

**Implementation status of the
Global Plan of Action for the Conservation and
Sustainable Utilization of Plant Genetic Resources for
Food and Agriculture in Bhutan**





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National Biodiversity Centre
Ministry of Agriculture and Forests
Serbithang: Thimphu
BHUTAN

Implementation Status of GPA for PGRFA in Bhutan

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- Horticulture Division, DoA, MoAF, RGoB
- National Organic Program, Horticulture Division, DoA, MoAF, RGoB.
- National Potato Development Program, DoA, MoAF, RGoB
- National Seed Centre, DoA, MoAF, RGOB
- RNR-RDC, Bajo, DoA, MoAF, RGoB
- RNR-RDC, Wengkhar, MoAF, RGoB

Executive Summary

This report on the implementation status of GPA-PGRFA is one of the outcomes of the Government of Japan funded project “Capacity building and enhanced regional collaboration for the Conservation and Sustainable Use of Plant Genetic Resources in Asia (GCP/RAS/240/JPN)” that Bhutan endorsed and signed in November, 2008. National Biodiversity Center (NBC) as the National Focal Point for the project led the project implementation in collaboration with eight other stakeholders from within the Ministry of Agriculture and Forests. This report is based on the inputs provided by stakeholders into the National Information Sharing Mechanism (NISM) on PGRFA programs and activities, which was also developed as a part of the above project.

With the institutionalization of PGR programs in the country since 1998, significant progress has been made in the field of PGR conservation and sustainable utilization. Bhutan has also addressed most of the GPA-PGRFA priority areas. Noteworthy achievements are the completion of a baseline survey and inventory of field crops of the country, the establishment of a national *ex-situ* conservation facility (National Gene bank) along with more than 1100 accessions of crop landraces, promotion of on-farm conservation, targeted support for product development and commercialization of under-utilized crops, promotion of agriculture through crop diversification, etc. Since the first country report on PGRFA status to FAO in 1996, the research centres have also released more than 145 improved crop varieties.

Some of the major GPA areas that need to be addressed urgently are the development of a national action plan to address disaster situations in the agriculture system, monitoring and early warning system for genetic erosion, enhancement of seed production and distribution system, including seeds of landraces, characterization and evaluation of the existing collections, and survey and inventory of Crop Wild Relatives (CWR) and wild food plants.

List of Acronyms and Local Names

AEZ	Agro-ecological zone
BAP	Biodiversity Action Plan
BPDP	Bhutan Potato Development Program
BUCAP	Biodiversity Use and Conservation Asia Program
CBD	International Convention on Biological Diversity
CGRFA	Commission on Genetic Resources for Food and Agriculture
CGIAR	Consultative Group in International Agriculture Research
CNR	College of Natural resources
CWR	Crop Wild Relatives
CoRRB	Council for Renewable Natural Resources Research of Bhutan
DAMC	Department of Agriculture Marketing and Cooperatives
DoA	Department of Agriculture
DoFPS	Department of Forests and Park Services
DPA	Department of Public Accounts
DUS	Distinctness, Uniformity and Stability
EIA	Environmental Impact Assessments
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
GNHC	Gross National Happiness Commission
GPA	Global Plan of Action
GRIN	Germplasm Resource Information Network
GXE	Genotype Environment Interaction
IPGRI	International Plant Genetic Resources Intitute
ILCCP	Integrated Livestock and Crop Conservation Project
IRRI	International Rice Research Institute
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MoAF	Ministry of Agriculture and Forests
MAP	Marketing, Accessibility and Production
NBC	National Biodiversity Centre
NEC	National Environment Commission
NBPGR	National Bureau of Plant Genetic Resources
NISM	National Information Sharing Mechanism
NFP	National Focal Point

NGO	Non Governmental Organization
NSC	National Seed Center
PGRFA	Plant Genetic Resources for Food and Agriculture
PPD	Policy and Planning Division
PGR	Plant Genetic Resources
PPB	Participatory Plant Breeding
PVS	Participatory Varietal Selection
PAM	Production, Accessibility and Marketing
R&D	Research and Development
RDTC	Rural Development Training Centre
RNR	Renewable Natural Resources
RNRDC	Renewable Natural Resources Research and Development Centre
RGoB	Royal Government of Bhutan
SAARC	South Asian Association for Regional Cooperation
SANPGR	South Asia Network of Plant Genetic Resources
SEARICE	South East Asia Regional Initiatives for Community Empowerment
SH	Stakeholder
TRC	Technology Release Committee
TTF	Technical Task Force
TV	Television
UNDP	United Nations Development Program
VCU	Value for Cultivation and Use

Local Terms

Geog	Block
Dzongkha	National Language
Dzongkhag	District

Chapter 1

Background

Bhutan with its wide ranges of climatic and altitudinal variations within a small distance or area have allowed Bhutanese inhabitants from different ethnic backgrounds to grow a variety of crops (BAP, 2009). Further, this relatively difficult terrain with natural isolation of one area from another has allowed the natural selection and localized adaptation of crops and crop relatives. Bhutan's relative isolation from the other parts of the world until very recent has also provided an opportunity for Bhutanese farmers to select and develop their own locally adapted crops and crop varieties, resulting in this wide array of land races and varieties in the country. For example, Bhutan has more than 280 landraces of paddy and more than 80 land races of maize (NBC, 2008) and about 80 species of agricultural crops are expected to occur in the country (BAP, 2009). This diversity is significant for a country with less than 3 percent cultivated agriculture land from a total land area of 38,396 km² (LCMP, 2010).

Cognizant of its rich agricultural diversity and its importance for sustainable management to contribute to national and global food security, Bhutan has initiated strong programs on PGRFA. Till date the country report to FAO International Technical Conference on Plant genetic Resources (Pradhan, 1996) is the only status report of the country's PGRFA programs and activities. The report covered the country's overall plant diversity and general conservation measures. However, since that report, Bhutan has embarked on many new conservation programs in the country, including the establishment of the National Biodiversity Centre (NBC) in 1998, with strong PGRPFA management program. Further, Bhutan ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA) on 2nd September 2003 and since then the country has endeavored to abide and promote implementation of its obligations.

Therefore, this report is an attempt to summarize the achievements made in PGRFA programs and activities, especially in line with the Global Plan of Action on PGRFA since the first Country report of 1996. This report is prepared with the funding support from the project "Capacity building and enhanced regional collaboration for

the Conservation and Sustainable Use of Plant Genetic Resources in Asia (GCP/RAS/240/JPN)”. The project, funded by the Government of Japan, was a regional co-operative project between FAO and the member countries; members of the GCP/RAS/186/JPN project (Bangladesh, India, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam) and new member countries (Bhutan, Cambodia, Indonesia, Lao PDR, Mongolia, Myanmar, Nepal and Pakistan). The main objective of the project was to establish a country driven, Asia wide system that assists the Global Plan of Action (GPA) on PGRFA to support sustainable agricultural development in the Asian region. The project activities are closely linked to and contribute to FAO global efforts to support the implementation, monitoring and updating of the GPA-PGRFA and the preparation of Country’s State of PGRFA report.

Chapter 2

Methodology used in monitoring GPA-PGRFA in Bhutan

A Global Plan of Action (GPA) for *the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture* is a set of recommendations and activities which grows logically out of the Report on the State of the World's PGRFA. It consists of 20 inter-related priority activity areas organized into four groups:

- i) *In Situ* Conservation and Development;
- ii) *Ex Situ* Conservation;
- iii) Utilization of Plant Genetic Resources, and
- iv) Institutions and Capacity Building.

Each priority activity is supported by a list of indicators to measure and monitor the progress. Monitoring the implementation of the GPA and its related activities is essential for establishing priorities, developing future plans and for effectively using the financial resources available both at national and international levels for implementing the GPA. Moreover, policy makers, development agencies, researchers, and many other key-players dealing with PGRFA need precise and reliable information for decision making in addressing gaps and exploiting opportunities. Likewise, efficient mechanisms are needed to exchange information derived from PGRFA research and development at national, regional, and international levels.

Monitoring the implementation of GPA-PGRFA is supported by a set of tools agreed by the FAO Commission on Genetic Resources for Food and Agriculture:

- a list of internationally agreed indicators related to the 20 GPA priority activity areas.
- an information system including a database and a search engine (NISM-GPA database).

Bhutan followed the above sets of tools in monitoring the implementation of GPA-PGRFA programs and activities in the country. Data related to each of the 20 GPA

priority areas were collected from all the stakeholders of PGRFA in the country by National Biodiversity Centre (National Focal Point for the implementation of the project GCP/RAS/240/JPN and ITPGRFA). All the data collected from the stakeholders were uploaded in the National Information Sharing Mechanism database. It was followed by several rounds of consultation and validation meetings and workshops with the data providers- the stakeholders of PGRFA programs and activities in the country.

However, the information on the status of GPA-PGRFA implementation compiled in this report is based only on the published statistics and from few scattered databases, because not all institutions and agencies working with PGRFA have a comprehensive database maintaining records of all the PGRFA activities carried out, such as database on survey and inventory of PGR diversity. For example, except for the National Gene Bank database, no other stakeholder had any formal and electronic database system dedicated to PGRFA activities and diversity in place. The records were either kept in manual ledgers or in Excel sheets, which proved very difficult in data mining and collating. Therefore, the National Biodiversity Centre acknowledges that this report is just a first attempt to update the implementation status of GPA-PGRFA. Such reporting would be more comprehensive if the data management capacity is developed in all the stakeholders.

Chapter 3

Current status of GPA-PGRFA implementation in the country

The GPA-PGRFA was adopted by the fourth FAO International Technical Conference on Plant Genetic Resources held in Leipzig, Germany on 23rd June 1996 and, with it, a Leipzig Declaration that affirmed government-level commitment to implementing the *Global Plan of Action* in the context of national efforts to strengthen world food security. Subsequently the *Global Plan of Action* has been endorsed by the Conference of the Parties to the Convention on Biological Diversity (CBD) and by Heads of State and Government at the World Food Summit. Furthermore it was incorporated into the International Treaty on Plant Genetic Resources for Food and Agriculture (<http://www.itpgrfa.net>) as a supporting component.

The need to monitor the implementation GPA-PGRFA was raised during the Seventh through Ninth Regular Session of the Commission on Genetic Resources for Food and Agriculture (CGRFA). Thus, this report covers the implementation status of GPA-PGRFA based on the format and list of indicators for monitoring each of the 20 inter-related priority activity areas developed by the Inter-governmental Technical Working Group on PGRFA after the recommendations from the Ninth Session of the CGRFA in 2002.

A. *In Situ* Conservation and Development

Priority Activity Area 1:

Surveying and Inventorying Plant Genetic Resources for Food and Agriculture

The National Biodiversity Centre coordinated a major survey and inventory of field crops from 2002- 2003. The inventory covered at least one representative site from all the major Agro-Ecological Zones (AEZ) of the country. The inventory has used qualitative and quantitative survey techniques including individual interviews, village meetings, PGR mapping, and Participatory Rural Appraisal. The results of the survey are published as “Plant Genetic Resources of Bhutan, Vol. 1: Field Crops, 2008”. The inventory has identified the following threats to PGRFA diversity in the country:

- i. Displacement of land races by new and genetically uniform cultivars.
- ii. Switch from diverse cropping system to few market oriented cash cropping system.
- iii. Environmental degradation and destruction of habitats due to urbanization.
- iv. Wild animal damage.
- v. Drought/untimely rain/shortage of irrigation facilities.
- vi. Banning of shifting cultivation.
- vii. Low yield.
- viii. Land clearing/landslides and habitat loss/soil erosion problem.
- ix. Shortage of farm labour.
- x. Change of food habits.

In addition to the above survey and inventory, PGR diversity assessment was also carried out at Biodiversity Use and Conservation in Asia Program (BUCAP) project sites of the country. The project is coordinated by the On-farm Conservation unit under the PGR program of the National Biodiversity Centre (NBC) and is implemented by the RNR Research and Development Centres (RNR-RDCs) and Dzongkhag Agriculture Sector. Table 1 shows the sites of the survey carried out through the BUCAP project. This survey has identified access to improved varieties and change in food habitats as threats to traditional crop varieties. Details of the survey report can be found in the BUCAP project annual reports from NBC. Other SHs- Horticulture Division, RNR-RDCs (Wengkhaz and Bajo) have also carried out survey and inventory of horticultural crops and wild edible plants (Table 2). Comprehensive survey and inventory of horticultural crops are planned from 2012.



Table 1: Areas of BUCAP project sites surveyed for PGRFA diversity assessment

Area	District/Dzongkhag
Dramitse	Mongar
Kanglung	Trashigang
Khaling	Trashigang
Geyne	Thimphu
Dopshari	Paro
Goenshari	Punakha
Damji	Gasa
Thedtsho	Wangduephodrang
Samthang	Wangduephodrang
Rukha	Wangduephodrang
Taksha	Wangduephodrang
Silli	Wangduephodrang
Barshong	Sarpang

Table 2: PGREA diversity survey and inventory carried out by other agencies of the Ministry of Agriculture and Forests and the areas covered.

