- Continue and accelerate the phased approach to preparing and implementing management plans. Management planning for protected areas must reflect the reality of the conditions within each area (including conflicting traditional uses and existing populations) and the relationship to the surrounding (buffer) areas, land use, tenure and settlement patterns. Efforts are to be integrated as much as possible to resolve conflicting issues.

- Complete the review of the current protected areas to assess the full range of biodiversity, bio-physical and socio–economic situations. Each protected area should be examined in terms of land use, vegetative cover, pressure from the resource use, land tenure 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, enclave and buffer zones

- 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.

- For established and fully functioning PAs, implement management plans or prepare second management plans and proceed with zoning different areas (core, multiple use, and buffer zones), ICDP programs, monitoring, environmental education, data collection, field surveys and staff training.

- Formulate and implement an ecotourism strategy for all PAs by the end of the 9th Five Year Plan.

- Operationalize the Phibsoo Wildlife Sanctuary.

- Complete the biological and socio-economic inventory for the Sakteng Wildlife Sanctuary.

- Conduct preliminary surveys for the Khaling/Neoli Wildlife Sanctuary and the Toorsa Strict Nature Reserve.

3.1.1.2 Buffer Zones and Enclave Zones

Most of the current protected areas include scattered human settlements within their 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.

a). Long Term Objectives

- 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 natural resources in the protected area.

- To maintain existing forest cover and restore degraded forests through reforestation, agroforestry, social forestry, and alternative energy projects.

- To ensure that all major development activities 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 programs (NCS, 1995).

b). Actions

- Give priority attention to the 'enclave' and 'buffer' zones surrounding designated protected areas, including the needs of existing populations within and near the areas.

- Developing strategies to minimize the impact on such populations without adding to utilization pressures on the buffer zones.

- 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.

- Work closely with other governmental organizations, national development agencies and extension services to facilitate and co-ordinate the process, and develop and implement practical workable programs.

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

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.

a). 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.

b). Intermediate Objectives

- 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.

- 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.

- To establish better communication and co-ordination 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.

c). Actions

Policy Strategy

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

- 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;

- Consider integrating conservation and management of plant genetic resources in arable agriculture systems in national land use plans.

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

- 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;

- Recognize the rights of indigenous communities to PGRFA in protected areas.

- Recognize that women are a valuable source of information on the feasibility of in-situ conservation and management practices.

- Support indigenous and local communities' efforts to manage wild crop relatives and wild plants for food production in protected areas, or where existing rights are recognized.

- 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;

- 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 the co-operation 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:

- Establish conservation of wild crop-relatives and wild plants for food production as an integral component of land-use planning.

- 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:

- Develop a prioritised 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;

- Assist local communities in their efforts to identify, catalogue and manage wild crop relatives and wild foods.

- 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 programs with that of ex-situ programs and encourage private and non-governmental organizations to do likewise.

Co-ordination and Administration

- 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 ceners for crop genetic resources, national crop genetic resources co-ordinators, and botanical gardens.

- Designate a national focal point, as appropriate, to catalyze co-ordination of in-situ protection programs and liase with other countries in the region;

- Establish mechanisms for periodically reviewing and modifying conservation plans.

3.1.1.4 Conservation Outside Protected Areas

Given the commitment of the Royal government to maintain 60% forest cover, conservation outside the Protected Areas is of immense importance to Bhutan. Considering that we have all national parks under forest cover, 34% of the country's forests that lie outside the Protected Areas still need to be maintained. This makes conservation outside the Protected Areas more significant. With the limited capacity and resources of the government, NGOs have a greater role in conservation outside the Protected Areas. There is the need to direct and coordinate the efforts of agencies in the relevant areas of conservation.

