same creation of core scientific knowledge about the country's biodiversity that has been noted above in the discussions of ecotourism and non-timber forest products. Thus, investment in creating this knowledge base would be justified even if the country eventually decided not to engage in commercial bioprospecting.

Scientific Knowledge

Like any commodity, the trade in genetic or biochemical resources will contribute most to development if the country "adds value" to the raw material. Even so, most countries still are involved almost exclusively in the trade in raw genetic materials - often simply sending plant samples to firms without even performing the basic chemical extractions within the country. Countries have an opportunity to multiply the benefits they obtain from biodiversity if they choose - as part of a broader technology development plan -- to build technological capacity related to biochemistry, biotechnology, agriculture, or phan-naceuticals.

Bhutan should explore the merits of establishing the capacity to add value to biodiversity. However, given the country's small population, building more than the basic technological capacities -- such as perfomiing.extractions of plant samples - may not be justified. Instead, Bhutan could explore opportunities to establish joint ventures with institutions in other countries - like India or Costa Rica, or possibly even developed countries like the United States -- that would enable Bhutanese scientists to work directly with the partner institutions but not require the substantial time and investment needed to expand Bhutan's own technological capacity in this area.

Whether a country ends up only trading raw material or developing a value added capacity, the core scientific knowledge needed is the swne: What species are present? Where

they are located? What is the status of their populations? What is their ecological role? How are they used by traditional cultures? How do they interact with predators and pests? For a country like Bhutan, developing this core information is no small undertaking. Specific approaches to building this knowledge base (and the human capacity associated with it) are discussed in Chapter 4A. as part of the needed actions since this need cross-cuts many of the potential economic opportunities associated with biodiversity.

Access Legislation

As discussed in Chapter 4A, Bhutan may want to allow access for biodiversity research by foreign scientists as part of a broader effort to build its human capacity and scientific knowledge related to biodiversity. However, until Bhutan has built the capacity for negotiating equitable contracts and enforcing access legislation and has increased the information base regarding its biodiversity, the best policy may be to continue to disallow certain forms of commercial bioprospecting. It is difficult, however, to draw an unambiguous line between types of commercial bioprospecting that should be allowed and those that should not. For example, a no-conunercial-bioprospecting policy would presumably seek to prevent a local entrepreneur from making extracts of biodiversity and selling them to a pharmaceutical company. But should it also prevent a local entrepreneur from making extracts and selling those as essential oils? Would this latter case be "commercial bioprospecting," or "development of a non-timber forest product"? And if the latter case is allowed because it better fits the NTFP model, should the government seek to prevent the local entrepreneur from growing the species in India where the conditions may be better for production?

Technological advances will make it increasingly difficult for Bhutan to draw this line identifying acceptable commercial uses of biodiversity. For example, consider the different ways that one extract from a plant in Bhutan might be used for commercial purposes. The extract might be found to contain a valuable oil, creating a new "non-timber forest product" for Bhutan. Alternatively, it might be the source of a new fragrance of value to the perfume industry. This industry doesn't patent the chemical (it instead synthesizes a different compound that produces the same fragrance) but firms are willing to pay for exploration of new biodiversity-based fragrances. (INBio in Costa Rica has had contracts with the perfume industry, for example.) Alternatively, the same sample might contain a chemical that could be used as a pharmaceutical product. Pharmaceutical companies do patent the chemical involved, although the final drug often is synthesized and typically is somewhat different in structure from the original chemical. Finally, the sample, might show activity as a pesticide, leading genetic engineers to search for the gene that produced the chemical involved, patent the gene, and introduce it into a new crop.

A no-commercial-bioprospecting policy is thus too broad to protect the nation's economic interests. Instead, Bhutan should consider establishing a policy with criteria for access that would prevent specific types of biodiversity uses. For example, Bhutan may choose to prevent: a) patenting of a chemical or gene obtained from the country; and b) shifting of the source of production of a material produced by a Bhutanese species to another geographical location.

Thus, in the examples given above, Bhutan would want to avoid export of material that would lead to the new drug and the genetically engineered crop. It would also want to ensure that if a new essential oil was developed from a species endemic to Bhutan that the producer couldn't establish a plantation in India thereby cutting Bhutan out of the benefits. On the other hand, the country would allow research to develop a new fragrance or the production of a new essential oil so long as the production was based in Bhutan.