Lead agency of the survey	Title of survey/inventory	Name of area surveyed/inventoried	Reference	Description of major findings
CoRRB	Survey on Wild Edible Plants	Different parts of Bhutan	Wild Edible Plants and their Traditional Knowledge in Bhutan	Check list of wild edible plants
Horticulture Division, DoA, MoAF	Identification of Mandarin in Bhutan by using Morphological Characteristics and AFLP Analysis	Samtse Dzongkhag; Sarpang Dzongkhag; Tsirang Dzongkhag; Dagana Dzongkhag; Trongsa Dzongkhag; Zhemgang Dzongkhag; Mongar Dzongkhag	Identification of Mandarin in Bhutan by using Morphological Characteristics and AFLP Analysis	
Horticulture Division, DoA, MoAF	Phylogenetic relationships of Citrus and its relatives based on rbCL gene sequences	Mongar Dzongkhag; Punakha Dzongkhag; Lhuentse Dzonkhag; Trashi yangtse Dzongkhag; Trashigang Dzongkhag	Phylogenetic relationships of Citrus and its relatives based on rbCL gene sequences	

Renewable Natural Resources Research and Development Centre - Wengkhhar	Survey on local pear types available in the region	Pear growing regions in the country	RDC Wengkhhar Annual Report 2005-2006	Local pear diversity observed to be grown from 755masl in the south to as high as 2700masl in the north. About 11% of the pear fruits were found to be good in size. Majority of the local fruits were either acidic or astringent in nature. Local pears can be profitably employed as rootstock for multiplication of improved cultivars.
Renewable Natural Resources Research and Development Centre - Wengkhhar	Survey on Wild Kiwi available in Bhutan	Khaling, Trashigang; Sengor, Wengkhhar, Mongar; Korila; Phongmey, Trashigang	RDC Wengkhhar Annual Report 2005-2006	Wild kiwi was found in elevation range of 1500-3000 masl. The plant seems to require lot of sun shine and was observed growing in areas receiving adequate sunshine as in the open road side, open sites in the forest and among small trees and shrubs. The plant was observed to be grown naturally in the cloud forest area with high humidity.

Constraints and comments in carrying out the survey and inventory of PGRFA

The major constraints identified in carrying out the survey and inventory of PGRFA in the country are:

- i. Insufficient funds
- ii. Insufficient number of staff
- iii. Staff without adequate skills such as lack of adequate taxonomic skills

The first PGRFA survey and inventory led by NBC had covered only the grains and legume crops. As such the needs for survey of other groups of crops have been identified as a priority. However, development of technical skills of the staff involved, refinement of the survey methodology and fund sourcing are the prerequisites identified before embarking on the second phase survey.

Survey and inventory of indigenous vegetables and fruits, along with characterization (morphological, molecular, phyto-nutrient) of wild fruits and nuts, domestication, conservation and crop development are other priorities identified by Horticulture Division of the Department of Agriculture. Documentation and maintenance of Community Biodiversity Register is also a priority to understand the diversity at community level.

Priority Activity Area 2 :

Supporting On-Farm Management and Improvement of Plant Genetic Resources for Food and Agriculture

Currently, as per the data collected from stakeholders, there are about 10 programs and projects in place supporting the on-farm management and improvement of PGRFA. Table 3 shows the details of the projects/programs in the country.

Table 3: Programs and projects supporting on-farm management and improvement of PGRFA in the country.

Lead agency	Name of on-farm conservation programme/project	Local farmer community involved	Activities include:	Other activities
National Biodiversity Center	Integrated Livestock and Crop Conservation Program	Farmer's Community of: Chhoechor, Bumthang; Dechheling, Pema Gatshel; Dungtse, Samtse; Gakling, and Sombaykha, Haa; Mendrelgang and Semjong, Tsirang; Nangkori, Zhemgang;	<ol style="list-style-type: none"> 1. Pilot sites established in areas of high diversity; 2. Studies on local varieties population structure and dynamics; 3. Assessment of local varieties utilization and management; 4. Socio-economic assessment of PGRFA on-farm management and improvement 	<ol style="list-style-type: none"> 1. Seed selection and maintenance 2. Enhancing production through organic farming. 3. Value addition, marketing & income generation. 4. Community empowerment through trainings. 5. Restoration/maintenance of diversity and enhancing resilience of production system.
National Organic Program	Organic Buckwheat Program	Farmer's Community of: Chhoechor, Bumthang; Sombaykha, Haa	Seed multiplication and distribution of bred varieties	Value addition and marketing
National Organic Program	Organic Rice Program	Tsirang Farmers; Bumthang farmers	Studies on local varieties population structure and dynamics	value addition and marketing
National Organic Program	Organic Vegetable Program	Samdrup Jongkhar Farmers; Gasa Farmers; Paro farmers; Tsirang Farmers	<ol style="list-style-type: none"> 1. Assessment of local varieties utilization and management; 2. Assessment of improved varieties utilization and management 	

Renewable Natural Resources Research and Development Centre - Bajo	Biodiversity Use and Conservation in Asia Program	Farmer's Community: Samthang and Thedtsho, Wangdue Phodrang	3.Characterization and evaluation of local varieties; 4.On-farm breeding; 5.Seed multiplication and distribution of bred varieties; 5.Assessment of local varieties utilization and management	1. Broadening of genetic base of food crops 2. Training and empowerment of community 3. In situ conservation of food crops 4. PVS on rice and maize 5. Training on seed selection 6. Vegetables production and nutrition
Renewable Natural Resources Research and Development Centre (RNR-RDC) Wengkhar	On-farm vegetable seed production program	Samdrup Jongkhar Dzongkhag; Pemagatshel Dzongkhag; Trashiyangtse Dzongkhag; Lhuntse Dzongkhag; Mongar Dzongkhag; Trashigang Dzongkhag	Seed multiplication and distribution of bred varieties	Transfer of knowledge to the farmers on vegetable seed production and maintenance techniques.
RNR-RDC, Wengkhar	Improvement / rejuvenation of local fruits and nuts with improved cultivars through top-working techniques	Samdrupjongkhar Dzongkhag; Pemagatshel Dzongkhag; Trashiyangtse Dzongkhag; Lhuntse Dzongkhag; Mongar Dzongkhag; Trashigang Dzongkhag	Assessment of improved varieties utilization and management	Hands on practice on top-working technique.

RNR-RDC, Wengkhar	Community Based Seed Bank Tshogpa,	Phuntshothang, Samdrup Jongkhar	1. Pilot sites established in areas of high diversity; 2. Assessment of farmers' knowledge; 3. Seed multiplication and distribution of bred varieties	
RNR-RDC, Wengkhar	Community Based Seed Production Group		Seed multiplication and dis- tribution of bred varieties	
RNR-RDC, Wengkhar	Upland Paddy Cul- tivation Tshogpa	Farmers community of : Decheling and Norbugang, Samdrup Jongkhar. Silambe and Gongdue, Mongar	Seed multiplication and dis- tribution of bred varieties	

On-farm conservation and development programs in the country are fairly integrated into national programs and in some cases supplemented by government fund. There is policy and institutional support for on-farm management of PGRFA in the country. Currently, economic incentives such as support to product diversification, marketing, seed production and distribution services are provided through donor supported projects. Some of the major constraints to on-farm management and improvement of PGRFA are inadequate incentives to farmers, poor quality planting materials, insufficient skills and training, and financial support. Additional limitations pointed out by SHs in on-farm PGRFA management are:

- Farmers' illiteracy resulting in difficulty in convincing them about the values of managing diverse PGRFA on-farm;
- Lack of awareness;
- Out crossing resulting in degeneration of the varieties;
- Lack of information on functional component and nutritive value of local germplasm;
- Transition from subsistence agriculture (diverse cropping) to semi - commercial or mono cropping culture;
- Undesirable horticultural characteristics of local PGR (low yield, astringency, small size, seediness etc).

Conservation is a long term effort. In order not to negate the momentum the country has gained in on-farm management and improvement of PGRFA, it is imperative that the efforts and support be continued. The future focus of the country identified for successful on-farm management of PGRFA in the country is in the following areas:

- a. Development of national policy on PGRFA.
- b. Institutionalizing and strengthening of on-farm conservation unit at NBC.
- c. Mainstreaming PGRFA into national plans and programs.
- d. Capacity development of the local communities in on-farm management of PGRFA.
- e. Strengthening community seed systems.



Priority Activity Area 3 :

Assisting Farmers in Disaster Situations to Restore Agricultural Systems

Till date Bhutan has been fortunate that it has not faced any disasters requiring acquisition or reintroduction of germplasm from outside the country. However, as a precautionary measure for such situations, Bhutan is already on its path to establish mechanisms to facilitate rapid acquisition, multiplication, distribution and cultivation of reintroduced germplasm. In addition, NBC has also initiated discussions with the Department of Agriculture to look at the possibilities of setting up a National Seed Reserve within the scope of SAARC Seed Reserve Program. Till date three community based seed banks have already been established; two in the east and one in the south. However, as Bhutan does not have a national action plan to assist farmers to recover and preserve PGRFA following disasters, this need has to be urgently addressed by concerned agencies. Further, currently no assessments have been carried out on seed security in the country. There is a need to identify relevant agencies to conduct seed security assessment to enable formulation of effective measures and interventions to ensure national seed security. Bhutan also needs to draw agreements with regional and international organizations for rapid acquisition of PGRFA should any disaster befall the country. Further, there is also a need to strengthen the information system and information sharing mechanism on the local seed supply system and germplasms currently available in the national gene bank or in the community seed banks.

Priority Activity Area 4 :

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

Along with the rich diversity of domesticated crops, Bhutan is considered rich in wild relatives of many crops and wild food plants. Tamang (2003) reports 230 species of Crop Wild Relatives (CWR) belonging to 120 genera under 51 families. The strong and sound conservation policy of Bhutan with more than 50 percent of the country under a protected area system has led to the conservation of CWR and wild edible plants by default. However comprehensive surveys and inventory of CWR and

wild edible plants and their conservation have not been carried out in the country due to the lack of taxonomic expertise, inadequate staff and lack of funding support. In comparison, *in situ* conservation of wild food plants fares better than the crop wild relatives. For example, the organic mushroom program promotes *in-situ* conservation of wild mushroom (e.g *Pleurotus ostreatus* (Jacq. ex Fr.) P.Kumm.) through the implementation of sustainable management practices and involvement of local communities. Scattered records of wild edible plants are also available. Stronger programs focusing on the comprehensive inventory and survey of both CWR and wild food plants are needed to formulate *in-situ* conservation programs and to strengthen Environmental Impact Assessments (EIA). The need to inventory and survey these important resources has been identified in the National Biodiversity Action Plan (BAP, 2009) and in the National Action Plan for Biodiversity Persistence and Climate Change (NBC, 2010).

B. Ex- Situ Conservation

Priority Activity Area 5 :

Sustaining Existing *Ex Situ* Collections

The two major *ex situ* collection methods practiced in Bhutan are field gene bank and seed banks. Field gene banking has been practiced in Bhutan since agriculture development started in the late sixties to early seventies. Most collections in the field gene banks are of native fruit trees maintained for selection of better quality fruits or to provide scion wood for production of seedlings, while some collections are of improved cultivars. Seed banking with long term storage facility started very recently in Bhutan with the establishment of the National Gene bank at NBC in 2005. Seed banks maintained in other agencies are mostly short to medium term and only for evaluation and maintenance of basic seeds and seed multiplication to supply to commercial seed supplier. *Annex I* provides the details of *ex situ* collections programs in the country and *Annex II* provides the details of collections in *ex situ* holdings.

Bhutan currently has little more than 1100 accessions from 45 taxa at the National Genebank within the country, which is a huge achievement from 1996 stage when

in-country *ex situ* collection was non-existent. IPGRI had collected 465 accession of 33 taxa in 1981 and IRRI had collected 217 accession of rice from 1976 to 1984 (Pradhan, 1996) which are all held outside Bhutan.

The major constraints expressed by the SHs in implementing *ex-situ* conservation programs in the country are the lack of funding, training and facilities, insufficient staff and equipment. Some have also expressed occurrence of pest and disease and irregular electrical supply as the constraints in implementing *ex situ* conservation activities.

Needs and priorities to sustaining ex situ collections in the country.

- i. Improvement of germplasm quarantine facilities.
- ii. Building capacity in taxonomy, quarantine, characterization, seed storage behavior and equipment maintenance.
- iii. Development of an alternative arrangement to store duplicate accessions.
- iv. Expansion of the current mandates of field gene banks to include conservation concerns.
- v. Improvement of PGR documentation and information sharing system.

