Genebank Operation Manual

National Agricultural Genetic Resources Centre (NAGRC)
National Genebank
Kathmanud, Nepal

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Conserve and manage APGRs efficiently and scientifically, and use sustainably

Collect as much diversity as possible in a minimum sample
Consider: Species Diversity; Genetic/ Phenotypic Diversity; Ecotypes/ adaptation Diversity and Allelic/ Phenotypic Diversity

Contents

List of Tables

List of Figures

Foreword

Genebank Operation Manual is the outcome of the personnel involved in research and management of the agricultural/ plant genetic resources (A/PGRs), also popularly known as Genebank, the National Agriculture Genetic Resources Center (NAGRC) which was established under Nepal Agricultural Research Council (NARC) in 2010 (2066 BS) at Khumaltar, Lalitpur. It has been tried to publish the Genebank Operational Manual since its establishment. However, the due to publish the manual has been operationalzed in 2015/16 (2072/73) by the hard of the personnel working in the Genebank Nepal.

I am very much thankful to all the staff and stakeholders who provided valuable information and suggestion to publish this manual timely. The meticulous job carried out by senior scientists Messrs Dr. BK Joshi, DS Shrestha, KH Ghimire, Dr. D Gauchan, Scientist Bioversity International as well as SK Shrestha and S Khatiwada, Project officers, is highly acknowledged for their tireless contribution to prepare the manual in this form. I am equally thankful to the contribution made by admin/finance/technical officers namely AK Basnet, PP Dhungana, SK Budhathoki, Technicians S Sharma and KA Ansari. Also contribution made by all the support staff including technicians, drivers, and collaborators and participating farmers is thankfully acknowledged. Financial support from AFACI, RDA, Korea; Bioversity International, Rome and GEF/UNEP are highly appreciated. The help and cooperation provided by the Ministry of Agricultural Development and NARC management team of the Nepal Agricultural Research Council is thankfully appreciated.

I am confident that activities summarized in this manual will be valuable sources for researchers, administrators and planners to chalk out programs and activities related to APGRs in coming days as well. Genebank always welcomes constructive comments and suggestions to improve the quality of this publication in coming days ahead. Had this manual is useful for those who are involved in research and management of APGRs, it would be a matter of pride for Genebank as well.

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Abbreviation

ACR	Active Collection Room
APGR	Agricultural Plant Genetic Resources
ARS	Agriculture Research Station
CAT	Climate Analogue Tool
CBD	Convention on Biological Diversity
CBR	Community Biodiversity Register
CFGB	Community Field Genebank
CGB	Community Genebank
CGIAR	Consultative Group of International Agricultural Research
CSB	Community Seed Bank
DNA	Deoxyribose Nucleic Acid
DoA	Department of Agriculture
f	Form
FAO	Food and Agriculture Organization
FGB	Field Genebank
GB	Genebank
GIS	Geographic Information System
HGB	Household Genebank
IAAS	Institute of Agriculture and Animal Science
IPGRI	International Plant Genetic Resources Institute
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
M&E	Monitoring and Evaluation
MLS	Multi-Lateral System
MoAD	Ministry of Agricultural Development
MoFSC	Ministry of Forestry and Soil Conservation
NAGRC	National Agriculture Genetic Resources Centre
NARC	Nepal Agricultural Research Council
NGO	Non-Governmental Organization
NIL	Near Isogenic Lines
PCR	Polymerase Chain Reaction
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
RAPD	Random Amplified Polymorphic DNA
RARS	Regional Agriculture Research Station
RIL	Recombinant Inbred Lines
SFGB	School Field Genebank
sp	Species
SQCC	Seed Quality Control Centre
subsp	Subspecies
var	Variety
VDC	Village Development Committee
WSV	World Seed Vault

Glossary

Access to genetic resources	The arrangement made to collect, acquire, or receive genetic materials, resources, or traditional knowledge from the owner for the use of others.
Agricultural genetic resources	Any genetic material of actual or potential value for food and agriculture. Does not include human genetic resources.
Agricultural plant genetic resources	All cultivated plant landraces and varieties, wild edible plants, and wild relatives of crops.
Benefit-sharing	Sharing monetary or non-monetary benefit acquired by accessing and using genetic material, resources, or traditional knowledge as per an agreement between provider and receiver.
Black box	A system for depositing samples that does not constitute a legal transfer of genetic resources; the repository gene bank does not claim ownership over the deposited samples and that ownership remains with the depositor, who has sole right of access to the materials. The repository gene bank is not entitled to the use or distribute the germplasm. It is the depositor's responsibility to ensure that the deposited material is of high quality, to monitor seed viability over time, and to use their own base collection to regenerate the collection when it begins to lose viability.
Community gene bank	A community storage facility for seeds of orthodox types and a one or more fields where farmer communities grow recalcitrant types of crops and maintain them over time.
Cultivar	Any distinct genotype under cultivation, including both landraces and varieties.
Distribution	Fair and equitable distribution of acquired benefit from the access to genetic material, resources, or traditional knowledge between farmers and stakeholders.
Ex-situ conservation	The conservation of genetic resources maintained outside their natural habitat.
Farmer	The people and communities, who identify, conserve, preserve, develop, or use genetic material, resources, and traditional knowledge.
Genetic material	All or part of the functional units of heredity consisting of the genetic characteristics of domestic or wild animals, plants, microbial organisms, viruses, or other origin.
Global Annex 1 crops	Also called IT Annex 1 crops. Crop species that are included under the multilateral system, listed in Annex 1 of the ITPGRFA, and accessible to all contracting parties through a Standard Material Transfer Agreement.
Global crop gene pool	Agricultural plant genetic resources that are necessary to secure food and nutrition for the global community.
In-situ conservation	The conservation of genetic resources in their original ecosystem and natural habitat. In the context of agricultural genetic resources, conservation in the surroundings where they have developed their distinctive properties (with at least one allele originating there). Both active (growing) and dormancy (after seed matures) periods occur in the same place.
Landrace	Genotype not altered by breeders but grown continuously by farmers over years. It may be local or introduced.
Multilateral access	An arrangement made under the provisions of the ITPGRFA to access and use plant genetic resources for food and agriculture by national governments and international organizations working in the area of agriculture and food security for the welfare of human kind.
Multilateral system	Under the ITPGRFA, the multilateral system (MLS) comprises a pool of 64 selected crops that are made accessible. On ratifying the treaty, countries agree to make their genetic diversity and related information about the crops stored in their gene banks available to all through the MLS.
National crop gene pool	Agricultural plant genetic resources that are necessary to secure food and nutrition

	for human kind.
Nepal Annex 1 crops	List of accessions of crops from Nepal included in the MLS.
On-farm conservation	The conservation of agrobiodiversity in farmers' fields and/or in community gene banks (seed bank and field gene bank), where new traits or alleles have not originated, but have been cultivated over a period of time. Active life (growing period) remains in the field and dormancy period (after harvest) remains in the manmade structure nearby field.
Origin of landrace	Area where farming communities have been growing a landrace for more than 60 years or the location where a landrace was collected.
Origin of variety	Location where a distinct form of genotype is developed either by crossing or selection.
Safety backup	Safety duplication of accessions at one or more sites and/or using an alternative conservation method or strategy, such as in-vitro or cryopreservation or field gene bank. Both depositor and repository gene banks can use and distribute the germplasm.
Safety duplication	The duplication of genetically identical subsamples of an accession to mitigate the risk of its partial or total loss caused by natural or man-made catastrophes. Safety duplicates are genetically identical to the accessions in the base collection and are referred to as the second-most original samples. Safety duplicates include both the duplicated material and its related information and are deposited in a base collection at a different location from the originals, usually in another country. Safety duplication is generally organized under a black-box agreement.
Traditional knowledge	Knowledge, skills, technology, or practices used by farmers from generation to generation to identify, manage, conserve, develop, or use genetic material or resources.
Variety	Genotype developed by breeders. It may be under cultivation or in the process of development.

Introduction

With realization and importance of the agricultural/ plant genetic resources (A/PGRs), Genebank alias National Agriculture Genetic Resources Center (NAGRC) was established under Nepal Agricultural Research Council (NARC) in 2010 (2066 BS) at Khumaltar, Lalitpur. Management of APGRs is the regular activities undertaken by the Genebank, Nepal. It was established to spearhead conservation and utilization of agro-biodiversity available in the country. Genebank establishment is the milestone in supporting food and nutritional security and national economic development to meet the national obligation of implementing international agreements (the Convention on Biological Diversity (CBD), 1992 and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), 2004. An area of 2.4 ha is allocated for Genebank in Khumaltar premise. Out of 2.4 ha, Genebank building has occupied 0.092 ha, 0.26 ha is allocated for Field Genebank and 0.83 ha for regeneration, multiplication, characterization, evaluation and post quarantine activities of PGRs.

APGRs are the creation of nature for sustaining food, fiber, clothes, medicine, and energy to maintain lives in the world. It is the utmost importance of every country to conserve and utilize APGRs for present generation without compromising the need and utilization of the future generation as well. Genebank is virtually responsible to accomplish its mission, collection, characterization, preservation, regeneration and utilization of PGRs, and issues thereby objectives of Genebank could be achieved to meet the ever projecting food and nutritional security of Nepal in coming days.