In addition to these criteria setting the terms for the type of access that the country desires to allow, several other elements of access legislation, national environmental law, or formal government policy will be important as part of the country's efforts to regulate access and ensure the equitable sharing of benefits of the use of biodiversity.

a) ***Focalpoint contact.*** The Ministry, Commission, or Agency with final responsibility for reaching a decision and issuing or disallowing a collecting permit (or a permit enabling transfer of biological samples) should be clearly identified for users both within Bhutan and internationally. Any such focal point would need to consult broadly with potentially affected Ministries, and deal with all of Bhutan's biodiversity.

b) ***Scope of restriction.*** Bhutan should determine whether restrictions on commercial bioprospecting apply only to non-Bhutanese "prospectors" or to citizens as well. In other words, should **a** private business be allowed to be established in Bhutan that makes extracts of local species and then sells those extracts to pharmaceutical companies? Under **a** strict no-commercial-bioprospecting policy, both local entrepreneurs and foreign researchers would have to apply for permits.

c) ***Activities requiring permits..*** To protect against material being used in a manner that would lead to new patents on chemicals or genes or the loss of material to producers outside of Bhutan, the country should consider establishing a requirement for an export permit that anyone -- Bhutanese citizen or foreign national -- must obtain before exporting any biological material or material derived from biological material. Existing commodities exported from Bhutan (such as agricultural or timber products, resins, oils, etc) would be exempt from this permit requirement and exemptions could be granted for other commodities in the future.

The permitting procedure would have two basic purposes. First, it would ensure that the material exported could be used only for the stated purpose and any use of the material for developing other products would not be allowed without obtaining permission from the RGOB. Standard language could also state that the material could not be used as the basis for establishing populations of the species outside of Bhutan (e.g., through tissue culture or planting cuttings or seeds) without consent of RGOB. Second, the permit requirement would enable the authority responsible to prevent those activities clearly directed at conunercial exploration for new chemicals or genes that

could potentially be subject to patent. The permit process should be simply and efficient -- since most applications are likely to involve activities related to the development of NTFPs that the RGOB may want to encourage -- but it would provide the basis for preventing activities that held the potential of commercial exploitation before Bhutan is in a position to ensure that it gains an equitable share of the benefits.

d) ***Benefit sharing with local communities.*** Either through the permit process described above or thorough other mechanisms, Bhutan's policy should specify that the prior informed consent of local communities (or individuals such as traditional healers) must be obtained before using information from them for either collecting biodiversity or developing potential products. The policy should also specify the mechanism for ensuring equitable sharing of potential benefits from the use of that knowledge.

CARBON STORAGE

Bhutan is in a somewhat paradoxical situation with regards to its potential to capture greater economic value from the carbon content of its forests. Despite the fact that Bhutan is heavily forested and those forests play an important role in sequestering carbon from release in the atmosphere, any mechanism established for financial transfers to pay for carbon offsets -- either through Joint Implementation (JI) or carbon trading -- will hinge on the principle of incremental costs. Funds through JI, for example, would be available to pay for additional storage of carbon beyond what is already in the country's economic interests. In Bhutan's case, since loss of forest cover would be extremely damaging to the country's economy (due to the extensive erosion, degradation of hydropower potential, and loss of locally important biodiversity that would result), it is difficult to make a case that funds from JI or carbon trading should help to pay for the cost of protecting the forest.

Even so, three opportunities do exist to take advantage of these sources of funding:

1) *Fuelwood offsets. JI* funds could be used to help pay for the cost of hydropower developments that will lessen pressure on fuelwood supplies in areas that are facing fuelwood shortages. So long as fuelwood is not overharvested, it does not represent a net addition of carbon into the atmosphere. But where it is overharvested, leading to forest loss, then a case can be made that substitution of hydropower for fuelwood as an energy source will help prevent net additions of carbon into the atmosphere. Given current fuelwood consumption of 1,200,000 M3 and assuming that roughly one third of that consumption is now in areas facing fuelwood scarcity and that hydro development could reduce that demand by 2/3, the net carbon contribution would be the carbon equivalent of about 266,650 M3 of wood yielding a net value of 26,600 tons of carbon. Damage costs per ton of carbon released into the atmosphere are usually taken to be about $20 per ton, however, alternative carbon offset projects involving fuel conversion yield carbon savings at a value of $5 per ton. A rough estimate of the market value of the carbon offset associated with reduced fuelwood consumption based on the above assumptions and a price of $5 to $ 1 0 per ton offset would thus be about $125,000 to $250,000 per year.