Priority Activity Area 6 :

Regenerating Threatened Ex Situ Accessions

Since germplasm collection for *ex situ* conservation started very recently, towards the end of 2005, the priority has been to build up accession. In addition, as most of the accessions in the gene bank are fresh accessions with the oldest collection being only five years old, no regeneration has been carried out except for the on-station multiplication of 'small samples' obtained during germplasm exploration and collection for temperate cereal crops. In addition, when the sample quantity is inadequate and considered threatened, the donor farmers are asked to multiply the seed of target taxon in the target AEZ and provide sufficient quantity of seed to the Gene Bank. However, in order to initiate systematic regeneration, there is a need to improve the genebank monitoring system and develop capacity in regeneration and documentation.

Priority Activity Area 7 :

Supporting Planned and Targeted Collecting of Plant Genetic Resources for Food and Agriculture

Ex situ collections of PGRFA germplasm are being carried out from different AEZ across the country. However, the current collection is limited to only grain and legume crops. Annex 2 shows the details of *ex-situ* collections of PGRFA. Therefore, there is a need to carry out comprehensive exploration and collection of crop diversity, including horticultural crops, wild relatives and rare and endangered plant species. In addition, building technical capacities, expanding facilities for recalcitrant seeds and sourcing additional funding support are the priorities to enable comprehensive *ex-situ* collection and management of PGRFA.

Priority Activity Area 8 :

Expanding *Ex Situ* Conservation Activities

Ex situ conservation of PGRFA with orthodox seeds started in 2005. The current Gene Bank provides facilities for processing and preservation of only the crops with orthodox seeds. There are no facilities for other group of crops with recalcitrant seeds and those crops that require vegetative propagation techniques, emphasizing the need for the establishment of a Cryo Bank and an In-vitro Bank. To enable implementation of up scaled *ex situ* conservation activities, there is a strong need for adequate number of trained staff in this field and funding support.

C. Utilization of Plant Genetic Resources

The utilization of plant genetic resources is very high in Bhutan. About 69 percent of our rural population depends directly on natural resources for their livelihood (NBC, 2010). The National Mushroom Centre has documented more than 90 species of forest mushroom in the country. Several of these species such as *Catherellus cibarius*, *Clavaria botrytis*, *Auricularia auricula* are very popular in local cuisine. Many wild plants such as *Elastostema lineolatum*, *Laportea terminalis*, *Diplazium esculentum*, *Cymbidium spp.*, *Dioscorea sp.* and many species of Bamboos and Canes are

sources of alternative food for the local communities and are also found in local food markets. From the point of view of *ex situ* collection and utilization, though the accessions in the Gene Bank are minimal and collections are on-going, utilization of accessions from the gene bank has already been initiated. The re-introduction and rehabilitation of germplasm samples from the Gene Bank into the field for some crops like maize and buckwheat are some examples.

Priority Activity Area 9 :

Expanding the Characterization, Evaluation and Number of Core Collections to Facilitate Use

Out of 43 taxa held in collections by five SHs, most taxa are characterized based only on morphological traits. Except for rice, which has been evaluated for abiotic and biotic stresses to some extent, most taxa are evaluated only for agronomic traits.

In terms of technical capacity in characterization and evaluation, only two SHs and the NFP have some capacity in morphological characterization and evaluation for agronomic traits. Except for one staff of the NFP who has basic knowledge on molecular characterization, none of the SHs have capacity to perform molecular characterization. This emphasizes the need for enhancement of technical capacity to perform characterization and evaluation for various traits. There is also a need to establish a central/common laboratory facility for molecular characterization to assess and quantify genetic diversity. As the Genebank is new, the accessions are limited in number because of which development of core collections are yet to be initiated in the country. The Horticulture Division has also indicated the need for support in expanding characterization, evaluation and development of core collection for Citrus and other horticultural crops.

Some of the constraints reported in the characterization and evaluation of germplasm are the insufficient number and inadequate skills of the staff and lack of financial support.

Table 4: Percent of accession characterized and/or evaluated for different types of descriptors.

Stakeholder	Name of taxon	Name of crop/ crop group	Percent of accessions characterized		Percent of accessions evaluated			
			Morpho. traits	Mol. Markers	Agro. Traits	Biochem traits	Abiotic stress	Biotic stress
NBC	<i>Eleusine coracana</i>	Field Crops	0	0	0	0	0	0
NBC	<i>Amaranthus sp.</i>	Minor crops	0	0	0	0	0	0
NBC	<i>Hordeum vulgare</i>	Field Crops	0	0	0	0	0	0
NBC	<i>Phaseolus sp.</i>	Beans/Legumes	0	0	0	0	0	0
NBC	<i>Zea mays</i>	Maize/Field Crops	0	0	0	0	0	0
NBC	<i>Brassica campestris var. toria</i>	Mustard/Oil seeds	0	0	0	0	0	0
NBC	<i>Oryza sativa</i>	Rice/Field Crops	5	0	5	0	5	5
NBC	<i>Pisum sativum</i>	Green peas/Le-gumes	0	0	0	0	0	0
NBC	<i>Glycine max</i>	Soybean/Legumes	0	0	0	0	0	0
NBC	<i>Vigna sp.</i>	Mung bean/Le-gumes	0	0	0	0	0	0
NBC	<i>Triticum aestivum</i>	Wheat/Field Crops	0	0	0	0	0	0
BPDP	<i>Solanum tuberosum</i>	Potato	100					
RNR-RDC-Bajo	<i>Oryza sativa</i>	Rice	10	0	10	0	5	10
Horticulture Division	<i>Citrus reticulata</i>	Mandarin (Local)		0				
RNR-RDC-Wengkhhar	<i>Citrus reticulata</i>	Mandarin	60	0	90	0	0	0
RNR-RDC-Wengkhhar	<i>Citrus medica</i>	Citron	30		0	0	0	0

RNR-RDC-Wengkhar	Citrus aurantiifolia	Lime	30	0	0	0	0	0	0
RNR-RDC-Wengkhar	Citrus ichangensis	Papeda	30	0	0	0	0	0	0
RNR-RDC-Wengkhar	Citrus limon	Wild Lemon	30	0	0	0	0	0	0
RNR-RDC-Wengkhar	Diospyros sp.	Persimmon	0	0	0	0	0	0	0
RNR-RDC-Wengkhar	Juglans regia	Walnut	90	0	60	0	0	0	0
RNR-RDC-Wengkhar	Citrus reticulata	Ponkan Mandarin	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus unshiu	Satsuma Mandarin	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus reticulata	Tangelo Mandarin hybrids	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus reticulata	Common Mandarin	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus reticulata	Clementine Nules	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus limon	Lemon	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Citrus sinensis	Orange	70	0	80	0	0	0	0
RNR-RDC-Wengkhar	Pyrus pyrifolia	Asian Pear	60	0	80	0	0	0	0
RNR-RDC-Wengkhar	Diospyros kaki	Persimmon	60	0	80	0	0	0	0
RNR-RDC-Wengkhar	Prunus persica	Peach	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Prunus sp.	Plum	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Malus domestica	Apple	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Olea europaea	Olive	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Prunus cerasus	Cherry	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Vitis vinifera	Grapes	50	0	80	0	0	0	0
RNR-RDC-Wengkhar	Actinidia chinensis	Kiwifruit	50	0	80	0	0	0	0

RNR-RDC-Wengkhhar	<i>Persea americana</i>	Avocado	20	0	50	0	0	0
RNR-RDC-Wengkhhar	<i>Mangifera indica</i>	Mango	60	0	60	0	0	0
RNR-RDC-Wengkhhar	<i>Juglans regia</i>	Walnut	50	0	70	0	0	0
RNR-RDC-Wengkhhar	<i>Castanea sp.</i>	Chesnut	40	0	60	0	0	0
RNR-RDC-Wengkhhar	<i>Corylus avellana</i>	Hazelnut	50	0	60	0	0	0
RNR-RDC-Wengkhhar	<i>Brassica oleracea var. botrytis</i>	Cauliflower	100	0	100	0	0	0
RNR-RDC-Wengkhhar	<i>Brassica juncea</i>	Mustard Green	100	0	100	0	0	0
RNR-RDC-Wengkhhar	<i>Daucus carota</i>	Carrot	100	0	100	0	0	0
RNR-RDC-Wengkhhar	<i>Capsicum annuum</i>	chilli	100	0	100	0	0	0
RNR-RDC-Wengkhhar	<i>Cucurbita maxima</i>	Pumpkin	100	0	100	0	0	0
RNR-RDC-Wengkhhar	<i>Citrus paradisi</i>	Wild Grapefruit	30	0	0	0	0	0
RNR-RDC-Wengkhhar	<i>Poncirus trifoliata</i>	Citrus Rootstocks	70	0	80	0	0	0
RNR-RDC-Wengkhhar	<i>Fortunella japonica</i>	Kumquat						
RNR-RDC-Wengkhhar	<i>Citrus maxima</i>	Pomelo						

Priority Activity Area 10 :

Increasing Genetic Enhancement and Base-Broadening Efforts

All four SHs who responded had indicated that their capabilities to perform breeding were declining. *Annex 3* shows the plant breeding programs reported by SHs. Four genetic enhancement programs are reported. Genetic enhancement of rice was carried out through introgression for specific traits and for pear, walnut and persimmon, top working for population improvement was conducted. PVS is also under way in rice in some of the BUCAP project sites for broadening the genetic base.

Breeding is the mandate of research centers in the country and the priorities are to genetically improve the existing local materials so that they become more productive (high yields), resistant to prevailing pests and disease and tolerant to abiotic stress such as cold and drought. Since the capability to perform breeding is declining in general, there is a need for more collaboration with CGIAR centers and regional research centers for developing and exchanging expertise, as well as in germplasm exchange.

Needs and priorities in genetic enhancement and base-broadening efforts:

- PVS and PPB needs to be up-scaled to link farmers and researchers to enhance/ broaden genetic base and utilization of locally adapted traditional varieties and improve their traits as per the felt need of the farmers.
- Capacity building in PVS and PPB.

Priority Activity Area 11 :

Promoting Sustainable Agriculture through Diversification of Crop Production and Broader Diversity in Crops.

Five SHs are involved in implementing/coordinating programs and projects related to assessment or improvement of diversity within and amongst crops or crop production systems to promote sustainable agriculture. Three grain crops and other horticultural crops, including mushroom are the taxa involved in these projects. Inceas-

ing intra-specific diversity and increasing diversity in agricultural systems are the two most prominent issues addressed by these programs and projects. The incentive mechanisms to promote crop diversification include supply of locally adapted seeds, training on improved agronomic practices to enhance production, product development and diversification, supply of product processing equipment, and marketing.

Major constraints listed by SHs in diversification of crops and crop production systems are:

- i. Marketing/commercial obstacles;
- i. Obstacles to officially released heterogenic material as cultivars;
- ii. Manpower and financial shortage;
- iii. Transition from subsistence farming (diversity in farming) to semi -commercial or mono cropping culture;
- iv. Limited access to germplasm;
- v. Lack of scientific evidences (R&D) to support traditional knowledge on nutritive properties of traditional PGRFA.
- vi. Lack of value addition/processing facilities for traditional PGRFA for product development, product diversification and marketing.
- vii. Lack of technical capacity to assess ecosystem services of sustainable/diversity rich agriculture system versus monocropping/modern agriculture.
- viii. Lack of adequate research on production economy of diversity- rich agriculture systems/organic agriculture versus modern agriculture.