3.1.1.5. Conservation Areas

Phobjikha Conservation Area is has outstanding conservation significance and experience there has relevance to the other conservation areas in the country. This is due to the fact that it represents unique high altitude marshland ecosystem that serves to sustain the growing economic needs of its human inhabitants as well as habitat for the rare and endangered Black Necked Cranes. Research indicates that people are beginning to look at conservation there as an obstacle to economic development, which in the long term will be detrimental to ecosystem integrity. RSPN

has developed community based conservation and development programs to address the issue. However, it is equally concerned about the status of the area. RSPN's experience in the valley shows that the status of conservation areas needs to be strengthened as they lack a formalized protection.

a). Long Term Objective

- To protect the conservation values of conservation areas.

b). Immediate Objective

- To guarantee the future of the conservation areas, which, among other things, would justify and facilitate the efforts of donors, NGOs and relevant agencies in projects and programs to manage and protect the areas.
-

c). Actions

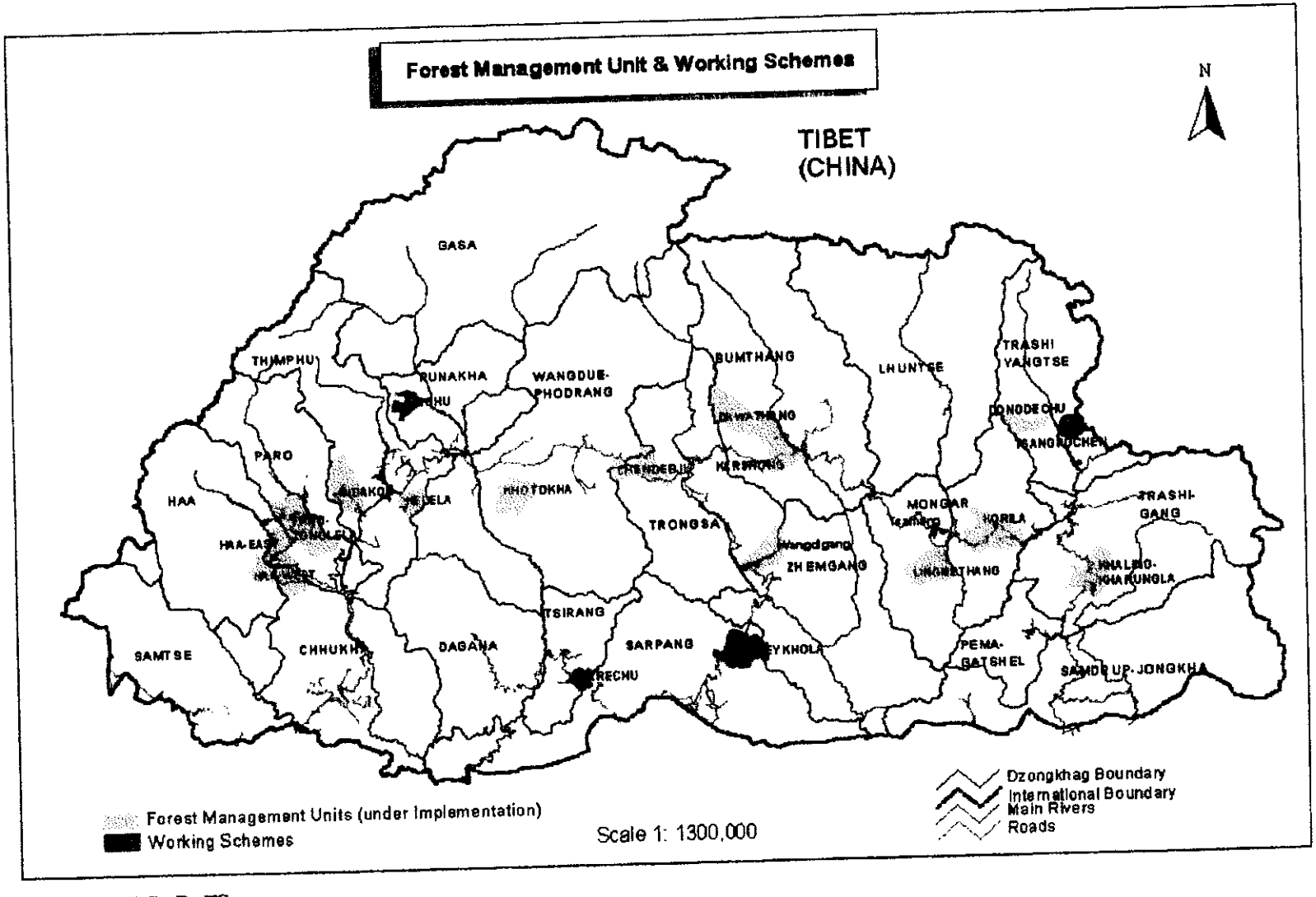
- Officially define and demarcate the boundaries of the conservation areas;
- Develop and enforce set of rules and regulations that are specific to that conservation area;
- Develop implementation arrangements for the conservation programs (including integrated conservation and development programs) and law enforcement.