2) *Reforestation. JI* funds could be used to pay for reforestation in areas where the forest has been degraded. Successful reforestation efforts have been undertaken in the area surrounding Thimphu and Wangdi, for example. JI could be used to support such reforestation efforts, so long as a strong case could be made that reforestation of a particular region was not simply displacing pressure to other forests that would then be cleared more quickly.

Bhutan recently rejected **a** proposal for **a** $20 million AU project from the FACE Foundation of the Netherlands out of concern over the potential loss of sovereignty implied in the project. Based on the lessons learned through the negotiation with the FACE foundation, and through consultation with other countries like Costa Rica that are actively implementing AIJ projects, the RGOB may wish to develop **a** set of criteria to help guide its future considerations of carbon offset proposals or to identify specific proposals it wishes to make to donors.

For any revegetation project to be considered as **a** target for JI funding, the donor will need long-tenn assurance that the carbon will remain sequestered. This criteria can be met in **a** manner that does not undermine the country's sovereignty over its resources. In effect, the country financing the JI project is paying for a long-term lease on land in Bhutan, just as the country might allow **a** long-term lease for **a** mining operation by **a** private company. In neither case is the sovereignty of the country placed in question -- **a** particular right to the land has simply been purchased for a specified period of time.

The donor would also need assurance that the restoration of a forest won't simply lead to the loss of an adjacent forest. This issue of carbon "leakage" can be difficult to address. As a rule of thumb, however, unless the proposed project has the effect of stopping the pressures that led to the original loss of the forest, then the result of the project is likely to be leakage. Thus, if the forest was degraded due to expansion of agricultural land, then revegetation of the forest will simply shift the pressure of expanding agriculture elsewhere. On the other hand, revegetation of the hills surrounding TWmphu was achieved in part by fencing cattle out while the forest was being established. Once the forest was re-established, the cattle could be allowed back into the forest without difficulty. There is thus less reason to expect that revegetation of this forest would lead to carbon leakage to other areas.

3. *Speed the rate of hydropower development.* Bhutan could seek JI funding for its hydro-development projects which will be producing power for India's electric grid thereby displacing other potential -- high carbon -- sources of power for India. Planned power development in Bhutan is being funded by a mix of grants and no- or low-interest loans. For example, the financing for the first stage of the Basochu Project (22.2 MW of the total 60.8 MW project) will be obtained from the Austrian government with 5 1% in grant support and 49% interest free loan (UNDP, 1996). Even though financing is already available for Bhutan's planned hydro projects, the case could be made that Bhutan could bring substantially more hydropower on line more rapidly if the financing were on better economic terms. In other words, while a given hydro project n-dght eventually be developed even without JI support, it would be developed more quickly with support. In the above example, Bhutan n-dght seek to replace the 49 percent of

financing now obtained through interest-free loans with direct grant support through a JI agreement. This would free up additional capital that could be invested in development of additional hydropower facilities (and enable Bhutan to earn more revenues from the Basochu plant).

ECOSYSTEM SERVICES

The maintenance of natural ecosystems in Bhutan provides economic benefits that fall into three general categories: market and non-market values associated with particular species (NTFP's, bioprospecting, genetic resources), aesthetic values that draw ecotourists to see the diversity of species or particularly charismatic species, and values associated with ecosystem services. Ecosystem service values have traditionally been least well appreciated by policymakers worldwide -- probably because of the difficulty in capturing their full economic value -- but they are likely to prove to be one of the most important sources of economic revenue associated with the maintenance of natural ecosystems in Bhutan.

Some examples of services provided by ecosystems are air filtration, water purification, maintenance of soil fertility, pollination of crops, flood control, erosion control, maintenance of stream discharge rates, protection of coastlines and so forth. Many of the services that an ecosystem provides are altered when changes are made to its species composition or structure, as for example when a forest is replaced with cropland or pasture. Sometimes the effects on ecosystem services are intentional -- for example, filling a wetland to reduce the threat of disease transmission by mosquitos. Other times, the effects are inadvertent - by filling that same wetland the next flood runoff may be exacerbated, destroying downstream settlements.