Genebank has considered the diverse strategies of ex-situ, on-farm and in-situ management of APGRs. In addition to these strategies, Genebank has encouraged other existing supplementary mechanisms for conserving agro-biodiversity in Nepal. These mechanisms are associated to religious practices of Hinduism and Buddhism with regards to some plants, culturally protected areas of temple and religious heritages, leasehold, and community forests where PGRs have been protected in these heritages areas as well.

As a result of the comprehending the importance of PGRs conservations, NARC has taken initiation of conserving APGRs in national and international genebank including CGIARs located in different parts of the world and in the World Seed Vault, Korea. It has been established that diverse genetic resources are the foundation for sustainable development of agriculture. Global food security relies on judicious use of PGRs and crop genetic resources which contain the essential building blocks critical to food and nutritional security of the world. It is the utmost important that there is the plenty of availability of these genetic materials as the basic requirement for enhancing and achieving food and nutritional security through research and management tailoring with the need and prerequisite of science led agriculture research and development of the 21st century. For this, it is crucial to conserve the existing crop diversity and to sustain and maintain basic needs of humans encompassing food, fiber, energy and full-fledged agriculture development of the country. Out of about 410 angiosperm families in the world, 203 (almost 50%) are represented in Nepal. Nepal is ranked the tenth richest flowering plant diversity country in Asia whereas in the world Nepal is placed in 31st position of with respect to biodiversity richness (The Biodiversity, 1995). More than 500 species of edible genetic resources are available, of which nearly 200 species are under cultivation (Upadhyay and Joshi 2003). The role of crop diversity for agriculture research for development will become even more important in the near future for achieving food security in a sustainable way. Plant genetic resources that are conserved in the Genebank can be used for safe conservation for future use, direct use for agricultural production, conservation of diversity in environment, scientific use for experimental materials, genetic enhancement/pre-breeding and breeding materials for the sustainable development (Genebank, 2010). According to the Food and

Agriculture Organization of the United Nations (FAO), more than 75% of global crop diversity has been disappeared irrevocably over the 20th century. A large number of wild relatives of important food crops are also likely to disappear over the next decades due to climate change (Genebank, 2010). This calls for the urgent conservation and management of APGRs for the well being of the world as a whole.

Genebank Operation Manual will help provide information to those who are interested to know about the system of Genebank with respect to its introduction encompassing activities under taken such as storage facilities, collection, processing, identification and regeneration of PGRs. Hence, Genebank Operation Manual has been published. Aside from this, the manual shall provide information about types of genebank functioning in Nepal, information about crop descriptors, evaluation and pre-breeding, uses and policy related issues of the Government and national and international institutions involved in the management and utilization of PGRs. The manual shall be valuable references to the researchers, academicians, policy makers and all of those who are concerned about APGRs.

Physical infrastructure and maintenance of Genebank

Table 1. Physical infrastructure and cost of maintenance

SN	**Lab**	**Equipment**	**Parts name**	**Repairing parts and time**	**Repairing cost**	**Replacement time**	**Replacement cost**	
Genebank								
1	ACR							
2	BCR							
3	Tissue culture							
4	Seed processing							
5	Seed drying							
6	Molecular lab							
Glass house								
1	Glass							
2	Fan							
Short term storage								
1	Rack							
2	Tray							
3								
Threshing floor and store								

1	Threshing floor							
2								
Agricultural tools and others								
1	Tractor							
2	Mower							
3								
4								

Table 2. Electric power consumption

SN	**Lab**	**Equipment**	**Power consumption/ month**	**Rate/unit, Rs**	**Cost/month, Rs**	**Cost/ year, Rs**
1	Long term storage	Cooling unit				
2	Medium term storage	Cooling and dehumidifier				
3	Seed processing lab	Germinator, seed graders, etc				
4	Seed drying room	Cooling and dehumidifier				
5	Tissue culture lab	Autoclave, laminar hood, deionized water plant, etc				
6	Molecular lab	Deep fridge, PCR machine, autoclave, gel unit, ice maker, etc				

Note: Diesel consumption for generator

Conservation strategies and methods

Different conservation strategies should be considered so that they complement each other and help to conserve maximum diversity as much as possible (FAO, 2009, 2010, 2012). There are four strategies namely ex-situ, on-farm, in-situ conservation and breeding adopted by the Center. These conservation strategies can be grouped in to two approaches, as static and dynamic (**Figure** 1).

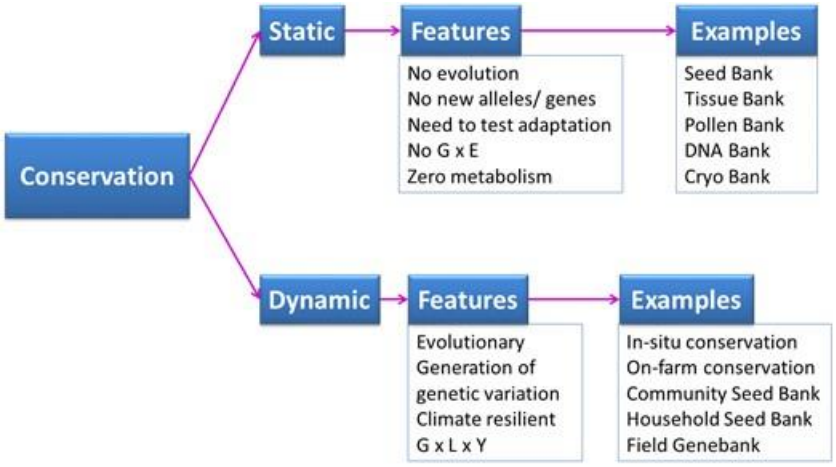

Figure 1. Conservation strategies and their features with examples.

Ex-situ conservation: It is the conservation of APGRs outside their natural habitats and farming areas (Plucknett et al 1987, FAO, 2009). Ex-situ conservation is usually carried out in genebanks, field genebanks and botanical gardens. Most common methods under ex-situ conservation are Seed Bank for orthodox seeds, Tissue Bank, Cryo bank, DNA Bank and Field Genebank/ Botanical Gardens/ Farms/Parks for recalcitrant seeds and vegetatively propagated crops.

On-farm conservation: It is a dynamic conservation of traditional and locally adopted varieties and landraces in farming community (Joshi *et al.,* 2013a). The continuous cultivation and management of a diverse set of populations by farmers in the agro-ecosystems is the technique of on-farm conservation. In this type of conservation, APGR grows in the farming land and seeds are stored in human made storage located nearby growing sites. Local landraces can be conserved by establishing community genebank (seed bank and field genebank), by strengthening household genebank (seed bank and field genebank), by enhancing landraces and by strengthening seed networks.

In-situ conservation: It is the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings (Collins & Hawtin, 1999, FAO, 2009) and in the case of domesticated or cultivated plant species, in the surroundings where they have developed their distinctive properties. Typical in-situ conservation is the method where active and dormant life (growing period and seed storage period) of APGR remain on the same location.

Breeding strategy: It gives emphasis on adopting the strategies of conservation plant breeding eg evolutionary rather than non-evolutionary, diversity not uniformity, specific not wide adaptation.

Conservation ladder: Conservation should be considered at all levels (**Figure** 2) involving maximum number of stakeholders.

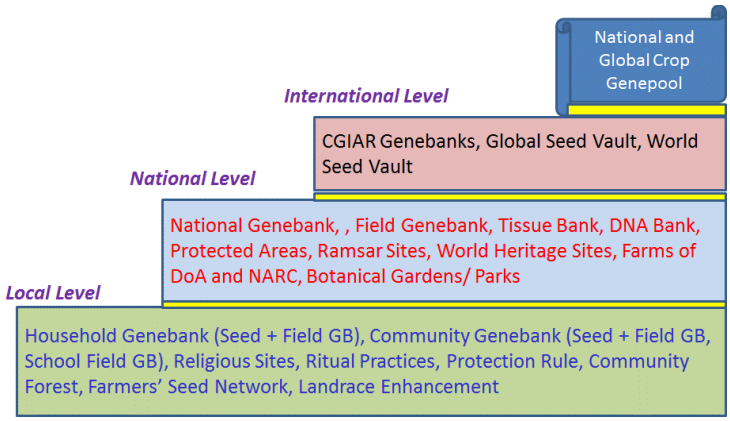

Figure 2. Conservation ladder adopted by NAGRC for management of APGRs in Nepal.

Agricultural plant genetic resources

Agricultural plant genetic resources (APGRs) includes all types of crops landraces that have value for food and agriculture. Followings are the types of APGRs considered by the Center.