Table 5: Programme/project/activity related to assessment or improvement of diversity within and among crops or crop production

SH	Name of programme/project/activity	Name of taxon	Name of crop	Topics covered
NBC	In-situ/On-farm Conservation Program, Agro-Biodiversity Conservation & Utilization Program	Oryza sativa	Rice	1.Increasing intra-specific diversity in crops; 2.Assessing/monitoring diversity in agricultural systems; 3.Increasing diversity in agricultural systems
NBC	In-situ/On-farm Conservation Program, Agro-Biodiversity Conservation & Utilization Program	Zea mays	Maize	1.Increasing intra-specific diversity in crops; 2.Assessing/monitoring diversity in agricultural systems; 3.Increasing diversity in agricultural systems; 4.Participatory diversity methods applied
NBC	In-situ/On-farm Conservation Program, Agro-Biodiversity Conservation & Utilization Program	Fagopyron esculentum	Buck-wheat	1.Assessing/monitoring intra-specific diversity in crops; 2.Increasing intra-specific diversity in crops; 3.Assessing/monitoring diversity in agricultural systems; 4.Increasing diversity in agricultural systems; 5.Participatory diversity methods applied
NOP	Organic Vegetable Program	Solanum tuberosum	Potato	Increasing diversity in agricultural systems
NOP	Organic Vegetable Program	Asparagus officinalis	Asparagus	Increasing diversity in agricultural systems

NOP	Organic Vegetable Program	Capsicum annum	Chilli	Increasing diversity in agricultural systems
NOP	Organic Vegetable Program	Brassica oleracea	Broccoli	Increasing diversity in agricultural systems
NOP	Organic Vegetable Program	Zingiber officinale	Ginger	Increasing diversity in agricultural systems
NOP	Organic Mushroom Program	Pleurotus ostreatus (jacq.P.Kumm)	Straw mushroom	Increasing diversity in agricultural systems
BPDP	Potato Development Program	Solanum tuberosum	Potato	1.Increasing intra-specific diversity in crops; 2.Increasing diversity in agricultural systems
RNR-RDC, Bajo	Rice breeding	Oryza sativa	Rice	1.Increasing intra-specific diversity in crops; 2.Increasing diversity in agricultural systems
RNR-RDC, Bajo	Maize Development Program	Zea mays	maize	1.Increasing intra-specific diversity in crops; 2.Increasing diversity in agricultural systems
RNR-RDC, Weng-khar	Research Outreach Program		Fruits and Vegetables	1. Assessing/monitoring diversity in agricultural systems; 2. Increasing diversity in agricultural systems

The diverse topography, micro-environment and agro-ecological zones of Bhutan requires farmers to grow diverse crops. This provides an opportunity to promote on-farm conservation and management of this diversity. However, for farmers to continue maintaining this diversity there are priorities and needs to be addressed, some of which are listed below:

- Create an enabling policy environment to support diversification of crops and agriculture system.
- Promote utilization of local diversity through value additions, product development and diversification.
- Improve market accessibility and marketing.
- Promote farmers organization/groups for product diversification and marketing.
- Promote awareness amongst consumers through different forms of media (Print, biodiversity and food fairs, TV shows in Dzongkha and English) on the importance of local crops and their significance.
- Make information on collected germplasm accessions accessible to researchers, extension officers and farmers to promote utilization of *ex-situ* conserved materials.
- Promote seed exchange by providing different forums e.g: biodiversity fairs.
- Improve informal/farmers' seed system.
- Research and training support in PVS/PPB/GXE experiments.

Priority Activity Area 12 :

Promoting Development and Commercialization of Under-Utilized Crops and Species

17 under-utilized taxa are identified in the country, out of which nine are identified as medium priority for development and sustainable use. There are four on-going projects for development and commercialization of three taxa, viz: *Fagopyrum esculentum*, *Pyrus communis* and *Juglans regia*. Although there are some on-going post

harvest and marketing activities for some taxa, other activities such as mapping geographical distribution, characterization/evaluation, multiplication of seed/planting materials and development of a documentation system are only at the planning stage for most of the taxa. However, development and commercialization of under-utilized crops are included in the Biodiversity Action Plan and Draft Food and Nutrition Security Policy of Bhutan, indicating strong policy support in the country.

Some of the constraints faced in promoting development and commercialization of under-utilized crops and species are:

- i. Insufficient number of staff
- ii. Lack of sufficient skills in product development and diversification
- iii. Low yield and low volume of production to meet the economy of scale
- iv. Shortage of man power in the field
- v. Lack of expertise in product diversification

Priorities and needs to promote development and utilization of under-utilized crops and crop species

1. Exploration and collection of diverse under-utilized crop and crop species
2. Building technical capacity in value addition, characterization and evaluation
3. Setting up of small agro-industries/explore private firms to promote product development and diversification.

Priority Activity Area 13 :

Supporting Seed Production and Distribution

The National Seed Centre (NSC) is the main SH involved in seed production and distribution of all released crop varieties in the country. Other SHs are involved with seed production and distribution of only specific crop groups related to their mandates. *Annex 4* shows the details of the programs/projects/activities related to seed production and distribution in the country. In terms of legal requirement for variety registration, all crops are required to follow the standard procedure of varietal evaluation and registration. Distinctness, Uniformity and Stability (DUS) and Value for

Cultivation and Use (VCU) are the criteria used for registration. Council for RNR Research of Bhutan (CoRRB) with technical support and guidance from Technology Release Committee (TRC) of the MoAF is responsible for variety scrutinization, registration and release in the country.

Major constraints in the country in making seeds of new varieties available in the market are:

- i. Availability and cost of required production inputs;
- ii. Distance to seed supplier;
- iii. Inadequate seed distribution systems;
- iv. Inadequate seed production systems;
- v. Limited availability of basic/foundation seed;
- vi. Insufficient availability of commercial seed;
- vii. Insufficient availability of disease-free planting material;
- viii. Insufficient availability of registered/certified seed;
- ix. Low seed physical purity;
- x. Poor seed germinability;
- xi. Poor seed storage facilities;
- xii. Seed price too high compared to commodity price.

Despite the mechanism in place to support local seed growers associations, the seed sector in Bhutan is under-developed, because of which farmers face the problems of getting timely and affordable seeds and planting materials. Government supports promotion of local varieties but there are no firms multiplying and supplying seeds of local varieties. As seen in *annex 5*, most of the varieties registered and supplied are of improved varieties. More than fifty percent of the area under rice, wheat and maize and 100 percent under potato and cardamom cultivation are with modern varieties.

In Bhutan about 98 percent of the seeds used by our farmers are informal seeds or seeds of traditional crop varieties maintained by the farmers themselves. Therefore, in a way, our farmers are seed secure and not controlled by externalities that is being confronted by farmers in other regions. However, the seed quality is one of the major constraints of the informal seed system. Therefore, there is a need for intervention to improve both the informal and the formal seed systems in the country.



Priority Activity Area 14 :

Developing New Markets for Local Varieties and ‘Diversity-Rich’ Products

Policy documents such as Economic Development Policy of Bhutan 2010, Cooperative Act of Bhutan 2009, and National Organic Program Strategy (Draft) support the development of new markets for local varieties and product diversification. However, since these policy documents and strategies are still at an initial stage, only attempts such as promotion of organic farming, Biodiversity fairs/Food fairs, and formation and strengthening of farmers’ groups to link scattered productions are under way. Value addition and processing are initiated in rice, maize and buck wheat while the National Organic Program has initiated packaging and marketing of organic vegetables in Gasa and Bumthang on a small scale.

Major constraints to up scaling these initiatives include:

- i. Emphasis on modern cultivars of staple crops.
- ii. Lack of financial support and trained personnel.
- iii. Industrial processing limitations.
- iv. Insufficient seed or planting material.
- v. Lack of consumer demand.
- vi. Inconsistent volume of production.
- vii. Lack of linkage between producer and consumer.
- viii. High transportation costs.
- ix. Lack of awareness on the importance of local varieties (eg: health benefits, culinary, local adaptation, etc).
- x. Shortage of man power in the field.
- xi. Lack of expertise in product diversification.

In addition to product development and marketing, other opportunities such as development of agro-based tourism and health food industry exists in the country to promote sustainable utilization of the local crops and crop varieties. However, to enable realization of these opportunities, regional and international support are required in capacity development in product diversification and value addition; setting up small scale agro-industries; formation of farmers groups and cooperatives; awareness raising and education; and in germplasm exchange.

D. Institutions and Capacity building

Priority Activity Area 15 :

Building Strong National Programmes

The National Biodiversity Centre (NBC) established in 1998, is the national agency responsible for coordinating and facilitating PGRFA activities in the country. The Biodiversity Management Board, which constitute of representatives from various agencies under the Ministry of Agriculture and Forests, Health, Education, Economic Affairs and National Environment Commission provides policy level guidance and oversight to NBC. The programs of NBC are also guided by the Biodiversity Action Plan (s) and the Biodiversity Act of Bhutan 2003, enacted to regulate access to genetic resources in the country. The Agro-biodiversity Conservation and Utilization program under NBC takes the lead role in coordinating and facilitating PGRFA activities in the country. The other participating stakeholders include various agencies under Department of Agriculture (DoA), Dzongkhag and Geog Agriculture Sectors, Council of RNR Research of Bhutan (CORRB), Department of Forests and Park Services (DoFPS), Department of Agriculture Marketing and Cooperatives (DAMC), Local Government and the farming communities.

Bhutan is party to the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The NBC is the implementing agency for CBD and focal point for the ITPGRFA. Therefore, Centre has endeavored to address most of the GPA activities. However, due to the disproportion in the number of professionals involved and the increasing PGRFA mandates, programs and activities, the need for strengthening capacity in terms of infrastructure, human resources, technical expertise and financial support are crucial to strengthen national PGRFA program in the country.

Priority Activity Area 16 :

Promoting Networks for Plant Genetic Resources for Food and Agriculture

Bhutan is a member of the South Asia Network of Plant Genetic Resources (SAN-PGR) and collaborates with South East Asia Regional Initiatives for Community Empowerment (SEARICE) in implementing BUCAP projects, which focuses in on-farm conservation of PGRFA and supports community seed systems. Bhutan supports participation in the network activities by providing institutional infrastructure to implement joint activities, organization and hosting of network meetings and providing information management support. Currently, there is only one active network project, implemented in collaboration with SEARICE. By being a member of such a network, Bhutan has gained benefits such as transfer of technology; increased stakeholder participation; access to financial resources; exchange of technical expertise; training for national scientists; exchange of information and increased awareness of PGRFA. SHs like Bhutan Potato Development Program (BPDP) and National Seed Centre (NSC) who do not have any current collaboration with PGRFA network have also expressed their interest in joining the network and in promoting active collaboration specific to their area of activity. However, lack of financial resources, difficulty in finding suitable partner for networking, and lack of clarity in benefits of participating in network are some of the constraints faced by the country in promoting networking in PGRFA.

Priority Activity Area 17 :

Constructing Comprehensive Information Systems for Plant Genetic Resources for Food and Agriculture

Bhutan currently does not have standardized data management and information system between and amongst different organizations working on PGRFA. Different organizations maintain their data in their own isolated way, for example, either by storing them in MS spread sheet or in physical stock ledgers. The National Genebank Information System is the only computerized PGRFA information system in the country, documenting and maintaining data using MS Access based program. As 30 to 60 percent of the SHs have computers and access to internet, there is an op-

portunity to develop a standardized PGR information system in the country. Many SHs have also expressed their need and interest in developing information system to manage their data. However, prior to the development and standardization of PGR information system in the country, there is a need to strengthen technical capacity of the staff involved in data and information system. Lack of technical expertise in PGR data management and dedicated staff for PGR data management are some of the constraints to the development of PGR information system. In addition to building capacity in information systems, there is also a need to build analytical/statistical skill of technical staff involved in PGR data management to optimize the utilization of the data. The compatibility and applicability of GRIN-Global that will be made available to all Gene Banks through Bioversity International is also an issue.

Priority Activity Area 18 :

Developing Monitoring and Early Warning Systems for Loss of Plant Genetic Resources for Food and Agriculture

Bhutan recognizes the threat of genetic erosion and genetic vulnerability and the need to assess them. There is a mechanism in place to assess genetic erosion for both *in situ* and *ex situ* collection. Field surveys and inventories, gene bank monitoring and monitoring of reports of land use changes are the mechanisms used for monitoring genetic erosion in the country. However, lack of skilled personnel, appropriate technology and financial resources have limited the development of a quantitative monitoring mechanism and early warning system for loss of PGRFA. The linkage between the genetic erosion and the causes also needs to be studied to develop appropriate interventions. Moreover, the concept of early warning system on the loss of PGRFA being new to Bhutan, there is a strong need to propound this concept and concurrently develop capacity to institute such a system. Monitoring and early warning systems for loss of PGRFA is crucial from the seed security perspective. Currently 98 percent of the seed needs are met from the informal or farmers' seeds and formal seeds accounts to only 2 percent of the total seed system. Therefore, loss of any indigenous crops and their varieties is likely to cause many adverse effects on the seed system as well as on the food, landscape, social and ecological systems as a whole. Development of such a system is also crucial in this era of accelerated development which is further exacerbated by impacts of climate change.

Priority Activity Area 19 :

Expanding and Improving Education and Training

Till date a total of 77 staff personnel have been trained through six training programs addressing most of the GPA areas (Table 10).