The maintenance of forest cover in Bhutan provides two particularly critical ecosystem services for the country: a) protection from erosion; and, b) maintenance of water discharge patterns. Without extensive forest cover, the steep slopes and highly erodible soils in much of the country would be subject to extensive landslides, slumps, and surface erosion. This would have both local and regional impacts. Locally, it would create water quality problems, threaten settlements and agricultural lands with landslides, and reduce the potential economic benefits from hydropower development either by shortening the effective life of reservoirs or increasing the maintenance costs of run-of-the-river hydro developments. Regionally, the added sediment load would accelerate the build-up of natural levies in low-lying areas in Bangladesh and India, raising the risk of massive devastation when natural levies break flooding low-lying areas.

Forest cover also evens out the discharge pattern of Bhutan's rivers. During wet periods, forests retain more moisture, lessening peak discharge rates and increasing discharge during periods with lower rainfall. A more uniform discharge rate provides substantial econonfic benefits for hydro development, since the pattern of power generation then more closely matches baseload power needs. And, because peak discharge rates are lessened when forest cover is maintained, the risk of devastating downstream floods is reduced. This again has

regional implications -protection of forest cover in Bhutan diminishes flood threats in India and Bangladesh.

As critical as ecosystem services may be to the sustainable development of a region, they are not something that can be commercialized in themselves for expanded economic returns. Countries typically experience an economic cost when a service is lost, but the benefits provided by ecosystem services do not show on up on a nation's econon-fit ledger as revenues. For example, if the mangroves protecting a coastline from erosion are destroyed, the country has to pay to build an artificial barrier to protect the coast from erosion. The mangroves thus provide an economic benefit at least equal to the cost of the replacement of that service, but that benefit doesn't show up as revenue in the budget of the forest manager responsible for protecting the mangroves.

How then are countries to pay the costs associated with protecting these important ecosystem services? The answer is straightforward -- the cost of maintaining the services should be built into the price paid for the ultimate product of the service. If mangroves are protecting a coastline from erosion, then a tax should be placed on the value of the property protected and the revenue should be used to maintain the mangroves. If a wetland is helping to clean a town's sewage, then a file should be placed on water use with the revenues used to help maintain the wetland. And, if the presence of forested watersheds increases the economic returns from downstream hydro development, then the cost of protecting those watersheds (or the opportunity cost of that forest if that value is greater) should be built into the price of electricity produced by the powerplant. In effect, the opportunity cost of alternative uses of a forested watershed is as much a cost of development of a hydropower plant as the concrete and labor required for construction. And the cost of maintaining that forest cover is as much an operations and maintenance cost as the cost of replacing worn-out equipment.

Costa Rica is perhaps the first country to build the cost of maintaining ecosystem services directly into the costs of the final product. Costa Rica depends on hydroelectricity for 99 percent of its electricity needs and a large portion of the water "fueling" that hydropower production -estimated to be 50 to 80 percent -- flows from the country's protected areas (GCR, 1992). In 1995, the country placed a small tax on users of water and electricity in the country. The revenue generated from that tax is then returned to the conservation areas. These revenues, combined with a small endowment and the revenues from Park entrance fees, will be able to cover 80 percent of the operating costs of the protected areas.

This same approach could be applied to planned hydro development in Bhutan. By way of example, consider the pre-feasibility study for the Kholong Chhu hydroproject. Development of this project is not planned for the Eighth Five Year Plan, so this example is strictly hypothetical.) The hydro project would have an installed capacity of 290 MW and the continuity of its power production would rely heavily on the maintenance of the integrity of the upstream catchment area (an estimated 1,134 square km. , or about 2.5 percent of Bhutan's land area). The pre-feasibirty study states, for example:

> "Significant upstream catchment changes are not presently planned or expected, as no major population changes or infrastructure developments are anticipated for this area. However, it appears that the major change in the upstream catchment which could potentially have an impact on the project would be road construction and associated logging activities. This might affect the project hydrology in that the timing and magnitude of low and high flows and floods could change, thus altering the project design parameters and operation characteristics. Likewise, extremely heavy logging, vegetation clearing or earth moving activities could cause a greater sediment load and inflow to the project." (IBRD, 1993; p. 6-7)

The economic evaluation of a project like this hinges on the cost of construction, the cost of operation and maintenance, and the price that the electricity will be sold. Electricity can be produced through Bhutan's hydropower projects at a much lower cost than the current market price in India. Market prices for energy in India in 1993 were 10.5 cents/kWh (peak), 7 cents/kWh (firm), and 3.5 cents/kWh (seasonal) -- these form the "ceiling" price for electricity sales from Bhutan. So long as Bhutan can cover the capital, financing, and operation and maintenance (O&M) costs at prices lower than these, then it stands to make a profit. (The pre-feasibifity study estimated the unit cost of supply to be 2.34cents/kWh; the 1993 tariff for domestic sales in Bhutan was 1.3cents/kWh.) Typically, the actual electricity costs are set through negotiation with India at a level between the cost of production and the "ceiling" price (and because India has financed past hydro development, it has additional leverage on keeping the costs low).