- Cultivated crops
    - Landraces
    - Modern and obsolete varieties
    - Breeding lines eg RILs, Genetic stocks, NILs, Differential lines
    - Exotic and introduced genetic resources
- Crop wild relatives
- Wild edible plants

Working classification of these APGRs

Based on the mode of reproduction

- Self pollinated: Rice, bean
- Cross pollinated: Maize, cauliflower
- Vegetatively propagated: Garlic, banana

Based on conservation strategy

- Orthodox crops: Rice, chili pepper
- Recalcitrant crops: Coffee, mango, citrus
- Seed less crops: Banana, taro

Based on the economic values

- Cereals
- Millets
- Pulses
- Vegetables
- Fruits
- Fibers
- Oil seeds
- Spices
- Beverages

Unit and major activities

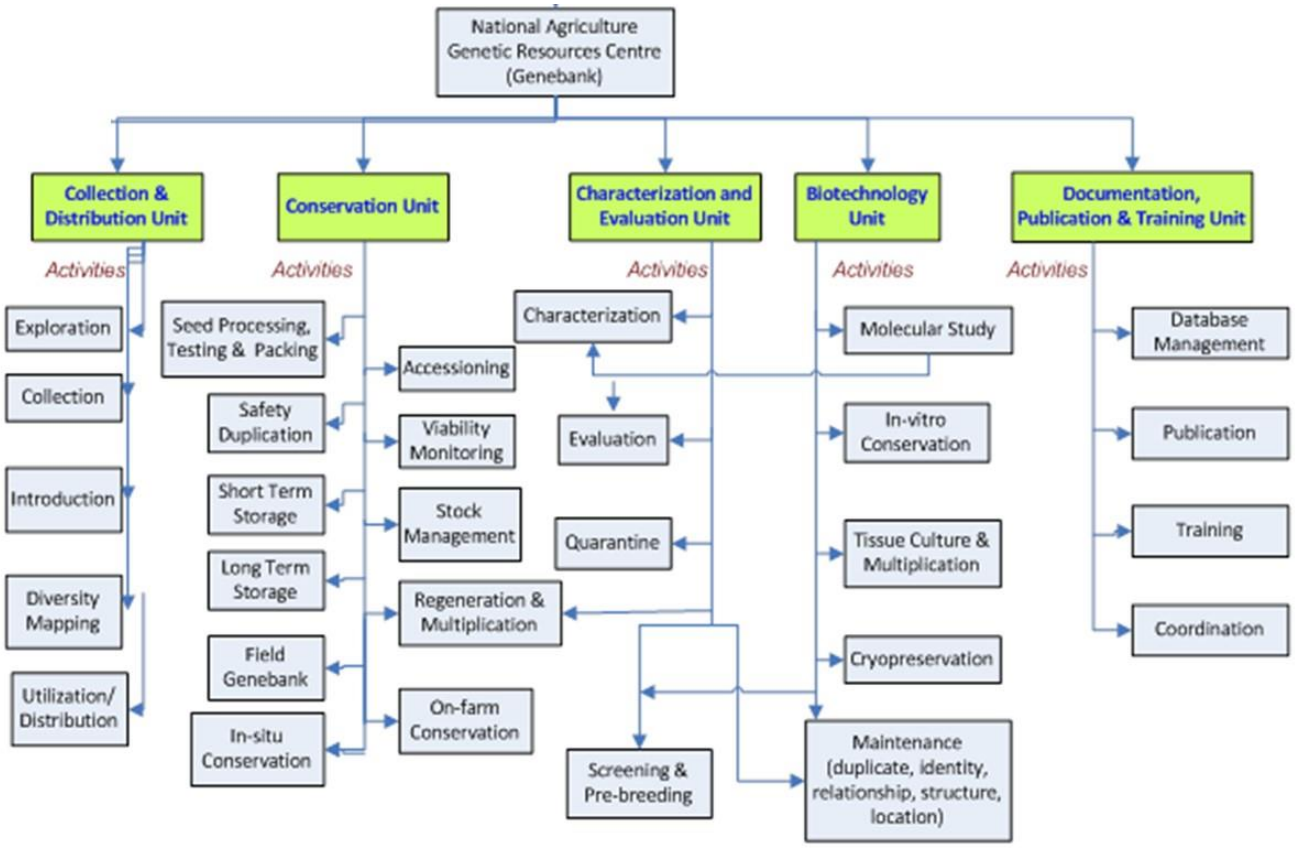

Figure 3. Working unit under National Genebank along with activities.

Exploration and collection

- Exploration and collection mission may be site (area) specific, crop specific (single crop), trait specific or general (broad based or multi-crop)
- Explore potential sites, diversity rich farmers, gaps in collections, list of potential local genetic resources (landraces) by:
  - Literature review
  - Gaps analysis
  - GIS analysis
  - Study previous collections in the Genebank
  - Interaction with NARC's scientists, DADO and ADC
  - Interview with progressive farmers, Community Seed Bank Committee, VDC, Local seed suppliers, Local NGOs and key personnel
- Develop diversity map (site specific or crop specific)
- Be familiar with target crops, target areas, time and duration, time of local hat-bazaar
- Unit of collection (sampling site) may be based on village, VDC, types of land (Khet, Bari, Pakho), caste of people, season of crop growing (winter, summer), altitudinal variation (foothill, mid hill,

hilltop), name of landraces or use values. Remember, genetic diversity within a species is strongly correlated with environmental dissimilarity

- Identify target population: Mendelian population based on the meterological, topographical, pedological, biological and above point
- One collection per landrace per site.
- Sample from different farmers (if the landraces are same) per village or per site (treat farmer as a single plant)
- If collection is from the fields, sample from more than 50 plants visiting different farmer's fields for the same landrace within a site (check name of landrace given by farmers, study phenotypic similarity, discuss with farmers for their similarity and then decide them as a single collection)
- If collections are from farm store, sample from 5-20 farmers to make a collection in case of the same landrace within a site
- Collect the maximum genetic diversity available in species with a minimum sample possible
- Can consider either random (unbiased) sampling (all genetic variation) or biased (selective) sampling (particular phenotype) method. Random sampling may be walking across the field in the form of + or X and clustered sampling
- If possible collect fresh seeds and required amount so that multiplication may not be necessary
- Collect only economical plant species and do not collect non-agricultural genetic resources. Do not collect improved varieties (see the name list of released varieties). Explore and collect landraces, wild relatives of cultivated crop species and wild edible plants
- Try to collect from the fields (ie standing crops)
- Collect more number of individuals from out crossing species
- Sample size: For heterogeneous population: 100 plants x 50 seeds; For homogeneous population: 50 plants x 50 seeds. In general: 50-100 plants per site or samplings may be random from 30- 60 plants or 5-20 farmers
- Samples should be free of weeds, disease and insect pests
- Label samples properly and packed in suitable container (better to use cloth bags)
- If samples could not be identified, take photo (whole plant, inflorescences and seeds or fruits) and/ or herbarium
- List the name of important local genetic resources including wild edible plants and wild relatives of cultivated crop species that are not collected in this trip due to seed unavailability or difficult to get them

Trip pack (exploration and collection trip)

- Crop code
- Crop calendar
- Methodology for crop growing
- Descriptors
- Passport format
- Seed number and weight
- GPS
- Non –collected APGR list format
- Dot pen
- Note book
- Herbarium sheet
- Press mold

- Camera
- Seed pack
- Tag/label
- Site map
- GB diversity kits
- Documents (name list of landraces, exploration and collection guidelines, crop dictionary,
- Crop name list and its breeding
- Step wise activity
- Collections target: Seeds, fruits, vegetative parts, passport data, not-collected list, information, photo, herbarium

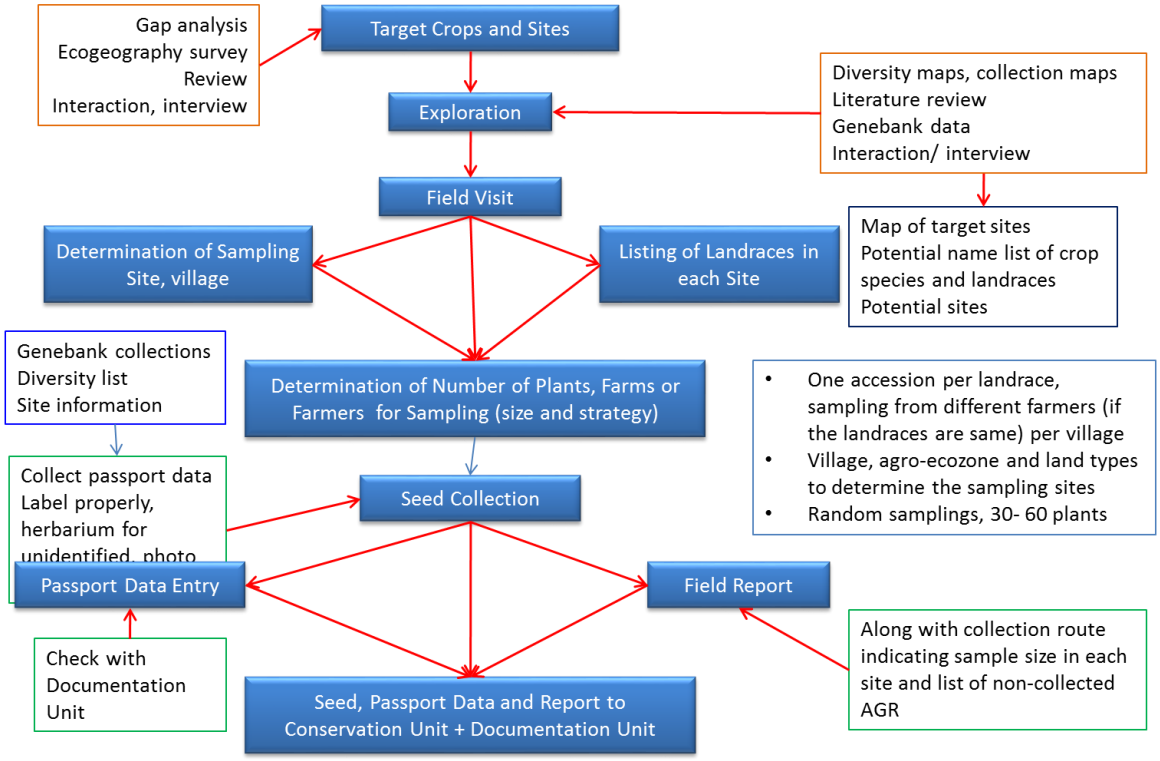

Figure 4. Steps for exploration and collection of AGR.