Table 6: Training addressing GPA priority activity areas

SH	Training course	GPA activity areas addressed	No. of part.
NBC	Training of the Trainers on PGR Conservation and Sustainable Agriculture	<ol style="list-style-type: none"> 1. Surveying and Inventorying PGRFA; 2. Supporting On-Farm Management and Improvement of PGRFA; 7. Supporting Planned and Targeted Collecting of PGRFA; 12. Promoting Development and Commercialization of Under-Utilized Crops and Species; 13. Supporting Seed Production and Distribution; 14. Developing New Markets for Local Varieties and 'Diversity-Rich' Products; 15. Building Strong National Programmes; 19. Expanding and Improving Education and Training; 20. Promoting Public Awareness of the Value of PGRFA Conservation and Use 	22
NBC	Training on PGR Conservation and Sustainable Use	<ol style="list-style-type: none"> 1. Surveying and Inventorying PGRFA; 2. Supporting On-Farm Management and Improvement of PGRFA; 7. Supporting Planned and Targeted Collecting of PGRFA; 11. Promoting Sustainable Agriculture through Diversification of Crop Production and Broader Diversity in Crops; 13. Supporting Seed Production and Distribution; 19. Expanding and Improving Education and Training; 20. Promoting Public Awareness of the Value of PGRFA Conservation and Use 	22

NBC	Training of Trainers on Maize Conservation, Breeding and Management	1.4 Agro-ecological and ecoregional surveying; 1.5 Indigenous knowledge; 9.1 Germplasm characterization and/or evaluation; 9.2 On-farm evaluation; 10.1 Plant breeding; 11. Promoting Sustainable Agriculture through Diversification of Crop Production and Broader Diversity in Crops; 13. Supporting Seed Production and Distribution; 19. Expanding and Improving Education and Training	
NSC	Organic Seed Production and Post Harvest technology	13. Supporting Seed Production and Distribution	1
RNR-RDC, Bajo	Rice Germplasm Collection training	1. Surveying and Inventorying PGRFA; 8. Expanding Ex Situ Conservation Activities	30
RNR-RDC, Weng-khar	Vegetable seed production techniques	13. Supporting Seed Production and Distribution	2

Currently, education and training on PGRFA is not sufficiently incorporated in the formal education curricula. There are certain initiatives such as the School Agriculture Program piloted in some schools as an extra curricula activity at this stage. The College of Natural Resources which offers undergraduate and diploma courses covers PGRFA component under agriculture modules. At the ministry level, Rural Development Training Centre (RDTC) imparts vocational training to rural communities on farming and farm based enterprises. Department of Agriculture through its Research and Development Centers, Central programs and Dzongkhag Agriculture sector also provide training on different aspects of PGRFA to the farming communities and extension agents. However, there is still a need to increase opportunities on PGRFA education and training.

While efforts are ongoing, the major constraints that are faced in this regard still remain as follows:

- Lack of trained personnel to provide training
- Inadequate financial resources

- Paucity of education and training resource materials

SHs have recommended setting up a network of relevant experts at national and regional level to enable countries to exchange knowledge, and technology.

The following are the trainings prioritized by the SHs in PGRFA management.

Table 7: Priority trainings in PGRFA

Stakeholder	Training topic	Training not available at:
NSC	Vegetable seed production	National level
NSC	Fruit plant production technique	National level
RNR-RDC-Bajo	Participatory Plant Breeding	National level
RNR-RDC-Bajo	Taxonomy of food crops	National level
RNR-RDC-Bajo	Exploration and Survey of Crop wild relatives	National level
Horticulture Division	Molecular and Morphological characterization	National level
RNR-RDC, Weng-khar	Breeding	National level
RNR-RDC, Weng-khar	Surveying and inventorying PGRFA	National level
CoRRB	Monitoring and evaluation of PGRFA	National level
CoRRB	Advanced technologies to enhance sustainable production and use of PGRFA	National level
CoRRB	PGRFA database development and data management	National level
NBC	Surveying and inventorying PGRFA	National level
NBC	Spatial analysis and mapping of genetic resources using GIS program	NBC
NBC	PVS and value addition	National level
NBC	Exploration and Collecting of Plant Genetic Resources particularly CWR and Horticultural crops	National level
NBC	Taxonomy of legumes and Crop Wild Relatives	National level
NBC	Germplasm quarantine	NBC
NBC	In Situ Conservation of Crop Wild Relatives	National level

NBC	Characterization, Evaluation and development of core collection	National level
NBC	Statistical analysis of PGRFA data	National level
NBC	Ex-situ conservation of horticultural crops	National level
NBC	PGRFA database maintenance	NBC
NBC	PGRFA Monitoring and development of Early Warning Systems	National level
NBC	Genetic erosion and genetic drift assessment	National level
NBC	Field Gene Bank Management	National level
NBC	Cryo and In-vitro preservation	National level
NBC	Gene Bank equipment maintenance	National level

Priority Activity Area 20 :

Promoting Public Awareness of the Value of Plant Genetic Resources for Food and Agriculture Conservation and Use

Since the institutionalization of PGR program in the country and establishment of NBC in 1998, concerted efforts have been made in promoting awareness on the value of diverse PGRFA as a foundation for promoting sustainable agriculture and food security. The NBC has been successful in garnering support from many agencies such as the Dzongkhag Agriculture Sector/Agriculture Extension officials and RNR-RDC in promoting public awareness at the community level. The Centre continues to enhance public awareness every year by using different tools such as meetings, village gatherings, students' visits to NBC facilities, seminars, brochures, leaflets, posters, biodiversity fairs, food fairs, etc. RNR conferences and sectoral workshops are also used as opportunities to sensitize stakeholders and the public at large on issues related to PGRFA.

The NBC received initial support from Bioversity International (the then IPGRI) in 1999 for promoting public awareness on the value of PGRFA and currently, the Centre receives support for these activities under the BUCAP project (under the SEARICE network) and UNDP-GEF funded Integrated Livestock and Crop Conservation Project (ILCCP).

The value of PGRFA has advanced compared to a decade ago, but it is still inadequate. This could be due to limited coordinated and complementary activities and lack of integration of PGRFA education into school and university curricula in the country. The role of NGOs has also been very minimal with the exception of one national NGO, the Tarayana Foundation, which has some activities that involve the utilization of PGRFA and thereby promote awareness to some extent. Otherwise there are no national NGOs involved in promoting public education on PGRFA. The situation is further aggravated by common constraints such as insufficient manpower, inadequate funds and lack of skills and knowledge in conducting public awareness programs.

The need to enhance public awareness on the value of maintaining diverse PGRFA is becoming more critical because of the emerging threats to PGRFA such as replacement by improved cultivars with uniform genetic base, dwindling farm labour in managing diverse agriculture systems, land use change, etc. Since genetic diversity serves as an insurance against the impacts of climate change on agriculture as well as food security, raising public awareness on the value of PGRFA from this angle is yet another important issue that needs to be addressed.

The lack of public education and the need to raise it through the development of public education materials and use of diverse media such as national TV and radio, targeting different groups of people are acknowledged and recommended by many SHs.



Chapter 5:

Constraints in monitoring GPA-PGRFA

Bhutan started the process of monitoring and updating status of GPA-PGRFA activities with the development of National Information Sharing Mechanism (NISM) for PGRFA, funded through of project “Capacity building and enhanced regional collaboration for the Conservation and Sustainable Use of Plant genetic Resources in Asia” (GCP/RAS/240/JPN). The following are some of the constraints faced during the gathering of the data for NISM, which also affected the comprehensive monitoring of GPA-PGRFA.

- i. Poor documentation system and dedicated manpower to manage data on the PGRFA activities taken up by the stakeholders. Further, most of the representative of SH had their own normal workload, which did not give adequate time even to collate available data and provide it to NFP.
- ii. Lack of understanding on the concept and importance of NISM-GPA and monitoring the status of GPA-PGRFA by most of the stakeholders.

Chapter 6: Conclusion and way forward

The picture of current PGRFA activities in the country is incomplete because of the above mentioned constraints. This is only the first attempt in the country in developing such a monitoring system through NISM, where all PGRFA data would be available from one source, Bhutan is confident that it can move forward in improving the system. However, to accelerate and facilitate development of a comprehensive and complete NISM on PGRFA for Bhutan, and thus comprehensive monitoring, the following actions need to be taken:

- Improvement of PGRFA activities documentation system.
- Dedicated staff for PGRFA data management for all SHs.
- Longer trainings for data managers of NFP and SHs.
- A standardized PGR database for all SHs, along with facilities such as dedicated computers for PGR database.
- More exposure and workshops for PGR researchers and program manager on GPA for Conservation and Sustainable Utilization of PGRFA, as well as on the importance of maintaining and sharing information.

Further, since the NISM data base, which is an effective tool to monitor the status, could not be institutionalized within the SHs' normal programs through the project, it is important to receive subsequent financial support for institutionalization. Further, as indicated above, there is a real necessity for enhancing the awareness on the GPA – PGRFA and the use and importance of an information sharing mechanism as a tool to monitor the progress in implementation of the GPA.

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Annexure 1: Programme/project/activity relating to sustaining ex situ collection.

Stakeholder	Ex situ conservation programme/project/activity	Type of activity	Other activity type	Number of professionals involved
National Biodiversity Center	Agrobiodiversity Conservation Project	Seed genebank (long term collections); Seed genebank (medium term collections); Seed genebank (short term collections); Botanical garden		5
Bhutan Potato Development Program	Potato Seed Production	In vitro conservation	Field Assessment and Multiplication	8
RNR-RDC-Wengkhar	Field genebank of local citrus cultivars collected from citrus growing region in Bhutan	Field genebank	Germplasm collection, Evaluation and selection of better quality fruits, Source of scion wood for production of seedlings	5
RNR-RDC-Wengkhar	Evaluation and germplasm collection of wild citrus species and its relatives.	Field genebank		1
RNR-RDC-Wengkhar	Evaluation and germplasm collection of wild persimmon species	Field genebank	To study the graft compatibility with the improved cultivars	5
RNR-RDC-Wengkhar	Germplasm collection of local soft-shell walnut selections	Field genebank	Source of scion wood for seedling production	2

RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of Exotic citrus cultivar	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	5
RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of Asian pears	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	4
RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of Persimmon	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	4
RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	3
RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of Avocado	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	1
RNR-RDC- Wengkhaz	Evaluation and germ- plasm collection of Mango	Field genebank	Germplasm collection, Evalua- tion and selection of better qual- ity fruits, Source of scion wood for production of seedlings	1

RNR-RDC-Wengkhhar	Evaluation and germplasm collection of Exotic walnut varieties	Field genebank	Germplasm collection, Evaluation and selection of better quality fruits, Source of scion wood for production of seedlings	2
RNR-RDC-Wengkhhar	Evaluation and germplasm collection of Chestnut	Field genebank	Germplasm collection, Evaluation and selection of better quality fruits, Source of scion wood for production of seedlings	2
RNR-RDC-Wengkhhar	Germplasm collection of Hazelnut varieties	Field genebank	Source of planting material	2
RNR-RDC-Wengkhhar	Evaluation and germplasm collection of Cherry cultivars	Field genebank	Germplasm collection, Evaluation and selection of better quality fruits, Source of scion wood for production of seedlings	2
RNR-RDC-Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Seed genebank (short term collections)	Seed production and maintenance, supply to National Seed Centre every year for further multiplication	3
RNR-RDC-Wengkhhar	Evaluation and maintenance of maize germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	4
RNR-RDC-Wengkhhar	Evaluation and maintenance of rice germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	

RNR-RDC-Wengkhhar	Evaluation and maintenance of Legumes germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	
RNR-RDC-Wengkhhar	Evaluation and maintenance of Finger millet germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	
RNR-RDC-Wengkhhar	Evaluation and maintenance of Wheat germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	
RNR-RDC-Wengkhhar	Evaluation and maintenance of Barley germplasm at RDC Wengkhhar	Seed genebank (medium term collections)	Evaluation and maintenance of basic seeds	

Annexure 2: Details of *ex situ* collections in the country.

Stakeholder	Name of ex situ collection	Name of taxon	Status of accessions	Geog origin	No. of accessions	No. of accessions safety-duplicated at other genebanks	Genebank holding safety-duplicate
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Amaranthus L	Traditional cultivar/Landrace	Different locations in Bhutan	10	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Hordeum vulgare	Traditional cultivar/Landrace	Different locations in Bhutan	30	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Phaseolus vulgaris	Traditional cultivar/Landrace	Different locations in Bhutan	57	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Fagopyron esculentum	Traditional cultivar/Landrace	Different locations in Bhutan	74	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Eleusine coracana	Traditional cultivar/Landrace	Different locations in Bhutan	70	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Zea mays	Traditional cultivar/Landrace	Different locations in Bhutan	80	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Brassica campestris var. toria	Traditional cultivar/Landrace	Different locations in Bhutan	40	0	NBC

NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Oryza sativa	Traditional cultivar/Landrace	Different locations in Bhutan	338	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Pisum sativum	Traditional cultivar/Landrace	Different locations in Bhutan	3	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Glycine max	Traditional cultivar/Landrace	Different locations in Bhutan	20	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Vigna sp.	Traditional cultivar/Landrace	Different locations in Bhutan	40	0	NBC
NBC	Ex-situ/Gene bank Program, Agro-Biodiversity Conservation & Utilization Section	Triticum aestivum	Traditional cultivar/Landrace	Different locations in Bhutan	23	0	NBC
BPDP	Potato Seed Production	Solanum tuberosum	Advanced/Improved cultivar				BPDP
RNR-RDC, Bajor	Rice gene pool strengthening project	Oryza sativa	Traditional cultivar/Landrace	Bhutan	150	150	IRRI
RNR-RDC, Wengkhar	Local Mandarin germplasm collection	Citrus reticulata	Traditional cultivar/Landrace	Citrus growing region of Bhutan	57		
RNR-RDC, Wengkhar	Evaluation and germplasm collection of wild citrus species and its relatives.	Citrus sp.	Traditional cultivar/Landrace	Native to Bhutan	5		