In the pre-feasibility study, capital expenditures for the project were estimated to be $215 million with operation and maintenance costs (O&K estimated to be about $2 million per year for the 25-year life of the plant. The capital expenditure for the site, however, does not include the opportunity cost of other uses of the catclunent area (e.g., for timber harvesting) and the O&M costs do not include the cost of protecting and sustainably managing the forests in the catchment area. In the future, the RGOB may want to include both of these costs in the economic evaluation of specific hydroprojects. A substantial fraction of these costs could logically be covered as part of the O&M costs for various hydropower developments.

For an initial approximation of the value of this service, the RGOB could consider the costs of maintaining the forest cover to be equal to the Forest Service Division's budget. The annual Forest Services Division budget for the 8th Five Year Plan is projected to be about $6 million. Since the catchment of this planned project covers about 2.5 percent of the country, a rough allocation of the Forest Services Budget to the O&M costs for the project would be 2.5 percent of $6 million, or $150,000 per year -- an increase of only 7.5 percent in the O&M costs for the project. The net effect would be to slightly increase the O&M costs of the projects thereby increasing the unit cost of electricity supply. Through negotiations with the power purchaser the effect would be to slightly raise the minimum cost and slightly raise the final negotiated price. Bhutan would then obtain greater revenues from the electricity sales, and some of those revenues could then be channeled back to support the protected areas and to support forest management.

In principle, to the extent that Bhutan protects more forest cover than is justified from its own economic self-interest, but which serves to lessen flood damage in Bangladesh or India, those countries should contribute to the cost of forest protection. In practice, capturing these economic benefits is likely to be difficult. First, the same issue of incremental cost arises here that bedevils the Joint Implementation issues. Protecting natural forest is largely justified in Bhutan simply because the costs of logging or converting the forest exceed the benefits that would be gained. Second, the actual link between forest cover in the lemalayas and flood risks in the lowland area is poorly understood. It would be in the interest of all three countries -- Bhutan, India, and Bangladesh -- to expand research on this issue. At the outset, it may be more appropriate to pursue the goal of support from India for research in Bhutan. Eventually, however, Bhutan may wish to consider seeking watershed protection grants from India, or building additional watershed protection costs into the electricity tariff charged to India and Bangladesh. In effect, India and Bangladesh would pay an additional "tax" on electricity which would help to justify (and pay for the management of) the maintenance of forest cover in Bhutan, since the loss of that forest cover would have serious economic consequences for India and Bangladesh.

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THE USE OF INDICATORS TO DETERMINE EFFECTIVENESS

Introduction

Indicators can provide policy-relevant performance measures for a wide range of policy issues, particularly in national reporting. They can be used to suinmarise quantitative information on the status and trends of elements of biological diversity, as well as relevant socioeconomic, cultural and other data, so as to be comparable across time and space. Because they lend context to data, and simplify sometimes complex processes and conflicting trends, indicators are useful tools for conveying reporting information to policy makers and other audiences.

Indicators in this sense are essentially used to convey often complex data in a simplified form. As such, they should be viewed in the context of the entire information chain, Which includes:

I. Data/Reports: (disaggregated statistics, integrated data bases, indicators, indices, integrated reports) and-,
2. Processes: (planning, surveys/inventory', data/information management, monitoring, evaluation (analysis and integration), reporting).

Indicator criteria

Statistical data should meet certain criteria in order to be considered effective for indicator use. Good indicators should simplify information, be scientifically credible, relevant to policv or management, and be responsive to changes in time and/or space. In addition, indicators should be able to show changes against a target or threshold, and be comprehensible to the intended audience.

Indices

Indicator information can be further aggregated into indices by combining several indicators (or different, statistical datasets). These i-neasures provide "bottom line" information -- summarising sometimes conflicting conditions and trends (for example, summarisinl) data for chanaes in vegetation for all cover types within a country), While useful for painting broad-brush pictures of the status and changes in a particular environmental (or economic) sector. indices can be misleading because, through aggregation, they may mask or understate significant events.