Table 3. Name list of unique/ important local genetic resources not collected in this trip and wild edible plants and wild relatives of cultivated crop species

District: Location/ VDC:

SN	Crop	Landraces (in Nepali)	Location	Collection time	SN	Crop	Wild edible plant/ wild relatives (in Nepali)	Location	Collection time

Information collection and data entry

- Fill passport completely
- Do not write just local in local name field. There should be some form of name for each landrace. If there is no name, then leave field empty
- Check the spelling in case of roman words

- Follow standard format, style and coding
- Initials of collector name followed by sequential number can be used for collection number (eg BK55)
- Use hyphen (-) for missing data
- Provide authority for the species and subspecies names
- Do not provide space or hyphen between abbreviated letters (all abbreviated letters should be capital) and number (eg NGR0435)
- If a field allows multiple values, separate them by comma (,)
- Record date of collection (last field in the passport descriptors) following English calendar as DD/MM/YYYY. Missing data (MM or DD) should be indicated with double zero (00)
- Record harvest date of the sample for which you are going to collect in Nepal calendar as YYYY/MM/DD
- Use initial uppercase letter for genus and all words of common crop name
- Follow Decimal degrees format (6 digits after decimal point) for latitude (2 digits before decimal point, DD.DDDDDD) and longitude (3 digits before decimal point, DDD.DDDDDD) eg latitude = , longitude =
- Georeferencing can be determined by GPS, from map, gazetteer or software
- Type landrace name in Nepali
- Enter data in Excel Template (available from Surendra and Joshi)
- Minimize error during data entry, check data yourself and give to Surendra for data verification
- Data format, style must be uniform
- Explore the public areas where vegetatively propagated crops and crops with recalcitrant seeds are being maintained. List the species in such area which can be considered as Field Genebank

Crop Classification: Taxonomy

- Family Genus Species
- Sub-species Cultivar (variety/ landraces)
- Accession (collection/ genotype/ population)
- Binomial name English name
- Nepali name Local name (do not translate) Parentage

For Identification and validation of Taxon names

- National Herbarium and Plant Laboratories, Godavari
- Department of Plant Resources, Thapathali
- Department of Agriculture, Hariharbhawan
- Natural History Museum, TU, Soyambu
- National Genebank, Khumaltar
- Books, Web sites, Key personnel, Discussion with farmers
- Links to sites where single taxa can be checked:
  - GRIN taxonomy: http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl?
  - Mansfeld catalogue: http://mansfeld.ipk-gatersleben.de/mansfeld/Query.htm
  - IPNI: http://www.ipni.org/ipni/query_ipni.html
- Links to the taxonomic nomenclature checker, a tool that allows to check whole lists of names against the GRIN taxonomy and the Mansfeld catalogue:
  - http://pgrdoc.ipgri.cgiar.org/taxcheck/grin/index.html
  - http://pgrdoc.ipgri.cgiar.org/taxcheck/mansfeld/index.html

Table 4. Passport format (English language)

Genebank-NARC, Khumaltar, PO Box 3055, Kathmandu. Tel: 01 500 3331, 500 3125. www.genebank-narc.gov.np

Passport Descriptors for Collection of Agricultural Genetic Resources

A. SAMPLE IDENTIFICATION
Collection /Donor number:
Crop (English name):
बाली (नेपाली नाम):
बाली (स्थानिय नाम):
Name of cultivar (in Nepali and local language with meaning):

Genus:
Species:
Subspecies/ var:
Parentage:

B. COLLECTING SITE
Farmer's or Donor's name:

I. General
District: VDC:
Ward: Village/Tole:
Distance (from VDC office):
Nearest market/ famous place:
Latitude (N):
Longitude (E):
Altitude (m):

II. Collection source (circle one)
1. Wild 2. Farmland
3. Farm store 4. Kitchen garden
5. Village market 6. Commercial market
7. Institute (name) 8. Other (specify)

III. Cultivating domain (circle one)
1. Mountain 2. High hill 3. Mid hill
4. Foot hill 5. Tarai and Inner Tarai

IV. Collection/ growing site (circle one)
1. Sloppy 2. Swampy land 3. Plain
4. Terrace 5. River basin 6. Other (specify)

V. Associated wild, weedy and crops species (specify):

C. CHARACTERIZATION AND MANAGEMENT
Sowing month (Nepali):
Harvest date of this sample in Nepali Calendar (YYYY/MM):
Usage (specify):
Important traits or reason of growing:

Disease & insect pest in field and store (specify):

D. SAMPLE
I. Status of sample (circle one)
1. Landrace 2. Cultivar (advanced/ improved)
3. Wild 4. Weedy 5. Breeder's line
6. Other (specify)

II. Original source (circle one and give name)
1. Own 2. Local 3. Market
4. Institute 5. Other (specify)

III. When it is introduced & from where?

IV. Frequency (circle one)
1. Widely cultivated 2. Localized 3. Rare

V. Population variability (circle one)
1. Uniform 2. Not uniform 3. Mix type

VI. Sampling method (circle one)
1. Bulk 2. Random 3. Selective

VII. Number of plants or farmers sampled:

VIII. Quantity of material (number of seeds, fruits or wt /sample):

IX. Type of sample (circle one)
1. Vegetative 2. Seed
3. Both 4. Fruit

X. Herbarium sample: 1. Yes 2. No

XI. Photo: 1. Yes 2. No

XII. Cultural practices
1. Irrigated 1. Yes 2. No
2. Transplanted 1. Yes 2. No
3. High inputs 1. Yes 2. No
4. Others (specify):

E. OTHER OBSERVATIONS & COMMENTS:

Collector's name & institute:

Date of collection (English calendar as DD/MM/YYYY):

Table 5. Passport format (Nepali language)

जिन बैंक, नार्क, खुमलटार, पोष्ट बक्स ३०५५, काठमाण्डौं. फोन: ०१ ५०० ३३३१, ५०० ३१२५. www.genebank-narc.gov.np

कृषि आनुबंशिक स्रोत सङ्कलन पासपोर्ट फारम

क. नमुनाको परिचय
सङ्कलन वा दाताको नं:
बाली (Crop):
बाली (स्थानिय नाम):
जाति (Genus):
प्रजाति (Species):
उपप्रजाति (Subspecies):
पूर्ख्यौंलि (Parentage):
जातको नाम (नेपाली तथा स्थानिय भाषामा) र अर्थ:

ख. सङ्कलन स्थान
कृषक वा दाताको नाम:

I. साधारण
जिल्ला: गा.वि.स.:
वार्ड नं: गाउँ:
गा.वि.स. देखिको दुरी:
नजिकको बजार वा प्रसिद्ध ठाउँ:
सङ्कलन स्थानको अक्षांस (उ):
सङ्कलन स्थानको देशान्तर (पू):
सङ्कलन स्थानको उचाई (मि):

II. सङ्कलन श्रोत स्थान (गोलो लगाउनुस्)
१. जङ्गली २. कृषि जमिन ३. भण्डारण ४. घर वगैचा
५. गाउँको बजार ६. ब्यापारिक बजार ७. सस्था
८. अन्य (कुनै भए लेख्नुस्)

III. खेती गरिने क्षेत्र (गोलो लगाउनुस्)
१. उच्च पर्वत २. उच्च पहाड ३. मध्य पहाड
४. वेंसी ५. तराई तथा भित्री मधेश

IV. संकलित वा उत्पादित क्षेत्रको अवस्था (गोलो लगाउनुस्)
१. भिरालो २. दलदल ३. समथल ४. उवड खाबड
५. नदि-किनार ६. अन्य (कुनै भए लेख्नुस्)

V. बालीसङ्ग फिल्डमा संलग्न झारपात, प्रजातिहरु (उल्लेख गर्नुस्):

ग. जातको गुणहरु तथा व्यवस्थापन
बाली रोप्ने महिना:
संकलित बाली भित्र्याएको साल र महिना:
प्रयोग:

महत्वपूर्ण गुणहरु:

रोग तथा किराहरु (फिल्ड र भण्डारमा):