RNR-RDC, Wengkhār	Evaluation and germplasm collection of wild persimmon species	Diospyros sp.	Wild	Native to Bhutan	1	
RNR-RDC, Wengkhār	Germplasm collection of local soft-shell walnut selections	Juglans regia	Traditional cultivar/Landrace	Eastern region of Bhutan	24	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus reticulata	Advanced/Improved cultivar	Japan	3	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus unshiu	Advanced/Improved cultivar	Japan	6	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus reticulata	Advanced/Improved cultivar	Japan	3	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus reticulata	Advanced/Improved cultivar	Nepal, Bhutan	4	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus reticulata	Advanced/Improved cultivar		1	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus limon	Advanced/Improved cultivar	Japan	1	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus sinensis	Advanced/Improved cultivar	Japan	2	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus maxima	Advanced/Improved cultivar	Japan	1	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Asian pears	Pyrus pyrifolia	Advanced/Improved cultivar	Japan	11	
RNR-RDC, Wengkhār	Evaluation and germplasm collection of Persimmon	Diospyros kaki	Advanced/Improved cultivar	Japan	7	

RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Prunus persica	Advanced/Improved cultivar	Japan	7	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Prunus sp.	Advanced/Improved cultivar	Japan	8	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Malus domestica	Advanced/Improved cultivar	RDC Bajo	2	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Prunus cerasus	Advanced/Improved cultivar	Japan	5	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Vitis vinifera	Advanced/Improved cultivar	Japan	3	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Olea europaea	Advanced/Improved cultivar	Japan	4	
RNR-RDC, Wengkhar	Evaluation and germplasm collection of peach, plum, apricot, loquat, apple, olive, grapes, cherry,kiwifruit	Actinidia deliciosa	Advanced/Improved cultivar	Semtokha	5	

RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Mango	Mangifera indica	Advanced/Improved cultivar	India	4		
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Exotic walnut varieties	Juglans regia	Advanced/Improved cultivar	India, Holland	19		
RNR-RDC, Wengkhhar	Germplasm collection of Hazelnut varieties	Corylus avellana	Advanced/Improved cultivar	Germany	6		
RNR-RDC, Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Brassica oleracea var. botrytis	Advanced/Improved cultivar	Japan	2		
RNR-RDC, Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Brassica juncea	Advanced/Improved cultivar	Japan	2		
RNR-RDC, Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Daucus carota	Traditional cultivar/Landrace	Japan	1		
RNR-RDC, Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Capsicum annuum	Traditional cultivar/Landrace	Japan and landrace	2		
RNR-RDC, Wengkhhar	Maintenance of basic seed of released varieties of vegetables	Cucurbita maxima	Traditional cultivar/Landrace	Japan	1		
RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Zea mays	Traditional cultivar/Landrace				
RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Oryza sativa	Traditional cultivar/Landrace				
RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Phaseolus sp.	Traditional cultivar/Landrace				

RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Eleusine coracana	Traditional cultivar/Landrace					
RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Triticum sp.	Traditional cultivar/Landrace					
RNR-RDC, Wengkhhar	Ex-situ conservation of PGREA using conventional seed storage methods	Hordeum vulgare	Traditional cultivar/Landrace					
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Exotic citrus cultivar	Citrus paradisi	Advanced/Improved cultivar		2			
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Exotic citrus cultivar	Poncirus trifoliata	Advanced/Improved cultivar		3			
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Exotic citrus cultivar	Fortunella japonica	Advanced/Improved cultivar	Japan	1			
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Avocado	Persea americana	Advanced/Improved cultivar		4			
RNR-RDC, Wengkhhar	Evaluation and germplasm collection of Chestnut	Castanea sp.	Advanced/Improved cultivar	Holland	5			

Annexure 3: Crop breeding programs carried out in the country.

Name of crop	Trait(s)/charac.	Agro-eco.zone(s)/Farm. Sys.	Estimated imp. of the improv.	Germplasm source(s)	Farmers invol. in	No. of prof. Staff	Output prod.	Out-put prod. Yr.
Potato	Yield, pest and disease resistance, maturity, tuber quality.	Dry land farming system in High and mid altitude zones.	High	Regional/International network;CGIAR genebank;Public organization from developed country	Selecting from fixed lines or finished varieties (participatory varietal selection)	8	4 varieties released (Desiree - 1988, Kufri Jyoti- 1988, Yusi Kaap- 1988, Khangma Kaap- 2002)	2002
Rice	High yield Disease resistance Drought tolerance Grain quality	Rice based system High and mid altitude areas	High	Regional/International network;CGIAR genebank	Selecting from fixed lines or finished varieties (participatory varietal selection)	4	6 HYVs The program commenced from 1988 and continued till 2010.	
Maize	Yield, disease resistance, crop duration, height, husk cover, lodging tolerance.	High, mid and low altitude zones	High	Regional/International network;CGIAR genebank	Selecting from fixed lines or finished varieties (participatory varietal selection)	5	3 varieties (Yangt-sipa, Khangma Ashom 1 and Khangma Ashom 2) released between 1988 to 1990	1990

Wheat	Yield, Rust resistance.	Rice based farming system	Medium	Regional/ International network; CGIAR genebank	Selecting from fixed lines or finished varieties (participatory varietal selection)	4	3 varieties released (Sonalika in 1988, Bajo Ka 1 - 1991, Bajo Ka 2 - 1994)	1994
Mustard	Yield, oil recovery, pest and disease resistance.	Wet land and dry land farming systems	Medium	Regional/ International network; CGIAR genebank	Selecting from fixed lines or finished varieties (participatory varietal selection)	4	4 varieties released (Type 9- 1989, M 27- 1989, Bajo Peka 1- 1994 and Bajo Peka 2- 1994)	1994

Annexure 4: Programs/projects/activities related to seed production and distribution in the country.

SH	Name of programme/project/activity	Name of crop/crop group	Name of taxon	Topics covered	Reference
NSC	Contract Growers	Rice/Cereals	Oryza sativa	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	
NSC	Contract Growers	Maize/Cereal	Zea mays	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	
NSC	Contract Growers	Soya/Legume	Glycine max	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	Major vegetable crop and seed production guidebook
NSC	Contract Growers	Seed potato	Solanum tuberosum	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	
NSC	Contract Growers	Pea/Legumes	Pisum sativum	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	Major vegetable crop and seed production guidebook

NSC	Contract Growers	Beans/Legume	Phaseolus vulgaris	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	Major vegetable crop and seed production guidebook
NSC	Farm production	Radhis/Root crops	Raphanus sativus	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	Major vegetable crop and seed production guidebook
NSC	Contract Growers	Broccoli/ Cole crops	Brassica oleracea var. italica	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	
NSC	Contract Growers	Cauliflower/ Cole Crops	Brassica oleracea var. botrytis	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors.	
NOP	Organic Vegetable Program	Vegetables	Lycopersicon esculentum	Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan;National Framework for Organic farming in Bhutan;Training Manual;National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Spinacia oleracea	Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan;National Framework for Organic farming in Bhutan;Training Manual;National Organic Standards

NOP	Organic Vegetable Program	Vegetables	Cap-sicum annum	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Daucus carota	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards.
NOP	Organic Vegetable Program	Vegetables	Lactuca sativa	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Beta vulgaris	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Amaranthus sp.	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards

NOP	Organic Vegetable Program	Vegetables	Chenopodium quinoa	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Ocimum basilicum	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Atriplex hortensis	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Cucumis melo	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Vegetable Program	Vegetables	Solanum melongena	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards

NOP	Organic Vegetable Program	Vegetables	Cucumis sativus	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	A Guide to Organic Agriculture in Bhutan; National Framework for Organic Farming in Bhutan; Training Manual; National Organic Standards
NOP	Organic Fruit Program	Fruits	Cucurbita pepo	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	
NOP	Organic Fruit Program	Fruits	Cucurbita moschata	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	
NOP	Organic Maize Program	Cereal	Zea mays	Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	
BPD	Potato Seed Production	Seed potato	Solanum tuberosum	Seed production; Seed storage; Seed processing; Seed quality control; Seed distribution; Participatory community-based activities; Linkages between formal and informal seed sectors	
Hot. Div	Citrus rootstock seed production and distribution	Fruits	Poncirus trifoliata	Seed production; Seed processing; Seed distribution	

RNR-RDC-Weng-khar	Maintenance of basic seed of released varieties of vegetables	Vegetables		Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution	Annual Reports
RNR-RDC-Weng-khar	On-farm vegetable seed production program	Vegetables		Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution;Participatory community-based activities;Linkages between formal and informal seed sectors.	Horticulture Research and Development Project Report
RNR-RDC-Weng-khar	Citrus root-stock seed production and distribution	USDA trifoliolate orange	Poncirus trifoliata	Seed production;Seed storage;Seed processing;Seed quality control;Seed distribution	

Annexure 5: List of registered, released and cultivated varieties.

Name of crop	Name of cultivar	Type	Year of regis.	Year of release	Target agro-ecological environment(s)	Important characteristics
Ladies Finger/Okra	Kranti	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-600-1500	Yield Potential (t/acre):- 3.0 - 5.0 Maturity (days after sowing)-70-80
Bulb Onion	Bajogop 1	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-<2200	Yield Potential (t/acre):- 7.0 - 8.0 Maturity (days after sowing)-120 - 140
Bulb Onion	Bombay Red	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-<2200	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-110-160
Bunching Onion	No 21	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 1.0 - 3.0 Maturity (days after sowing)-80-90
Bulb Onion	Senshu Red	Improved variety	1994	1994	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 7.0 Maturity (days after sowing)-120 - 170
Bulb Onion	White Creole	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-120 - 160
Garlic (bulb)	Local Selection	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-<2000	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-230-250
Cardamom	Bharlangey	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-900 - 1600	Yield Potential (t/acre):- 0.25 - 0.35 Maturity (days after sowing)-Sept-Oct
Cardamom	Golsey	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-900 - 1200	Yield Potential (t/acre):- 0.25 - 0.35 Maturity (days after sowing)-August-Sept
Almonds	Dhebbhar Badhan	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-1302 - 2500	Yield Potential (t/acre):- 2.5 kg/tree Maturity (days after sowing)-Late August

Almonds	Drake	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-1301 - 2500	Yield Potential (t/acre):- 0.45 kg/tree Maturity (days after sowing)-Late August
Almonds	Kagzi	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-1303 - 2500	Yield Potential (t/acre):- 1.6 kg/tree Maturity (days after sowing)-Early August
Almonds	Texas	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-1300 - 2500	Yield Potential (t/acre):- 0.12 kg/tree Maturity (days after sowing)-Late August
Celery	Cornel	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 5.0 - 6.0 Maturity (days after sowing)-120-160
Fodder peanut	Fodder peanut	Improved variety	2001	2001	Recommended Agro-ecology (MASL):-<1500	Yield Potential (t/acre):- 1.1 - 2.0 Maturity (days after sowing)-1yr (Perennial)
Arecanut	Bhur selection	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-<1000	Yield Potential (t/acre):- 3.0 - 5.0 Maturity (days after sowing)-Dec-March
Asparagus	Mary Washington	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-1000-2500	Yield Potential (t/acre):- 0.5 - 1 Maturity (days after sowing)-2-3 yrs
Asparagus	UC-157 (Hybrid)	Improved variety	2006	2006	Recommended Agro-ecology (MASL):-1000-2600	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-2-3 yrs
Oat (FOB)	Oat (FOB)	Improved variety	2001	2001	Recommended Agro-ecology (MASL):-20 - 4000	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)- 1 yr (Annual)
Oat (Naked)	Oat (Naked)	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-200-4000	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-1 yr (Annual)
Oat (Stampede)	Oat (Stampede)	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-200-4000	Yield Potential (t/acre):- 2.2 - 4.0 Maturity (days after sowing)-1 yr (Annual)