Frameworks

Indicator frameworks organise indicators so as to present trends, processes and interrelationships in one coherent picture (for example- to provide an overview of the conditions of and trends in biological diversity within a particular country). Various framework approaches have been developed for this purpose. For example, the media approach presents environmental information by broad sector (air, water, land, and living resources). 'The pressure-state-response (P-S-R) framework relates ressures on the environment to the state of the resource or system in question, the impact these pressures have on the resource and/or system.- and management and policv responses to these impacts. Because it highlights

relationships between actions and responses, the PS-R framework is a particularly useful way of presenting indicator information to decision-makers.

Presentation formats

Indicators and indices can be presented through a variety of formats to depict changes over time and/or space: as tabular information (e.g., percentage of country X's vascular plant species that occur within publicly owned lands), as a graphic (e.g., as a bar chart depicting the percentage of vascular plant species occurring within publicly owned lands, by land use type), or as a map (e.g., a map depicting the location of public land, colourcoded to depict the percentage range of vascular plant species found within a given map unit).

Indicator selection process

In choosing indicators of biological diversity, information managers should:

1. Define the indicator audience, and its information needs.
2. The audience to be reached, its level of technical expertise, and its information needs determine not only what kinds of data should be presented through indicators, but also:
   - the number of indicators that are to be presented, and the degree to which indicator information should be aggregated;
   - the reporting units to be used. For example, managers generally require indicator results by management unit (by the watershed area, forest type, protected area they are working in). Policy analysts and policy makers, on the other hand, may prefer results by the administrative unit for which they are responsible (by state, or province, or country);
   - the spatial and temporal scale of measurement;
   - the thresholds, targets and benchmarks that are to be used in constructing indicators; and
   - the presentation formats that can effectively communicate information to the target audience.

Articulate the criteria to be measured

Once the audiences and their general information needs have been defined, information managers should first work with these user groups to define the specific questions for which they need answers. The managers should then articulate criteria -- textual descriptions of the phenomena to be measured -- that might answer these questions. For example, in answering the question "are wild fisheries being managed sustainably?". information managers should work with scientists to prepare a series of criteria describing what a sustainable fisheries would look like, then define indicators that can measure whether these criteria have been achieved.

Select appropriate indicators for these criteria

Not all criteria will be measurable by indicators, and of those that are so measurable, not all can be measured directly. For example, in defining criteria to assess forest condition, some of these criteria might best be answered qualitatively (e.g., whether forests are "pristine"), others can be captured directly through indicators (e.g., plantations as a percent of total forest cover, as a measure of naturalness), and others can only be measured indirectly (percent of forest cover in large blocks of roadless areas, as an indirect measure of human disturbance).

Critically test the indicators

Most environmental indicators have only recently been developed and should be considered as being in an experimental phase. It is important that indicators be tested against the wider phenomena they are intended to represent or summarise so that they can be relied upon, As with anv such process, this testing can be expected to lead to modification, refinement, or even the abandoning of some indicators if they are found to be unreliable.

Establish appropriate targets, thresholds and/or benchmarks for these indicators

Indicators of use to policy makers provide context to data so they can be understood by non-tee@cal audiences. Indicators do this by referencing targets, thresholds and/or benchmarks. Such references may include: change since a baseline year- benchmarks that describe a subcomponent relative to the whole (e.g., the number of livestock breeds within a country relative to the total number of known extant plus extinct breeds); criterion benchmarks (e.g., the percentage of coral reef area threatened by pollution, where the criteria spell out ambient pollutant levels that might constitute a "threat"); and distance to a policy target, or goal (e.g., the ambient water pollution relative to the ambient level desired by year X),

"Field test" the indicators

Once the indicators have been developed, information managers should vet these indicators with individuals representing a sample of the target audience(s). The objective of this step is to ensure that these indicators effectively answer users' questions (and also that indicators are understood, that the reporting units are appropriate, that thresholds and benchmarks are intuitive, etc.).