3.1.1.6. Conservation in Forest Management Units (FMUs)

Forest management outside protected areas is through the establishment of FMU's, Working schemes and Cushion areas located at strategic parts of the country to cater to rural as well as urban demand of timber and other forest resources in the country. Existing and potential FMUs in Bhutan not only have an important biodiversity conservation function, 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 circle blocks at the FMU level will not fulfil these functions and this concept should be abandoned in favor of integrated biodiversity conservation at landscape and stand levels. Cushion areas are constituted for harvesting mature and over-mature trees, from small pockets of forest areas that are scattered throughout the country, (FRDD, 2001).

The total forested area in the country is about 2,90,450,000 ha, out of which about 46,140,000 ha can be operated (FRDD, 2001). At present about 152,455 ha of forest area are being managed which relates to about 4% of the total land area, (FRDD, 2001). And this process is intended to continue so that all direct forest management will be within the FMU system. There are about 14 FMUs distributed throughout the country. The present potential gross growing stock is about 184 million cubic meter and the potential annual allowable cut (AAC) is estimated at 1.1 million cubic meters, (FRDD, 2001). As of now about 4,790,960 ha of forest area have been demarcated. While the objectives are environmentally sound, care must be taken to assure that during planning and implementation, these objectives are adhered to.

Map 3: Map of Forest Management Units and Working Schemes



Source: FRDD, DoFS

a). Long term objective

- To protect forests, soil, water and wildlife and to assure successful conservation of the forest ecosystems, their genetic resources and biodiversity in Bhutan.

b). Immediate objective

- To balance commodity production with the maintenance of biological diversity and forest landscape stability.

c). Actions

- Assure that the FMUs are planned for integrated biodiversity conservation rather than as single isolated working circle blocks. Protection areas within a FMU must be established to meet very 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;

- Assure that only degraded forest areas and not productive mature forests are converted to plantations.

- Assure 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.

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

- Management plans when developed and approved should be carefully implemented and monitored and the performance evaluated, particularly with respect to anticipated impacts of harvesting and other uses.

- Update plans on a periodic basis based on feedback from actual operational implementation.

- 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.

3.1.2 Ex-Situ Conservation Efforts

3.1.2.1. Expansion of Royal Botanical Garden and Arboretum and Establishment of Branch Botanical Gardens

"Botanical Gardens are institutions holding documented collections of living plants for the purpose of scientific research, conservation, display and education" (Jackson 1999). Botanical gardens therefore play an important and a complementary role to herbariums in building the scientific knowledge base of the floristic diversity of a country.

The first botanical garden in Bhutan was established in Serbithang in May 1999 as an ex-situ conservation effort to represent the floristic diversity of Bhutan and to function as a recreational as

well as an educational center. As Bhutan has diverse ecological zones and microclimates, the experiences have indicated that the garden at Serbithang cannot represent the nations floristic diversity due to high costs associated with the creation and maintenance of artificial environments. Therefore, the establishment of the branch botanical gardens in different ecological zones need to be established as a means of ex-situ conservation efforts, for financial sustainability and true representation of the floral diversity of Bhutan.