Beetroot	DDR*	Improved variety	2004	2004	Recommended Agro-ecology (MASL)-:<2500	Yield Potential (t/acre)-: 4.0 - 5.0 Maturity (days after sowing)-70-80
Fodder Beet (Alba)	Fodder Beet (Alba)	Improved variety	2004	2004	Recommended Agro-ecology (MASL)-:2000-3500	Yield Potential (t/acre)-: 1.5 - 3.0 Maturity (days after sowing)-1 yr (Annual)
Palisade Grass	Palisade Grass	Improved variety	2002	2002	Recommended Agro-ecology (MASL)-:<1500	Yield Potential (t/acre)-: 3.2 - 3.6 Maturity (days after sowing)-1 yr (Perennial)
Ruzi	Ruzi	Improved variety	2002	2002	Recommended Agro-ecology (MASL)-:500-2000	Yield Potential (t/acre)-: 2.8 - 3.2 Maturity (days after sowing)-1 yr (Perennial)
Turnip	Local Purple	Improved variety	1990	1990	Recommended Agro-ecology (MASL)-:>1000	Yield Potential (t/acre)-: 8-12 t/ac Maturity (days after sowing)-70-90
Turnip	PTWG	Improved variety	1990	1990	Recommended Agro-ecology (MASL)-:>1000	Yield Potential (t/acre)-: 8.0 - 12.0 Maturity (days after sowing)-60-70
Mustard Oil Seed	Bajo Peka 1	Improved variety	1994	1994	Recommended Agro-ecology (MASL)-:< 2000	Yield Potential (t/acre)-: 0.5 Maturity (days after sowing)-145-155
Mustard Oil Seed	Bajo Peka 2	Improved variety	1994	1994	Recommended Agro-ecology (MASL)-:< 2000	Yield Potential (t/acre)-: 0.4 Maturity (days after sowing)-120-130
Mustard Green	Him Beauty	Improved variety	1990	1990	Recommended Agro-ecology (MASL)-:1200 - 2600	Yield Potential (t/acre)-: 2.5 - 4.0 Maturity (days after sowing)-50-60
Mustard Oil Seed	M-27	Improved variety	1989	1989	Recommended Agro-ecology (MASL)-:< 2000	Yield Potential (t/acre)-: 0.4 Maturity (days after sowing)-85-90
Mustard Green	Takana Red	Improved variety	1990	1990	Recommended Agro-ecology (MASL)-:1200 - 2600	Yield Potential (t/acre)-: 2.0 - 3.0 Maturity (days after sowing)-50-60
Mustard Green	Wengkhars Petshe 1*	Improved variety	2004	2004	Recommended Agro-ecology (MASL)-:600 - 2600	Yield Potential (t/acre)-: 3.5 - 4.0 Maturity (days after sowing)-100-120

Mustard Green	Wengkhhar Petshe 2*	2004	2004	2004	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-600 - 2600	Yield Potential (t/acre):- 3.5 - 4.0 Maturity (days after sowing)-100-120
Rapeseed	Jakar pekha*	2004	2004	2004	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-2600-3200	Yield Potential (t/acre):- 0.4 - 0.5 Maturity (days after sowing)-110-130
Swede Var. Ostega	Swede Var. Ostega	2001	2001	2001	Improved variety	2001	2001	Recommended Agro-ecology (MASL):-2500-2700	Yield Potential (t/acre):- 2.0 - 2.5 Maturity (days after sowing)-1 year (annual)
Cauliflower	19905	2002	2002	2002	Improved variety	2002	2002	Recommended Agro-ecology (MASL):-1500-2200	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-120
Cauliflower	Khangma Kopi 1	2004	2004	2004	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-600 to 2500	Yield Potential (t/acre):- 7.0 - 8.0 Maturity (days after sowing)-90
Cauliflower	Khangma Kopi 2	2004	2004	2004	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-600 to 2500	Yield Potential (t/acre):- 10.0 - 12.0 Maturity (days after sowing)-120
Cauliflower	White Summer	1990	1990	1990	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-1500-2000	Yield Potential (t/acre):- 10.0 - 12.0 Maturity (days after sowing)-90-100
Cauliflower	White Top	1990	1990	1990	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-1500-2600	Yield Potential (t/acre):- 10.0 - 15.0 Maturity (days after sowing)-100
Cabbage	Bonday Cross (Hybrid)	2006	2006	2006	Improved variety	2006	2006	Recommended Agro-ecology (MASL):-Across all AEZ	Yield Potential (t/acre):- 10.0 - 11.0 Maturity (days after sowing)-90-110
Cabbage	Copenhagen Market	1990	1990	1990	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 9.0 - 10.0 Maturity (days after sowing)-75-85
Cabbage	Gianty (Hybrid)	2006	2006	2006	Improved variety	2006	2006	Recommended Agro-ecology (MASL):-Across all AEZ	Yield Potential (t/acre):- 11.0 - 12.0 Maturity (days after sowing)-70-80

Cabbage	Golden Acre	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 5.0 - 6.0 Maturity (days after sowing)-70-80
Cabbage	Green Coronnate (Hybrid)	Improved variety	2006	2006	Recommended Agro-ecology (MASL):-Across all AEZ	Yield Potential (t/acre):- 12.0 - 13.0 Maturity (days after sowing)-80-90
Chinese Cabbage	Kyoto 1	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-1500-2200	Yield Potential (t/acre):- 12.0 - 16.0 Maturity (days after sowing)-60-85
Cabbage	Lucky Ball (Hybrid)	Improved variety	2007	2007	Recommended Agro-ecology (MASL):-	Yield Potential (t/acre):- 9.0 - 10.0 Maturity (days after sowing)-80-100
Cabbage	T1-163 (Hybrid)	Improved variety	2006	2006	Recommended Agro-ecology (MASL):-Across all AEZ	Yield Potential (t/acre):- 10.0 - 11.0 Maturity (days after sowing)-65-75
Broccoli	Desico	Improved variety	1994	1994	Recommended Agro-ecology (MASL):-600-2600	Yield Potential (t/acre):- 0.8 - 1.0 Maturity (days after sowing)-100-110
Japanese Green	Mibuna	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-40-50
Japanese Green	Taisai	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-<2600	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-40-50
Capsicum	California Wonder	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-700-2000	Yield Potential (t/acre):- 4.0 - 5.0 Maturity (days after sowing)-75-80
Chilli	Sha Ema	Improved variety	1990	1990	Recommended Agro-ecology (MASL):-600-2000	Yield Potential (t/acre):- 15.0 - 20.0 Maturity (days after sowing)-90-100
Chilli	Super Solo *	Improved variety	2004	2004	Recommended Agro-ecology (MASL):-700 to 2500	Yield Potential (t/acre):- 19.0 Maturity (days after sowing)-90-10
Chilli	Yangtse aeyma	Improved variety	2007	2007	Recommended Agro-ecology (MASL):-1000-2000	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-90-100

Centro	Centro	Improved variety					
Lime	Bears (Swingle)	Improved variety	2004	2004	2004	Yield Potential (t/acre)-: 1.0 - 2.0 Maturity (days after sowing)-Aug-January	
Lime	Rangpur lime (as rootstock)	Improved variety	2004	2004	2004	Yield Potential (t/acre)-: Rootstock Maturity (days after sowing)-Rootstock	
Mandarin/Orange	Dorokha Selection*	Improved variety	2004	2004	2004	Yield Potential (t/acre)-: 4.0 - 5.0 Maturity (days after sowing)-October	
Mandarin/Orange	Wengkhar Tshalu 1	Improved variety	2007	2007	2007	Yield Potential (t/acre)-: >3.0 Maturity (days after sowing)-Mid November	
Mandarin/Orange	Wengkhar Tshalu 2	Improved variety	2007	2007	2007	Yield Potential (t/acre)-: >3.0 Maturity (days after sowing)-Mid November	
Mandarin rootstock	Carrizo citrange	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: Rootstock Maturity (days after sowing)-	
Mandarin rootstock	Cleopatra mandarin	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: Rootstock Maturity (days after sowing)-	
Mandarin rootstock	Troyer citrange	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: Rootstock Maturity (days after sowing)-	
Mandarin rootstock	Wengkhar Tshalu Rhato 1	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: Rootstock Maturity (days after sowing)-	
Musk Melon	Honey Dew	Improved variety	1990	1990	1990	Yield Potential (t/acre)-: 2.0 - 4.0 Maturity (days after sowing)-90-110	
Cucumber	Bajogenchu-1	Improved variety	1999	1999	1999	Yield Potential (t/acre)-: 2.0 - 4.0 Maturity (days after sowing)-70-85	
Cucumber	Shabi Genchu	Improved variety	1990	1990	1990	Yield Potential (t/acre)-: 1.2 - 2.0 Maturity (days after sowing)-70 - 100	

Pumpkin	Rongthong Brumsha	Improved variety	1990	1990	Yield Potential (t/acre):- 2.0 - 4.0 Maturity (days after sowing)-100-140
Pumpkin	Summer Squash	Improved variety	1994	1994	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-60-80
Pumpkin	Tetsu Kabuta	Improved variety	1990	1990	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-90-100
Pumpkin	Wengkhar Kakur I	Improved variety	2007	2007	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-90-100
Cocks foot., Var Amba	Cocks foot., Var Amba	Improved variety	2001	2001	Yield Potential (t/acre):- 0.8 - 1.2 Maturity (days after sowing)-1 yr (Perennial)
Carrot	All Seasons Cross (Hybrid)	Improved variety	2006	2006	Yield Potential (t/acre):- 8.0 - 10.0 Maturity (days after sowing)-110-120
Carrot	Early Nantes	Improved variety	1990	1990	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-80-90
Carrot	Wengkhar laphu maap	Improved variety	2006	2006	Yield Potential (t/acre):- 14.0 Maturity (days after sowing)-105
Carrot	New Khuruda	Improved variety	2006	2006	Yield Potential (t/acre):- 8.0 - 9.0 Maturity (days after sowing)-100-110
Carrot	Nisa	Improved variety	2002	2002	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-90-100
Greenleaf desmodium	Greenleaf desmodium	Improved variety	2001	2001	Yield Potential (t/acre):- 2.0 - 2.5 Maturity (days after sowing)-1 yr (Perennial)
Persimom	Fuyu*	Improved variety	2004	2004	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-Mid November
Persimom	Jiro*	Improved variety	2004	2004	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-Early October

Persimom	Wengkhar anday 1	Improved variety	2007	2007	2007	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-Mid October
Finger millet	Lingmithang Kongpu-1	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.7 - 0.8 Maturity (days after sowing)-120
Finger millet	Lingmithang Kongpu-2	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.84 - 0.85 Maturity (days after sowing)-140
Tall Fescue Var. Barcel	Tall Fescue Var. Barcel	Improved variety	2001	2001	2001	Yield Potential (t/acre):- 1.5 - 3.0 Maturity (days after sowing)-1 yr (Perennial)
Fig	Fig	Improved variety	2001	2001	2001	Yield Potential (t/acre):- 3.0 - 3.5 Maturity (days after sowing)-2-3 yrs (Fodder Tree)
Straw berry	Yusi sagong 1	Improved variety	2006	2006	2006	Yield Potential (t/acre):- 0.7 Maturity (days after sowing)-8 months
Soybean	Bragg	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.6 - 1.0 Maturity (days after sowing)-130-140
Soybean	Khangma Libi-1	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 0.4 - 0.6 Maturity (days after sowing)-140
Soybean	Khangma Libi-2	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.3 - 1.2 Maturity (days after sowing)-130
Soybean	One Daughter	Improved variety	1994	1994	1994	Yield Potential (t/acre):- 0.3-0.4 Maturity (days after sowing)- 160
Walnut	KantheI	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 1.0 - 1.5 Maturity (days after sowing)-September
Walnut	Yusipang 2	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 0.5 - 1.0 Maturity (days after sowing)-September
Lettuce	Great Lake	Improved variety	1990	1990	1990	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-70-80

Bottle Gourd	Mindapur Round	Improved variety	1999	1999	Yield Potential (t/acre):- 6.0 - 7.0 Maturity (days after sowing)-85-95
Litchi	Bhur selection-1*	Improved variety	2004	2004	Yield Potential (t/acre):- 9.0 -10.0 Maturity (days after sowing)-June-July
Litchi	Early Bedana	Improved variety	2006	2006	Yield Potential (t/acre):- 8.0 - 9.0 Maturity (days after sowing)-Early June
Litchi	Shahi*	Improved variety	2006	2006	Yield Potential (t/acre):- 10.0 - 12.0 Maturity (days after sowing)-Late June
Italian Rye grass Var. Lipo	Italian Rye grass Var. Lipo	Improved variety	2001	2001	Yield Potential (t/acre):- 1.2 - 2.2 Maturity (days after sowing)-1 yr (Perennial)
Tomato	Bajo Lambenda 1	Improved variety	2002	2002	Yield Potential (t/acre):- 9.0 - 10.0 Maturity (days after sowing)-80-90
Tomato	Cherry Tomato	Improved variety	1999	1999	Yield Potential (t/acre):- 8.0 - 12.0 Maturity (days after sowing)-60-70
Tomato	Nozomi	Improved variety	1990	1990	Yield Potential (t/acre):- 4.5 - 6.0 Maturity (days after sowing)-90-100
Tomato	Roma	Improved variety	1990	1990	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-90-150
Apple (Scion)	Bajo Apple	Improved variety	2004	2004	Yield Potential (t/acre):- 2.5 Maturity (days after sowing)-Mid July
Apple (Scion)	Fuji	Improved variety	2007	2007	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-October
Apple (Scion)	Golden Delicious	Improved variety	1994	1994	Yield Potential (t/acre):- 3.7 Maturity (days after sowing)-Sept-Oct
Apple (Scion)	Jonathan	Improved variety	1994	1994	Yield Potential (t/acre):- 5.0 Maturity (days after sowing)-October