घ. सङ्कलित नमुना
I. नमुनाको अवस्था (गोलो लगाउनुस्)
१. स्थानिय जात २. उन्नत जात ३. जङ्गली
४. झारपात ५. प्रजनन् ६. अन्य (कुनै भए उल्लेख गर्नुस्)

II. सङ्कलित जातको स्रोत (गोलो लगाउनुस् र नाम लेख्नुस्)
१. आफ्नै २. स्थानिय ३. बजार ४. संस्था
५. अन्य (उल्लेख गर्नुस्)

III. कहिले र कहाँबाट ल्याइएको:

IV. सङ्कलित जातको अवस्था
१. धेरै ठाउँमा खेती गरिने २. थोरै ठाउँमा खेती गरिने
३. लोपोन्मुख

V. सङ्कलित जातमा विविधता
१. एकैनास २. एकैनास नभएको ३. मिश्रित

VI. नमुना संकलन तरिका (गोलो लगाउनुस्)
१. मिश्रित २. छानेर ३. हचुवा

VII. नमुना संकलनमा संलग्न बिरुवा वा कृषकको संख्या:

VIII. सङ्कलित बस्तुको परिमाण (बीउ वा बिरुवाको संख्या वा तौल प्रति नमुना):

IX. नमुनाको प्रकार (गोलो लगाउनुस)
१. वानस्पतिक २. बीउ ३. दुबै ४. फल

X. हर्बेरियम् (बिरुवा वा बिरुवाको अङ्ग) को नमुना:
१. छ २. छैन

XI. फोटो लिएको: १. छ २. छैन

XII. खेती गरिने तरिका:
१. सिंचित खेती १. छ २. छैन
२. रोप्ने वा सार्ने १. छ २. छैन
३. उच्च प्रविधि खेती १. छ २. छैन
४. अन्य (उल्लेख गर्नुस्):

ङ. अन्य कुनै अवलोकन तथा सुझावहरु :

संकलनकर्ताको नाम र संस्था:

सङ्कलन मिति (YYYY/MM/DD):

Table 6. Brief Passport Descriptors for Agricultural Genetic Resources available in the Research and Development Organizations

Genebank-NARC, Khumaltar, PO Box 3055, Kathmandu. Tel: 01 500 3331, 500 3125. www.genebank-narc.gov.np

Brief Passport Descriptors for Agricultural Genetic Resources available in the Research and Development Organizations

Crop name: Institute/organization:

Institute address:

SN	Genotype		Origin/ Source	Type	Parentage/ Cross	Breeder/ Collector	Seeding time	Date of harvest	Amt, g or n	Resistance or susceptible to biotic & abiotic factors	Quality or other important traits	Cultivating domain	Remarks/ others
	Number	Name											

- Origin/ source: Name of country or location from where it is introduced or collected. Type: Indicate whether it is released variety, landrace, breeding line, wild or inbred or any other (specify). Date (year) of harvest: Date in which this sample was harvested. Amt: Amount of sample. Cultivating domain: Indicate where it is commonly grown, ie Tarai, Foot Hill, Mid Hill, High Hill or Lek or any other (specify)
- If the sample is your collection, then use collection passport descriptors form (downloadable from www.genebank-narc.gov.np). Genebank also requests to send characterization, evaluation data, photo and other information of each genotype (if any) via email (nagrc2010@yahoo.com or joshisbalak@yahoo.com).

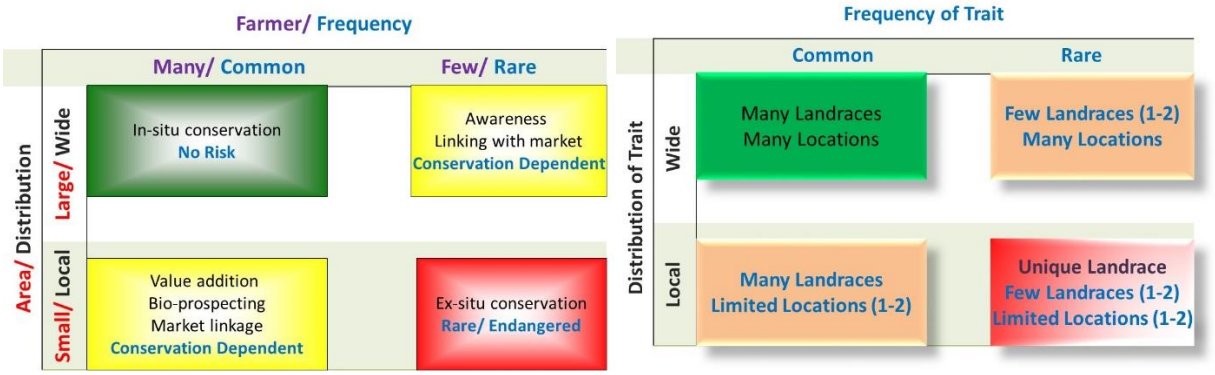

Figure 5**.** Method of determining the status of landraces (left) and identifying unique landrace based on the trait distribution analysis (right).

Plant quarantine

- All germplasm entering in the NAGRC should be passed from the technical committee.
- Need to inspect all germplasm for diseases and insects.
- Remove all infected germplasm and clean with appropriate chemicals.
- Introduced germplasm should be checked more rigorously in collaboration with National Plant Quarantine Program, Hariharbhawan.
- Destroy infected germplasm
- If there are presence of diseases and insects, need to grow in confined areas eg glass house or ICU.
- These are applicable to all kinds of APGRs

Germplasm registration

- There will be three number for each collection, registration number, collection number and accession number.
- Each germplasm with passport information should be registered after checking by the technical committee.
- Registered number will be given separately to orthodox and non-orthodox types of germplasm.
- This number will be B for breeding lines, L for landraces, I for introduced in combination with O for orthodox and R for non-orthodox followed by sequential number in each year (initial year of each fiscal year in Nepali calendar) eg BO-001, BR-002, etc.
- Collection number will be used temporarily to handle each collection before getting accession number. After assigning accession number (passport number or permanent number), this accession number will be used for handling the collection.
- Germplasm can get accession number only after meeting the standard of NAGRC.

Labelling accessions and locations

- Collection number (during processing in the Genebank, before getting accession number)
- Accession number is prefixed by
  - NGRC… for orthodox collections, which is stored in Seed Bank
  - NGRV… for non-orthodox collections which is maintained in Filed Genebank and/or Tissue Bank
- Basic information for labeling accession during growing, exchange, etc
  - Collection district
  - Local name
  - Crop name
  - Accession number
- Label in orthodox seed container

Labeling locations

- Door Numbering (GB-101… for first floor, GB-201… for second floor)
- Room labeling (BCR-I, BCR-II, ACR-I, ACR-II)
- Rack Numbering (A, B, C, …)
- Shelf numbering (I, II, III, …)
- Tray Numbering (1, 2, 3, …)
- Container numbering (NGRC-00010, NGRC-00011, …)

Germplasm processing

- Any germplasm with passport information will be checked by technical committee.
- Gerplasm photo will be taken.
- Register germplasm
- Clean seeds
- Check for seed amount
- If amount is enough, test germination
- If seed amount is not enough and poor germination, multiply them
- Provide accession number to entry that meet seed amount the germination percentage
- Characterize seeds and take photos
- Dry seeds, check moisture content, weigh seeds, label container
- Put seeds in plastic bottle for medium term storage and aluminum foil for long term storage
- Put small pouch of silica gel and seal container
- Store in proper location
- Update stock management database and passport database
- Specific requirements and further process are given in following figure.

Germination test

Table 7. Germination test sheet.

LabNo	Crop	Accession	Date Test	Subtr / Temp	Seed Tested, n	Final Count, n				Remarks
						Count Date	Grmtd / Abn	Hard	Dead	