Objectives

To strengthen the ex-situ conservation efforts towards Bhutan's Floristic Diversity representing the different ecological zones and their representative floristic diversity.

Actions:

- Expand and improve on the existing physical facilities at Serbithang.
- Establish branch botanical gardens representing alpine and subtropical plant diversity
- Select suitable sites and develop the associated infrastructures and facilities.
- Develop and implement collection and management protocols for all botanical gardens according to international scientific and horticultural standards.
- Establish the information system on the plant collections using international IMS standards.
- Establish linkages with regional and international Botanic Gardens, Universities etc, to develop further ex-situ conservation techniques and practices.
- Develop educational displays of rare, endangered and economically significant plant species, to highlight the need for their conservation.
- Develop the technical capacities for the development and the management of representative Botanic Gardens.

3.2. Domestic Biodiversity

3.2.1 In-situ Conservation Efforts

3.2.1.1 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. Some policy guidelines now exist with regard to introduction and use of exotic germplasm vs the native with the enactment of National Seeds Act and Seed Policy. HYVs especially if they contain native genetic materials (e.g. crossbred rice varieties are an improvement over the locals that are low productive and disease-prone. In fact there is genetic base broadening rather than narrowing. In Bhutan due to diversity in environments and ecologies, 'diversity has to replace diversity'. So exotics are a lesser threat than in flat, uniform environments.

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 as 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, plantations of exotics should not replace intact native forest systems. 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.

3.2.1.2 Surveying and Inventorying Crop Genetic Resources

Rational conservation ideally begins with the surveying and inventorying of existing resources. In order to elaborate policies and strategies for the conservation and utilization of 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.

a). Long-term Objectives

- To identify, 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.

- 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.

b). Intermediate Objective

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

c). Actions

- 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.

- The RGOB 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.

- Adequate support should be given to developing better methodologies for the surveying and assessment of intra and inter-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.

- The National Biodiversity Center has been established to provide a strong co-ordinating body, with policy support and high level institutional mandate. It is to establish strong linkages with central programs, 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 programs and projects are to collaborate in surveying and inventorying activities in order to build incountry capacity development.

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

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 to serve this large, economically disadvantaged population completely. The RGOB must also seek broad-based participation to realise farmers' rights through national legislation, as appropriate.

Initiatives focusing on participatory, on-farm management and improvement of plant genetic resources in arable agriculture systems offer the potential to reach a large number 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 DRDS of MOA, especially the Research and the Extension Divisions 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 the maximum number of farmers across the country. In this way, the full potential of on-farm improvement may be realised. The present on-farm conservation program is

being implemented in collaboration with RNR-RCs and Dzonghags through the Biodiversity Use and Conservation in Asia Program (BUCAP) projects.

a). 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 realise 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 co-operative concerns as an outgrowth of successful on-farm selection and breeding. To encourage traditional seed exchange and supply systems.

b). Intermediate Objectives

- To gain greater knowledge about the dynamics, methodologies, effects, and potential of on-farm conservation and plant improvement.
- To establish or strengthen programs 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 programs.
- To build on-farm and garden programs based on local systems of knowledge, institutions, and management, ensuring local participation in planning, management and evaluation.

c). Actions

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 for 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 RNR-RCs 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 resource 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 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 programs should be developed for researchers, extension workers, contact farmers and others in facilitating and catalysing on-farm activities, including selection and breeding techniques appropriate to supplement and improve those already used by farmers. The focus of training programs 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 programs should be designed in close collaboration with the RNR-RCs and farmers and their organizations and be based on particular needs as they see them. Programs 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:

- Ethnobotanical and socio-economic research to understand and analyse 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;

- 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);

- 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.

- 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 co-operation between rural people and the staff of the DRDS. 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 genebank and the RNR-RCs.

Co-ordination and Administration

National co-ordination efforts in this area should allow for and encourage local, community-level initiatives in proposing programs. 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 collaboration between communities and research institutions. Subject to satisfactory progress, programs should be sufficiently long (10 years or more) to achieve results. Efforts should be co-ordinated closely with RNR-RCs, the decentralized extension network and the farming communities.