Apple (Scion)	Lobo	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 3.2 Maturity (days after sowing)-Late September
Apple (Scion)	Mutsu	Improved variety	2007	2007	2007	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-Early October
Apple (Scion)	Red chief	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-Sept October
Apple (Scion)	Red Delicious	Improved variety	1994	1994	1994	Yield Potential (t/acre):- 7.0 Maturity (days after sowing)-Sept-October
Apple (Scion)	Red Free	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 3.8 Maturity (days after sowing)-Mid August
Apple (Scion)	Rich-a-Red	Improved variety	1994	1994	1994	Yield Potential (t/acre):- 3.5 Maturity (days after sowing)-August-Sept
Apple (Scion)	Royal Delicious	Improved variety	1994	1994	1994	Yield Potential (t/acre):- 7.0 Maturity (days after sowing)-Sept-Oct
Apple Root Stock	MM-106	Improved variety	1994	1994	1994	Yield Potential (t/acre):- Rootstock Maturity (days after sowing)-
Apple Root Stock	MM-111	Improved variety	2006	2006	2006	Yield Potential (t/acre):- Rootstock Maturity (days after sowing)-
Apple Root Stock	MM9	Improved variety	2006	2006	2006	Yield Potential (t/acre):- Rootstock Maturity (days after sowing)-
Mango	Chausa	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-August
Mango	Bajo Aum-chu-kali 1	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-July-August
Mango	Bajo Aum-chu-kali 2	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-July-August

Lucerne Var. Eureka	Lucerne Var. Eureka	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 1.6 - 2.5 Maturity (days after sowing)-1 yr (Perennial)
Molasses grass	Molasses grass	Improved variety	2001	2001	2001	Yield Potential (t/acre):- 1.6 - 2.4 Maturity (days after sowing)-1 yr (Perennial)
Banana	Chinichampa	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 3.0 - 5.0 Maturity (days after sowing)-Sept - April
Banana	Gheukola	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-Sept - April
Banana	Jazi	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 5.0 - 7.0 Maturity (days after sowing)-Sept - April
RICE	Bajo Kaap 1	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 2.0 - 3.4 Maturity (days after sowing)-145-155
RICE	Bajo Kaap 2	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 2.0 - 3.4 Maturity (days after sowing)-150-165
RICE	Bajo Maap 1	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 2.0 - 3.2 Maturity (days after sowing)-150-155
RICE	Bajo Maap 2	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-145-155
RICE	BR 153	Improved variety	1989	1989	1989	Yield Potential (t/acre):- 1.2 - 1.6 Maturity (days after sowing)-140-150
RICE	BW 293	Improved variety	1990	1990	1990	Yield Potential (t/acre):- 1.2 - 1.8 Maturity (days after sowing)-140-150
RICE	IR 20913	Improved variety	1989	1989	1989	Yield Potential (t/acre):- 1.6 - 2.4 Maturity (days after sowing)-130-140
RICE	IR 64	Improved variety	1988	1988	1988	Yield Potential (t/acre):- 2.0 - 3.2 Maturity (days after sowing)-140-155

RICE	Jakar Rey Naab*	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: 1.5 - 2.0 Maturity (days after sowing)-180-195
RICE	Khangma Maap	Improved variety	1999	1999	1999	Yield Potential (t/acre)-: 1.6 - 2.4 Maturity (days after sowing)-120-130
RICE	No 11	Improved variety	1989	1989	1989	Yield Potential (t/acre)-: 1.6 - 2.4 Maturity (days after sowing)-160
RICE	Wengkhar Rey Kaap 2	Improved variety	2002	2002	2002	Yield Potential (t/acre)-: 1.7 - 1.9 Maturity (days after sowing)-160-165
RICE	Wengkhar Rey Kaap-6	Improved variety	2006	2006	2006	Yield Potential (t/acre)-: 1.7 - 1.9 Maturity (days after sowing)-160-165
RICE	Yusi Ray Kaap	Improved variety	2002	2002	2002	Yield Potential (t/acre)-: 2.5 - 3.5 Maturity (days after sowing)-170-180
RICE	Yusi Ray Maap	Improved variety	2002	2002	2002	Yield Potential (t/acre)-: 2.5 - 3.5 Maturity (days after sowing)-170-180
Guinea grass	Guinea grass	Improved variety	2007	2007	2007	Yield Potential (t/acre)-: 2.4 - 3.2 Maturity (days after sowing)-1 yr (Perennial)
Paspalum Atratum Var. CIAT 26986	Paspalum Atratum Var. CIAT 26986	Improved variety	2002	2002	2002	Yield Potential (t/acre)-: 2.0 - 3 Maturity (days after sowing)-1 yr (Perennial)
Kikuyu grass	Kikuyu grass	Improved variety	2001	2001	2001	Yield Potential (t/acre)-: 4.0 - 6.0 Maturity (days after sowing)-1 yr (Perennial)
Napier	Napier	Improved variety	2001	2001	2001	Yield Potential (t/acre)-: 4.0 - 6.0 Maturity (days after sowing)-1 yr (Perennial)
Parsley	Paramount	Improved variety	1990	1990	1990	Yield Potential (t/acre)-: 2.5 - 3.5 Maturity (days after sowing)-130-160
Beans	Borloto	Improved variety	1990	1990	1990	Yield Potential (t/acre)-: 2.0 - 4.0 Maturity (days after sowing)-65-70

Beans	Green Arrow	Improved variety	1999	1999	Yield Potential (t/acre):- 2.0 Maturity (days after sowing)-60
Beans	Pusa Parvati	Improved variety	1990	1990	Yield Potential (t/acre):- 2.5 - 3.5 Maturity (days after sowing)-50-60
Beans	Rasma	Improved variety	1994	1994	Yield Potential (t/acre):- 2.5 Maturity (days after sowing)-80-90
Beans	Selection 9**	Improved variety	2004	2004	Yield Potential (t/acre):- 1.5 - 3.0 Maturity (days after sowing)-70-80
Beans	Top Crop	Improved variety	1990	1990	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-70-85
Beans	White no.1**	Improved variety	2004	2004	Yield Potential (t/acre):- 1.5 - 2.5 Maturity (days after sowing)-70-80
Pea	Arkel	Improved variety	2002	2002	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-65-75
Pea	Usui	Improved variety	2002	2002	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-90-100
Apricot	Bajo Khamchung 1	Improved variety	2002	2002	Yield Potential (t/acre):- 2.5 - 4.8 Maturity (days after sowing)-Mid May
Apricot	Shakapara	Improved variety	2002	2002	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-May
Plum	Jambay Lhakhang Chuli*	Improved variety	2004	2004	Yield Potential (t/acre):- 4.0 - 5.0 Maturity (days after sowing)-July-August
Plum	Oishiwase	Improved variety	2002	2002	Yield Potential (t/acre):- 5.0 - 6.0 Maturity (days after sowing)-May-June
Plum	Santa Rosa	Improved variety	2002	2002	Yield Potential (t/acre):- 3.0 - 5.0 Maturity (days after sowing)-May-June

Peach	Bajokham 1	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 3.0 - 4.0 Maturity (days after sowing)-Mid May
Peach	Bajokham 2	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 2.9 - 3.7 Maturity (days after sowing)-July
Peach	Bathpala Super*	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 4.0 - 6.0 Maturity (days after sowing)-July-August
Peach	Nonomiwase	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 5.0 - 8.0 Maturity (days after sowing)-June-July
Pomegranate	Bedana*	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 2.5 - 4.0 Maturity (days after sowing)-Late August
Passion fruit	Local	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-May-June
Pear	Bajo Lhee 1	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-August
Pear	Hosui	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 6.0 - 7.0 Maturity (days after sowing)-Mid August
Pear	Kosui	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 5.0 - 6.0 Maturity (days after sowing)-July-Early August
Pear	Zhey Lhee *	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 4.8 - 5.5 Maturity (days after sowing)-Early October
Radish	Bajo Laphu 1	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 12.0 - 20.0 Maturity (days after sowing)-45
Radish	Minowase	Improved variety	1990	1990	1990	Yield Potential (t/acre):- 9.0 - 10.0 Maturity (days after sowing)-50-60

Radish	Spring Tokanashi	Improved variety	1990	1990	Yield Potential (t/acre):- 8.0 - 10.0 Maturity (days after sowing)-50-80
Sugarcane	Sugarcane	Improved variety	2002	2002	Yield Potential (t/acre):- 16.0 - 20.0 Maturity (days after sowing)-1 yr (Annual)
Willow	Willow	Improved variety	2001	2001	Yield Potential (t/acre):- 0.8 - 2.2 Maturity (days after sowing)-3 yr (Fodder tree)
Brinjal	Big Round	Improved variety	1990	1990	Yield Potential (t/acre):- 2.0 - 4.0 Maturity (days after sowing)-75-90
Brinjal	Paro Local	Improved variety	1990	1990	Yield Potential (t/acre):- 1.0 - 2.0 Maturity (days after sowing)-90-100
Brinjal	Pusa Purple Long	Improved variety	1990	1990	Yield Potential (t/acre):- 2.0 - 3.0 Maturity (days after sowing)-90-110
Potato	Desiree	Improved variety	1989	1989	Yield Potential (t/acre):- 15.0 - 18.0 Maturity (days after sowing)-90
Potato	Khangma Kaap	Improved variety	2002	2002	Yield Potential (t/acre):- 16.0 - 20.0 Maturity (days after sowing)-100-105
Potato	Kufri Jyoti	Improved variety	1989	1989	Yield Potential (t/acre):- 20.0 - 23.0 Maturity (days after sowing)-100-120
Potato	Yusikap	Improved variety	1988	1988	Yield Potential (t/acre):- 20.0 - 25.0 Maturity (days after sowing)-100-120
Spinach	All Green	Improved variety	1990	1990	Yield Potential (t/acre):- 4.0 - 10.0 Maturity (days after sowing)-50-60
Spinach	Leaf Beet	Improved variety	2002	2002	Yield Potential (t/acre):- 4.0 - 10.0 Maturity (days after sowing)-50-70
Stylo Var. CIAT 184	Stylo Var. CIAT 184	Improved variety	2001	2001	Yield Potential (t/acre):- 4.0 - 12.0 Maturity (days after sowing)-1 yr (Perennial)

White Clover Var. Ladino	White Clover Var. Ladino	Improved variety	2001	2001	2001	Yield Potential (t/acre):- 3.2 - 4.4 Maturity (days after sowing)-1 yr (Perennial)
Gautamala Grass	Gautamala Grass	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 1.2 - 2.4 Maturity (days after sowing)-1 yr (Annual)
Bajoka 1	Bajoka 1	Improved variety	1991	1991	1991	Yield Potential (t/acre):- 1.2 Maturity (days after sowing)-151-155
Bajoka 2	Bajoka 2	Improved variety	1994	1994	1994	Yield Potential (t/acre):- 1.2 Maturity (days after sowing)-150-155
Sonalika	Sonalika	Improved variety	1988	1988	1988	Yield Potential (t/acre):- 1.0 Maturity (days after sowing)-160-180
Hairy vetch	Hairy vetch	Improved variety				
Mungbean	Bari Mung -2	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.3 Maturity (days after sowing)-120-130
Mungbean	KPS-2	Improved variety	2002	2002	2002	Yield Potential (t/acre):- 0.3 Maturity (days after sowing)-120-130
Table Grapes	Muscate of Alexandria	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 3.0 Maturity (days after sowing)-August
Table Grapes	Perlette	Improved variety	2004	2004	2004	Yield Potential (t/acre):- 1.0 Maturity (days after sowing)-June
Maize	Khangma Ashom 1	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 2.0 Maturity (days after sowing)-140-160
Maize	Khangma Ashom 2	Improved variety	1999	1999	1999	Yield Potential (t/acre):- 1.6 - 2.0 Maturity (days after sowing)-110-120
Maize	Yangtsipa	Improved variety	1992	1992	1992	Yield Potential (t/acre):- 1.2 - 1.6 Maturity (days after sowing)-120-130

Mango	Bajo aumchukali 3	Improved variety	2010	2010		The mother blocks are located in Lingmethang, Bhur, Nangkhor and Bajo.
Guava	Bajobab-zeow 1	Improved variety	2010	2010		The mother blocks are located in Bajo.
Guava	Bajobab-zeow 2	Improved variety	2010	2010		The mother blocks are located in Bajo.
Chestnut	Wengkhhar Sokey	Improved variety	2007	2007		The mother blocks are located in Wengkhhar, Khangma and Yusipang.
Walnut	Kagzi	Improved variety	2002	2002		The mother blocks are located in Paro.
Walnut	Yusipang 1	Improved variety	2004	2004		The mother blocks are located in Yusipang, Khangma and Jakar
Walnut	Yusipang 2	Improved variety	2004	2004		The mother blocks are located in Yusipang.
Cherry	Seneka	Improved variety	1994	1994		The mother blocks are located in Paro.
Cherry	Jabouny	Improved variety	1994	1994		
Broccoli	Centauro	Improved variety				This is heading type of broccoli. Heads mature at the same time and is more suitable for commercial production.
Chilli	Yangtse Ema	Improved variety	2007	2007		

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