Note: Subtr: Subtratum; Temp: Temperature; Abn: Abnormal; Grmtd: Germinated

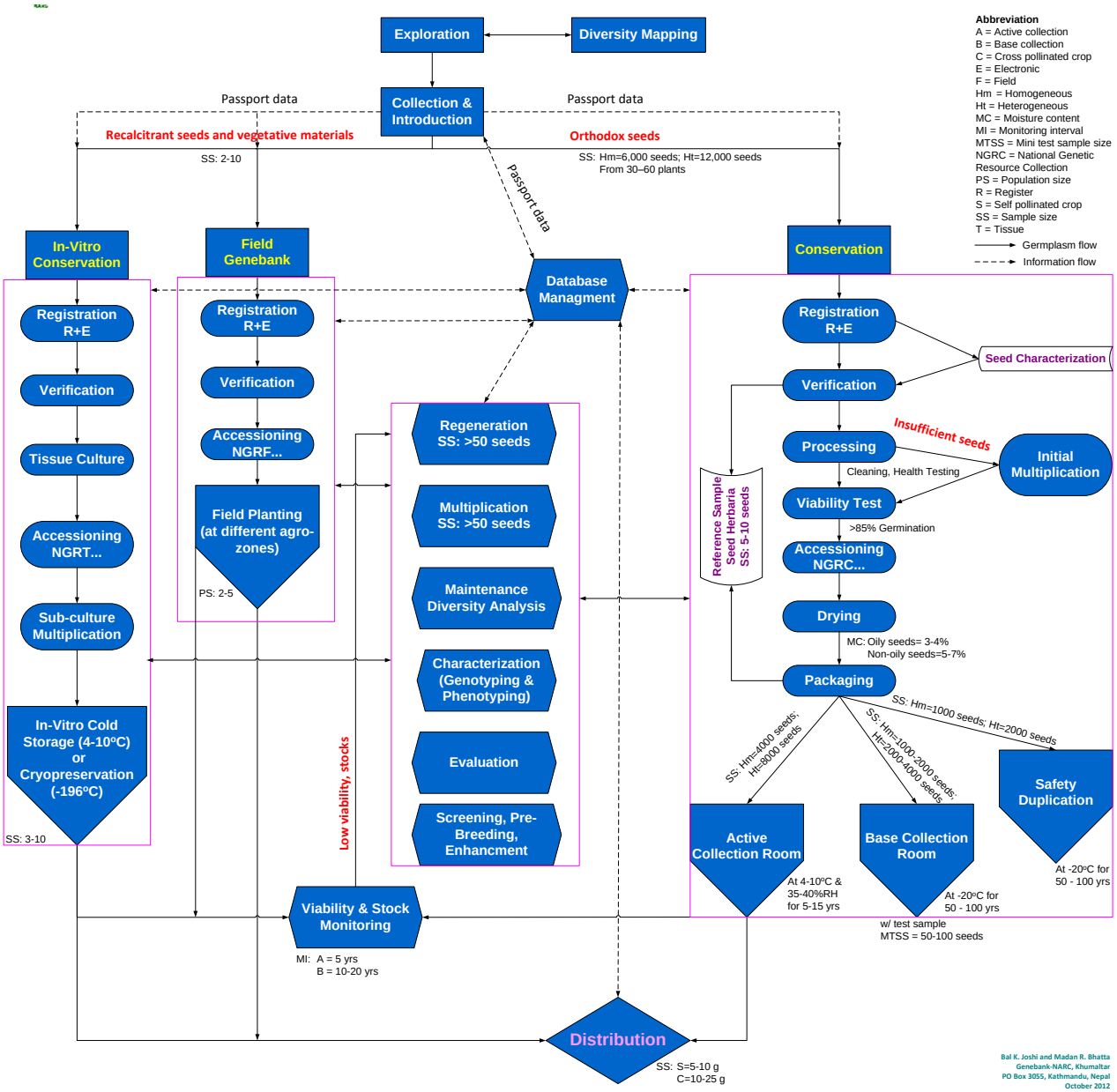

Figure 6. Stepwise activities for agricultural genetic resources management in NAGRC.

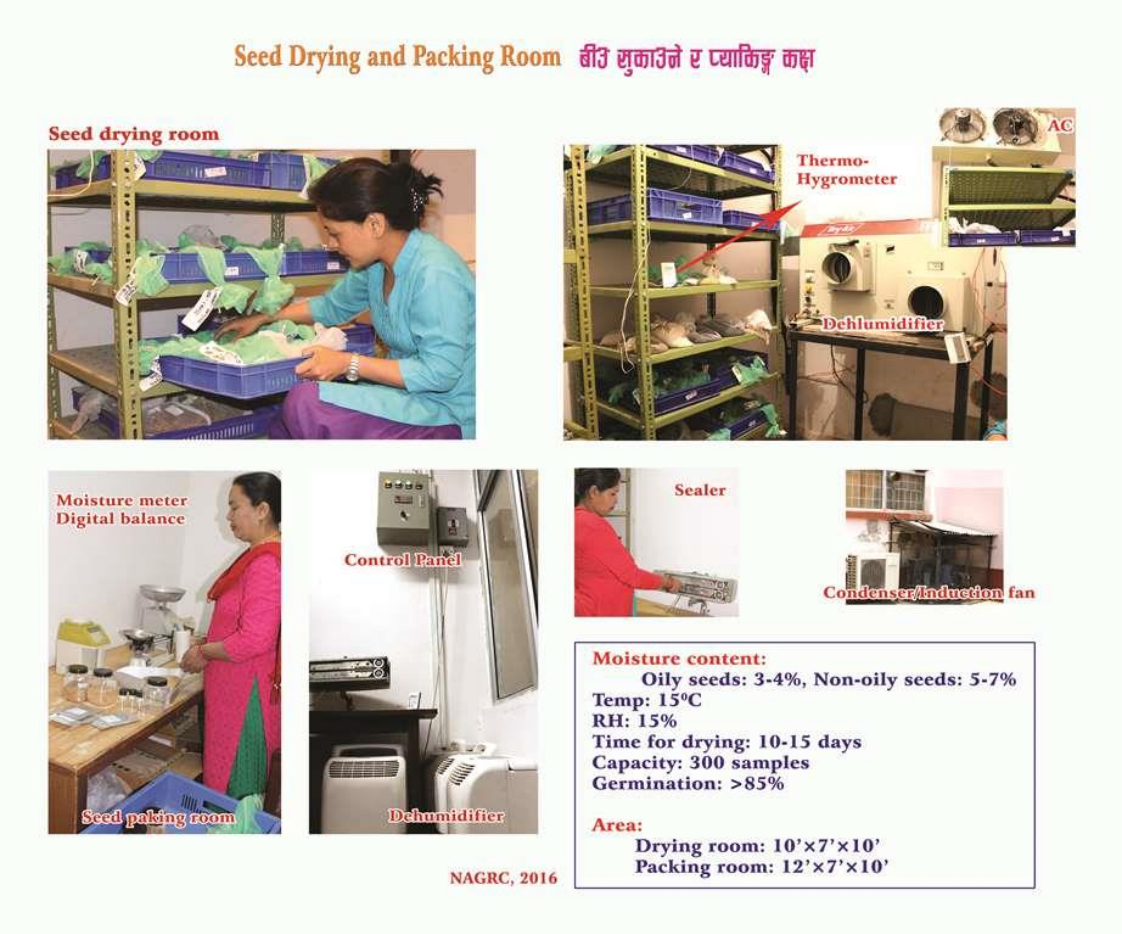

Figure 7. Functional parts, process and details of seed drying and packing room.

Germplasm storage

- Handle samples by collection number before assigning accession number, otherwise use always accession number
- Store labelled container in right room, rack, shelf and tray of base collection and active collection room
- Store base collection in long term storage at –20^{o}C
- Store distribution samples in medium term storage at 4-10^{o}C
- Prepare seed herbaria and test sample of each accession and store in appropriate location
- Maintain 2-10 plantlets of non-orthodox type of crops in test tube in Tissue bank
- Sub culture at certain interval
- Retard growth rate of tissue culture plants either keeping in cold temperature or providing less nutrient
- Maintain 2-10 plants of non-orthodox type of crops in field genebank
- Store planting materials of annual non-orthodox types of crops in short term storage.
- Provide minimum inputs and let them interact with environments
- Extract DNA and store in centrifuge tubes in deep fridge.

Figure 8. Functional parts, process and details of long term storage room.

Germplasm monitoring

- Monitor long term storage at 10 years interval, medium term storage at 5 years interval.
- Check short term storage, DNA bank and tissue bank regularly
- Monitor for seed viability and amount
- Check storages, equipment, and other physical items
- Monitor temperature and relative humidity

Figure 9. Functional parts, process and details of medium term storage room.

Sub genebanks and their working modalities

Seed Bank

Orthodox seeds (those seeds which can be dried to low moisture content and tolerate freezing temperatures such as rice, maize, beans are stored in controlled environment for medium (active collection) and long (base collection) terms, and such type of storage is called seed bank. Active collections also called working collections are the collections stored at 5 to 10°C with a relative humidity of 30 to 40% for 5 to 10 years. This is a medium term storage system with an accession size of about 1 to 5 kg seeds of each crop. Core collections are used to characterize, evaluate, multiply and distribute. Base collections are the collections stored at (minus) -20°C for 50 to 100 years. Seed moisture is lowered to 3 to 7%. Size of accession is about 2000 seeds for self-pollinated crops and 4000 seeds for each cross pollinated crop.

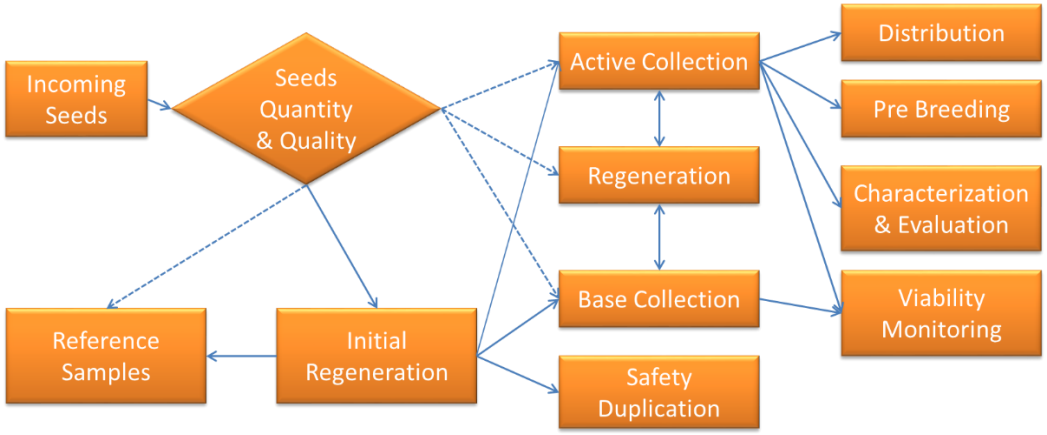

Figure 10. General system of seed storage (following two layers system).