3.2.1.4. Assisting Farmers In Disaster Situations to Restore Agricultural Systems

Natural and man-made disasters pose enormous threats 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.

a). Long-term Objectives

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.

b). 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 co-operation 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 neighbouring 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. Co-operation 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 the 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.

Co-ordination and Administration

This program should be co-ordinated administratively by MOA in close collaboration with the national and the international agricultural research centers, 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 program. Such efforts should also increase awareness of the need for safety duplication of materials in other countries.

3.2.2. Ex-situ Conservation Efforts

3.2.2.1. Supporting Planned and Targeted Collecting of Plant Genetic Resources in the Arable Agriculture System

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 re-collection. 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.

a). Long-term Objective

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

b). Intermediate Objective

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

c). Actions

Policy Strategy

- Develop collecting practices 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. 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 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. Collected materials will be preserved in the Bhutan National Genebank (BNGB), which is under construction at Serbithang. 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.

Co-ordination and Administration

- Co-ordination, as appropriate, should take place within the country. Regional and international level co-ordination, as appropriate, is needed to provide linkages with ex-situ collections and gap-filling and regeneration efforts. Such co-ordination 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 an early warning system at all levels. As part of the national plant genetic resources program, The RGOB may designate a focal point for administering requests for collecting.

3.2.2.2 Expanding Ex Situ Conservation Activities

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 co-ordinated 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. A proposal for both central and regional field genebanks is under development between the NBC and the RNR-RCs.

a). Long-term Objective

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

b). 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 botanical 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.

c). Actions

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 botanical 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, 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 co-ordination of collecting and conservation.

Administration and Co-ordination

- National Crop and in-country regional networks (between RNR-RCs) as well as relevant outside organizations, with the support of IARCs and RNR-RCs, 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 co-operation should be encouraged as a matter of priority.

3.2.3 Breed Conservation

The overview

1. Until about two years ago there was no method for monitoring the various species, breeds and crossbreeds. The recently launched (and ongoing) "breed survey" is aimed at identifying the different species, breeds, breeding systems and sub-breeds with productivity levels. It is done through a structured questionnaire to record breed levels, poductions and management practices. Attempts are underway to include these elements in the RNR census conducted every 5 years. The breed survey which was started in 1997 has not been completed for want of adequate resources. Presently data for only dzonghags are available.

2. The survey is structured in such a way it captures breeds and crossbreeds and also the level of crossbreeding based on which a proper strategy can be developed. In future works on sample recording of performance traits on a regular basis within sample villages through out the country, should be taken up on priority basis. 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 with 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 holds true to the horse, pig and 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 recognized by the 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 cannot. While there are concerns about damage from forest grazing, for some time to come livestock will still depend upon forest grazing. The impact of pigs on the environment is unlikely to become a serious problem as long as they are retained in small numbers usually with a household feeding domestic scrap 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 are during the summer when overgrazing may be a problem.

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

The conservation of native breed of livestock (cattle and yaks in particular) is of paramount importance in livestock development programs where extensive either systematic or haphazard cross breeding programs 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 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 to implement. 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 the indigenous/native population. The priority will be on breed research itself as the country lacks true scientific data on these native breeds.

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.

The new Livestock Breeding Policy document adequately forsees these concerns and address them in a scientific approach. The document will act as a guiding tool for breed conservation aspects. Breeding programs will be streamlined with the formation of Natioal Livestock Breeding Program, a central body to oversee all affairs related to livestock breeding and provide technical backstopping.

a). Siri cattle conservation plan

Considering the importance of Nublang for the farmers and the general lack of information regarding the genetic make-up of the indigenous breed of this nature, (information available is either scant or unreliable) a farm has been established. This farm will be the nucleus of the activities related to Nublang breeding particularly for:

- Investigation of detailed genesis of this breed;
- Producing, raising and supply of Nublang bulls to farmers at cost effective price; and,
- Monitoring the performance of the bulls in the field as well as in the crossbreeding program.