Indicators for the condition of biological diversity

Within a pressure-state-response framework, state indicators of biological diversity are ultimately of greatest importance. Only by assessing the state of biological diversity and how this changes through time will it be possible to assess the effectiveness of measures taken. Such indicators may be subsets of biodiversity, usually species or groups of species (indicator taxa), or may be other parameters. Biodiversitv state indicators may be essentially static, that is designed principally for geographical comparison (e.g., species richness or degree of endemism in a particular taxon), or may be dynamic, that is, intended to monitor change (e.g., percentage of species classified as threatened, area of habitat remaining). Indicators used for assessing the effectiveness of measures taken to maintain biological diversity "must, of necessity, have a dynamic component.

It is appropriate to consider indicators at the three commonly perceived levels of Organisation of biological diversity: ecosystems and habitats, species, and genes and genomes. Because the three levels are interdependent, appropriate indicators for one level may actually be subsets of another level (e.g., species as indicators for assessing the state of ecosystems). Indicators of the state of habitats and ecosystems are of particular importance.

Habitat and ecosystem indicators

Indicators for habitats and ecosystems may conveniently be divided into those of extent

(or area) and those of condition. in general, the former are more easily developed than the latter,, at least for terrestrial ecosystems. Indicators of ecosystem or habitat extent require that a definition of the ecosystem or habitat in terms of measurable parameters be settled. For example, a forest is generally defined in terms of percentage canopy cover, where the canopy is some minimum height. For the purposes of developing indicators, the exact definitions can be fairly arbitrary as long as they are applied consistently. The more easily and widely measurable the parameters are, the better. For this reason, parameters that are measurable by remote-sensing or aerial photography are to be preferred. Indicators can be developed in a straightforward manner from original data simply by calculating the percentage changes in extent of habitat from some baseline.

Indicators of extent provide valuable information with respect to one major pressure on biological diversity, namely, that of the complete conversion or destruction of habitats or ecosystems. However, adverse impacts on biological diversity often fall short of this and rather affect what may be loosely termed habitat or ecosystem quality. These impacts may be as far-reaching in their effects as conversion. A lake may be rendered virtually abiotic by pollutants, but still remain a take, or a species-rich grassland may have its diversity drastically reduced by input of nitrogenous fertihser, but still remain a grassland. Developing indicators for these situations is generally far more problematic, for both theoretical and practical reasons.

Because changes in habitat and ecosystem quality are essentially manifested in changes in the distribution and abundance of species, much attention has focused on developing the. latter as indicators. Several sets of criteria have been established for indicator species, but very few such indicators have yet been made operational. This is in large measure because the most basic attribute of indicators is that they must be correlated with some larger measure of biological diversity so that changes in the indicator over time or space mirror changes in biological diversity as a whole. Demonstrating this to be the case with species is problematic, for a range of theoretical and practical reasons. Although there is broad agreement that areas or ecosystems that are rich in one group of species are likely to be rich in others, this is by no means always the case and, indeed, at fine scales this relationship often breaks down, so that areas of richness in different taxonomic groups may be inversely correlated. Similarly responses to environmental change, both natural and human-induced, may be very different in different subsets of biological diversity. For example, populations of generalist species, including many large mammals that would be widely considered as excellent indicators, often increase in logged-over or partially degraded forest, while populations of species dependent on undisturbed forest decrease.

A further assumption is that changes in chosen indicator species can be related directly to causes. Within a pressure-state-response framework this means that changes in state can be related directly to changes in pressures or responses. However, because natural ecosystems **are** highly dynamic at all spatial and temporal scales, this is often very difficult to demonstrate. The populations and ranges of all species vary for a number of reasons, including cyclical and noncyclical environmental perturbations, through stochastic processes, and because of the impacts of humankind. Demonstrating that a change in the chosen indicator is the result of human actions, either beneficial (generally a response) or deleterious (a pressure), and not a product of other influences, is often not easy. Moreover, as noted above, because of the adaptive nature of natural systems, the responses of these systems to human actions are oflen complex and sometimes counterintuitive.

Practical problems in developing species indicators for biological diversity lie in the paucity of baseline data-sets in most parts of the world, and in the need for sustained monitoring programmes. Indicators of change by definition require monitoring through time, either continuously or periodically. Results

obtained at different points in time have to be comparable, so methods for measuring or sampling must themselves remain consistent. However, in the.vast majority of cases, monitoring the distribution and abundance of species is expensive and time-consuming, particularly if carried out over extensive areas, as is necessary if the indicators so developed are to have anything other than a very local application. As a result, few rigorous monitoring programmes have been sustained to date for any significant lengths of time.