Tissue Bank (In-vitro conservation)

In-vitro conservation is very effective for long term storage and economically applicable to those crop species, which either produce Recalcitrant seeds or non-orthodox seeds are those seeds that can be dried below a relatively critical moisture content and could not tolerate freezing temperatures. By and large, these seeds cannot resist the effects of drying or temperatures less than 10°C; thus, they cannot be stored for long periods like orthodox seeds because they can lose their viability. Plants that produce recalcitrant seeds include mango, litchi, citrus and many horticultural trees. Such type of materials can be multiplied rapidly and can easily be kept free from viruses, insect parasites, fungi or bacteria. Cultures can be kept in test tubes on nutrient medium for indefinite periods of time by transferring at regular interval.

Target and justification

1. Development of Tissue Bank and Cryobank
2. Conservation of plantlets of vegetatively propagated crop species and species with recalcitrant seeds, through in-vitro (shoot tip) culture in cold storage (Long term conservation)
3. Cryopreservation of vegetatively propagated crop species and species with recalcitrant seeds through shoot tip culture (Long term conservation)
4. Multiplication and distribution of in-vitro cultured plantlets
5. Very effective for conserving those crop species, which either produce recalcitrant seeds or does not produce any seeds
6. Plantlets can be kept in test tubes on nutrient medium for indefinite periods of time by transferring at regular interval
7. Requirement of little space for preservation of a large number of crop landraces
8. Maintenance of the plantlets in an environment free of pests or pathogens. Plantlets can easily be kept free from viruses, insect parasites, fungi or bacteria
9. Protection against dangers of natural environmental hazards
10. Availability of nucleus stock to multiply a large number of plants rapidly
11. Minimizing the obstacles generally imposed by quarantine systems on the movement of live plants

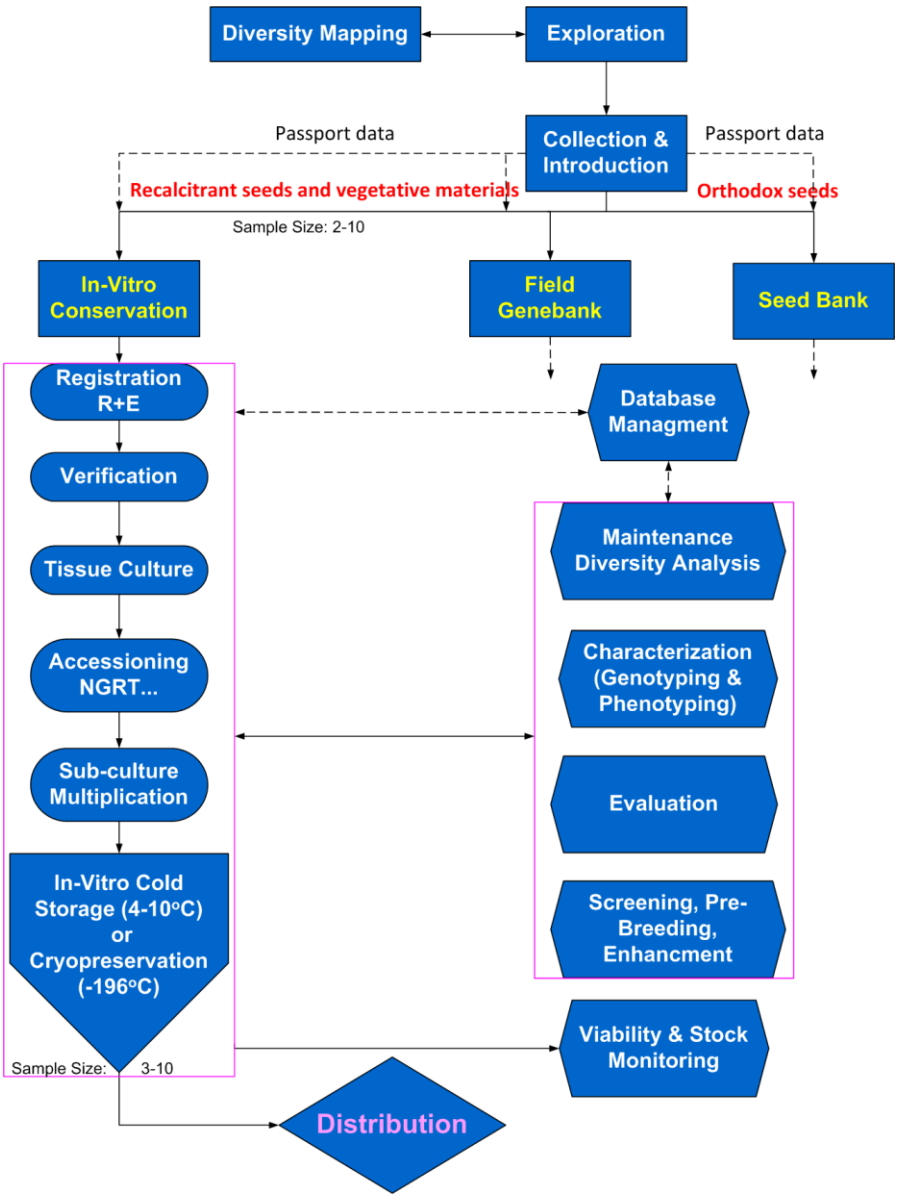

Figure 11. Stepwise activities in Tissue Bank.

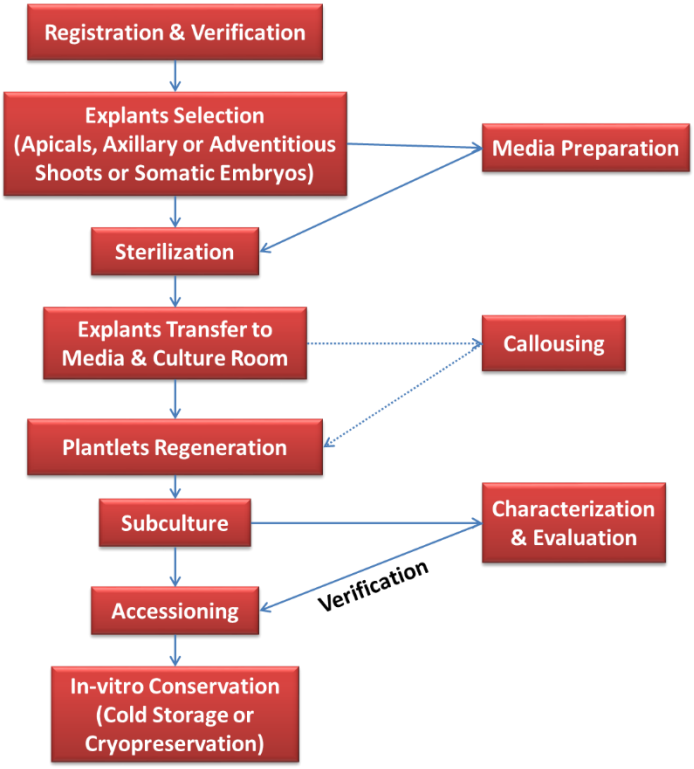

Figure 12. General steps in in-vitro conservation.

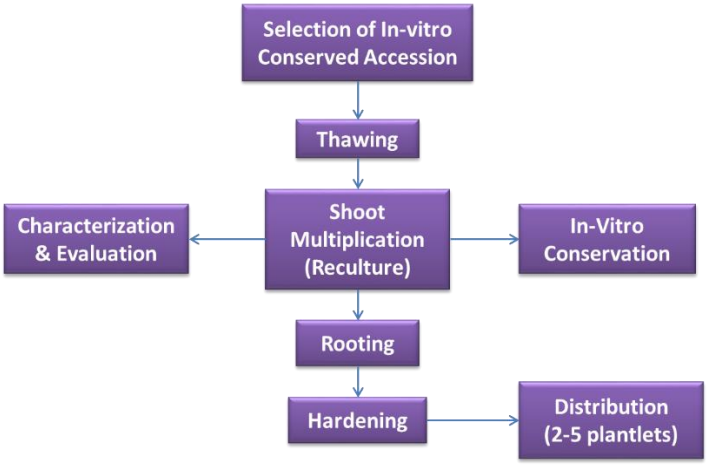

Figure 13. General steps for multiplication and distribution of tissue cultured plantlets.

Figure 14. Functional parts, process and details of medium term storage room.