Some of the **long-term objectives** of this program will be to:

- To study the genesis of Siri breed and make available facts for scientific adoption of conservation of the germplasm and to forgo degeneration through appropriate means.

- To adopt a scientifically sound crossbreeding program by producing Siri bulls for distribution in the field and for semen production and preservation.

Strategy for Siri preservation

- The center has already stocked adequate number of animals. The stock will ultimately be raised to 150 females and 6 males along with additional followers.

- All scientific measures to keep the performance efficiency to its optimum will be adopted.

- Systematic exchange and addition of both males and females shall be carried out periodically in order to prevent inbreeding in herds. At the same time Nublang semen will be preserved to create a genebank.

- Proper health coverage will be done and at the same time, disease/parasite patterns on Nublang will be investigated and studied in collaboration with the Regional Veterinary Laboratory in Khaling.

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

- Computerised data collection and processing will be initiated and to the extent possible external expertise will be invited for Nublang preservation logistics and techniques.
- Ex-situ (semen) conservation will be strengthened.

b). Sheep conservation

RGOB already has a breeding farm in Bumthang 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 nucleus flock of local (black) sheep will be established. And subsequaently selective breeding with the local (superior) rams will be initiated at the farmer level.

The following will be the core activities of the program:

- Breeding programs to find a breed suitable for the village condition;
- Production performance (wool, lambing, survivability etc.) of the improved sheep;
- Look into methods of culling which could overcome the religions sentiments; and
- Introduction of simple and efficient wool processing techniques.

c). Yak development strategies in hand

Yak development strategies include

- Efforts being made to introduce rangeland management practices for providing adequate fodder.
- Creating marketing outlets for the yak herders.
- Introduction of better animal health program.

I) The Government still supports the yak herders by supplying yak bulls procured from Ha 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 purposes.

ii) Artificial Insemination in Yaks: Introduction of AI in certain areas on trial basis.

- Artificial Insemination using frozen semen of Yak imported from China is being 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.

Further trials using frozen semen from Jersey & Tarentaise are still on. However, under the existing circumstances (there is no motorable road 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 the A.I program on a large scale is very difficult.

In the long-term, maintenance 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 semen production and exchange of this material in proper frequency. A nucleus farm, basically for bull maintenance (for semen production) and to act as a focal point for studying production and socio-economic aspects, may be the best option for long-term yak development and maintenance.

In the meanwhile genetic distancing work among yak herds in Bhutan has been done.

d). Pigs and Poultry

The population of local pigs/poultry is sharply falling. Although some steps are underway to collect local pigs and further breed them, expanding this effort should be seriously considered. A program to produce our own grandparents from the blend of local poultry and exotic should be urgently initiated. This will ensure that the local poultry are 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 Mithuns but the numbers are not adequate. A technological breathrough has been made in artificial insemination in mithun. Mithun semen has now been widely used in Bhutan as a means to crossbreeding.

f). Horse

Attempts are underway to identify suitable horse types for the country. A trial consignment of Spiti horse breeds of India has been brought and presently works are underway to establish a nucleus farm to produce the stallions.

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.

h). 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 RNR centres (including 20 veterinary hospitals) that provide services in the form of treatment of animals, deworming, vaccination and local extension programs at the Dzongkhag level.

b) Laboratory services: The laboratory services are provided 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, Deothang and Mongar) and the Royal Veterinary Epidemiology Centre (RVEC), 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 levels of farmers and in different remote areas, mobile laboratory facilities have been introduced. Apart from conducting epidemiological studies, this approach will take the diagnostic services 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 dependent.

c). Feed and fodder development support: Traditionally, forest browsing and feeding stubble/straw and kitchen waste has been the practice in livestock rearing. Improved pasture was introduced about two decades 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.

The proposed National Feed & Fodder Program will streamline the fodder aspects in the country.