Solutions to some of these methodological problems lie in: the use of sampling sites; the mobilising of large numbers of people, usually amateurs, as is done with annual wild bird counts in several countries; the use of aerial surveys to count large species, generally mammals and some birds in open ecosystems such as grasslands.

State indicators for species

Problems with monitoring and developing indicators for the state of species are discussed in general terms above. At national or global levels, however, species indicators do not necessarily have to be tied to particular habitats or ecosystems. An important potential indicator of the state of species is the number or percentage of threatened species in a given area or country, as assessed under some standardised system such as that in use by the IUCN -- the World Conservation LJnion. However, assessing the threat status of species is very incomplete and very taxonomically skewed, so that only higher vertebrates (namely mammals and birds) and a few other smaller groups of organisms (e.g., conifers, cycads, swallowtail butterflies) have been at all completely assessed. It is only feasible to attempt to derive indicators for these few groups.

Such indicators may provide a useful static picture of the state of biological diversity, that is, they may be useful for geographic comparisons, but are at present of limited use in tracking trends in time. This is because changes in listings unconnected to species status -- mainly taxonomic changes, improved information and changing classification criteria -- generally swamp genuine changes in status. With the establishment of new, more objective, listing criteria and a growing tendency to adopt standard classifications, the situation may improve, but it will be several years before useful indicators of change emerge.

State indicators for genes and genomes

Direct monitoring of the state of genes and genomes, particularly in wild populations, is generally not feasible at present. Presently, genetic diversity is of greatest importance in agricultural systems. Here, there are possibilities of developing indirect measures or indicators- for example, through assessing rates of loss of landraces or changes in the proportion of production from traditional as opposed to modern or improved varieties. Genetic erosion on the regional and species level is a measure of loss of genotypes of a particular crop. From the crop data, genetic erosion and genetic integrity for groups of crops and for areas can be calculated.

Pressure indicators

Pressure indicators are essentially indicators of the processes and categories of activities that have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity. A number of pressure impacts can be measured, directly or indirectly, and can be used to generate indicators of threat. Of particular importance in predictions of future pressures on biological diversity is

the development of indicators for the major socioeconomic factors that lead to adverse impacts on biological diversity, as land tenure, population change, cost-benefit imbalances, cultural factors and misdirected economic incentives.

Indicators of some aspects of pressure may be easier to develop than state indicators of biological diversity. Decreases or negative changes in pressure indicators will imply that measures taken, to some degree, have been effective. Nevertheless, the crucial step will still be to link a decrease in pressure indicators to an amelioration in, or at least stabilisation of, the state of biological diversity. To achieve this, state indicators will ultimately have to be developed.

Response indicators

Responses to adverse impacts on biological diversity lie within the human domain and many of thei-n are of a legal or formalised nature. The formal designation of protected areas is one obvious example. Such responses lend themselves well to the development of indicators because they are measurable atid can be translated into terms understood by a wider audience. More generated responses, such as changes in public attitudes and behaviour, are more difficult to assess and develop indicators froi-n. However, there are well-defined and tested methodologies for this outside the realm of biological diversity.

Again, as with pressure indicators, the challenge, and the principal slibject lies in relating such response indicators to state indicators, for it is only through this link that the effectiveness of these responses can be assessed.

Indicators of sustainability

The CBD defines "sustainable use" as: "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations". This defines sustainability in terms of the effects of use on biological diversity. Indicators of sustainability can therefore effectively be seen as state indicators of biological diversity, discussed in detail above. Within a pressure-state-response framework, unregulated use is a pressure, while forms of regulation of use, including a wide range of traditional management systems, are responses.

CONCLUSION

Indicators should be viewed as series of tools that can support a range of activities and processes under the proposed institutional structure. Progress in those actions, or "policy performance", will require indicators of not only the policy and programme initiatives taken by the Biodiversity Actors, but also of the periodic assessments of the threats to and condition of biodiversity as evidence of the effectiveness of measures taken in maintaining biological diversity. In addition to being used as measures of policy performance, indicators that provide an early warning role will be useful. Indicators that signal changes in the condition of biological diversity and sustainable use, along with those that measure pressures on these valued resources, can be powerful indicators to use in order to revise policies or adopt new actions to address emerging threats to biological diversity.

The development and use of indicators can be a key focal point in capacity-building efforts, whereby the entire data and information infrastructure and decision-support mechanisms are energised to deliver policy-relevant information.