Lab Protocol 1. Shoot tip culture

Media preparation

- MS+2mg/L NAA+4mg/L BAP+0.5 mg/L Kinetin
- Sucrose: 3%
- Agarose: 0.8%
- pH: 5.8
- Autoclave at 15 psi and 121^{o}C for 30 min
- Add 0.05% Plant preservative mixture (PPM) into media after autoclave prior to pouring into test tubes.

Sterilization

Step 1: Surface sterilization with Tween20 for 30 min and washing with running water
Step 2: Surface sterilization of explant with 70% ethanol for 10 min
Step 2: Surface sterilization of explant with 2% Sodium hypochloride for 10 min
Step 3: UV exposure to whole setup (media + explant) for ≥ 30 min
Step 4: 0.5% Plant preservative mixture (PPM) for ≥ 30 min

Explant size
1-2 cm meristem, based on nature of plant

DNA Bank

DNA Bank, as a part of the Genebank, is a repository of DNA, usually for research. The DNA Bank is to conserve the different kinds of DNA extracted from the genetic resources (rice, wheat, chayote, maize, buckwheat, etc) in tubes at -40^{o}C. DNA conserved in DNA Bank is used for studies and research at molecular levels. DNA banking is the secure, long term storage of an individual's genetic material (de Vicente 2006).

Target

1. Identification and duplication elimination (maintenance)
2. Diversity analysis, partition of variation (structure), formation of active collections and collection strategies (gap identification)
3. Development of DNA fingerprints of indigenous crop species
4. Screening of accessions using DNA markers
5. Mapping and tagging of genes and QTLs
6. Genotypic database development
7. Collaborative marker assisted selection and linkage map development

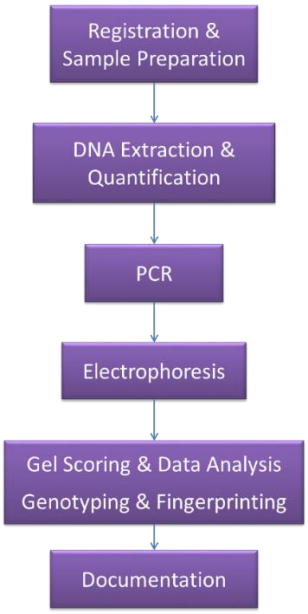

Figure 15. General steps in Molecular Lab.

Lab protocol 2. DNA extraction

1. Collect sample of size 100 to 150 mg and surface sterilize with 70% ethanol
2. Wash leaf sample with distill water twice and dry with tissue paper
3. Chop into pieces and place into 2 ml size eppendorf tube along with bead
4. Grind the samples with tissue lyser for 6 min (with two intervals of 3 min each)
5. Add 600 µl freshly prepared CTAB, pre heated at 65^{0}C and vortex the samples for 20 sec to mix whole macerated samples
6. Place the samples at water bath (65^{0}C) for 1 hr

7. Add 600 µl of 24:1 (Chloroform: Iso-amyl alcohol) to the preheated sample and gently mix by inverting 150 times
8. Centrifuge at 15000 rpm for 15 min
9. Pipette out supernatant approx. 500 µl into separate eppendorf tube (1.5 ml)
10. Add 500 µl of 24:1 (Chloroform: Iso-amyl alcohol) to the supernatant and gently mix by inverting 150 times
11. Centrifuge at 15000 rpm for 5 min
12. Repeat step 9 to 11 (optional)
13. Pipette out supernatant approx. 500 µl into separate eppendorf tube (1.5 ml)
14. Add Chilled absolute Ethanol and watch for precipitation of DNA
15. If precipitation do not occur place the sample at -20^{0}C for 15-30 min
16. Centrifuge the sample at 15000 rpm for 2 min for pellet formation
17. Wash the pellet twice with 70% ethanol
18. Air dry the sample
19. Add 50 µl TE buffer and store at -20^{0}C

Lab protocl3. PCR run
For 15 µl of reaction volume

- DNA: 50-100 ng (2 µl)
- Primer: 6 picomole for RAPD (0.6 µl), 15 picomole (1.5 µl) for SSR (Forward and Reverse)
- Master mix : 7.5 µl
- Water: necessary amount to make 15 µl

Reaction Cycle

- 94^{0}C-5 min
- 94^{0}C – 30 sec
- 36^{0}C- 45 sec (Temperature depends upon primer annealing temperature)
- 72^{0}C-1 min 30 sec
- Repeat step 2 through 4 for 40 cycle for RAPD, 30 cycle for SSR
- 72^{0}C- 10 min
- 4^{0}C- holding

Lab protocol 4. Gel run

1. Prepare gel of 1% gel for RAPD markers (4 gm of agarose into 1X TAE to make 400 ml) and of 2.5 % gel for SSR markers (10 gm of agarose into 1X TAE to make 400 ml)
2. Heat the setup to melt the agarose
3. Pre cool with running tape water
4. Add 32 µl of Ethidium Bromide to 400 ml of gel and mix well
5. Pour the gel into gel tank (gel tank placed in level surface with comb)
6. Wait for one and half hr or more to set the gel
7. Remove the comb and place the setup into gel tank with TAE buffer
8. Load 12 µl of PCR mix (after PCR) into gel with 1kb and 100 bp ladder on each side of samples
9. Run the setup at 150 V for one and half hr
10. Take picture of gel

Field Genebank

Field genebank is an essential for those crop species having recalcitrant seeds for conservation, characterization, evaluation and utilization. In addition to such type of crop, vegetatively propagated and apomictic crop species are also conserved. Climatically suitable crop species should be identified for a particular site. Instead of allocating separate field, government's farm, around the road and office buildings, community farms, botanical garden, culturally protected and heritage sites can be used. There are about 286 accessions of different crops in Khumal field genebank. NARC has started establishing sub field genebanks in many research stations across the country (**Figure** 3). As a sub field genebank, there are 29 accessions of taro in Agricultural Research Station (ARS), Pokhara; 54 mango in RARS (Regional ARS), Tarahara and 61 ginger in ARS, Kapurkot (Joshi 2014b).

Figure 16**.** Country map showing NARC stations where Field Genebank is planned to establish.

General Guidelines for establishing and maintaining field genebank

- Allocate some space in the farm for Field Genebank. Space may be around office buildings, in front of the office buildings, around the boarder of farm or separate one. Label these areas as Field Genebank.
- Select a site with environment and soil type best suited for the species.
- List the crop species and varieties that are vegetatively propagated and produce recalcitrant seeds, available in your areas (can cover larger areas). Group discussion may be the right approach to list the available local genetic resources.
- Give priority to endangered and local crop species.
- Collect the samples (propagating materials) from the farmers along with passport descriptors (available at www.genebank-narc.gov.np).
- Collect cultivated species, wild relatives of cultivated species and wild edible plants.

- Sample size for collections and maintenance in the Field Genebank may be 2 to 5 for larger size plants and 5 to 10 for small size plant per landrace or accession or genotype.
- Collect propagating materials from different plants, different farmers and different fields for each landrace or accession or genotype.
- Collect as much diversity as possible in a minimum samples and remove duplicates. Vegetative propagules and storage organs, such as rhizomes, tubers, bulbs, corms or cuttings are the same genotype as the mother plant. Therefore, vegetative collection need to be more extensive than seed collections in terms of the numbers of plants sampled in any one area.
- Samples should be free of weeds, disease and pests.
- Plants can be maintained as hedge rows and living fences in the office/ farm.
- Local genetic resources can be annually added to the Field Genebank.
- Duplicate field genebanks if possible, in more than one site or in an in-vitro genebank as a safety backup.
- Follow minimum cultural practices eg planting in less space (dense planting), providing minimum inputs, etc. Our objectives are to maintain them and provide to farmers and researchers. Can follow farmer's cultural practices. For annual crops, we need seasonally to grow and harvest and for perennial crops, we need to manage in the field.
- Characterize the accessions and if possible evaluate them.
- Send a copy of passport descriptors and characterization data to Genebank-NARC, Khumaltar. Also keep one copy of these data sets in your office.
- Genebank-NARC will provide a permanent number to each accession. All the future works will be base on this permanent number ie accessions number.
- Try to maintain diversity at species, genetic/ phenotypic, ecotypes/ adaptation and allelic levels. Even if we could maintain only one important local landrace, this will play a significant role in conservation and use and ultimately in food security.
- Consider propagation methods, selection of planting sites, planting procedures, cultivation practices, disease and pest management, harvest and storage of propagules, monitoring the genetic stability, rouging, labeling, protecting plants from biotic and abiotic stresses, characterization, evaluation and pre breeding works, etc.
- If you have already local genetic resources in the farm, turn them to Field Genebank. Old orchards in the public areas can also be turned to Field Genebank.
- Distribute plant germplasm conserved in the Field Genebank to farmers and researchers, maintaining the original stock.
- Field Genebank can also be extended to other offices (District Development Offices, Village Development Committee Offices), public areas, road sides, school areas, culturally protected areas (temple and other religious places), protected areas (National parks, Conservation areas, Wildlife reserves, Hunting reserves), world heritage sites, Ramsar sites, botanical gardens, zoological gardens, farms/parks, etc.
- Utilize both horizontal and vertical space.
- Collaborate with Genebank-NARC for exploration, collection and management of Field Genebank.

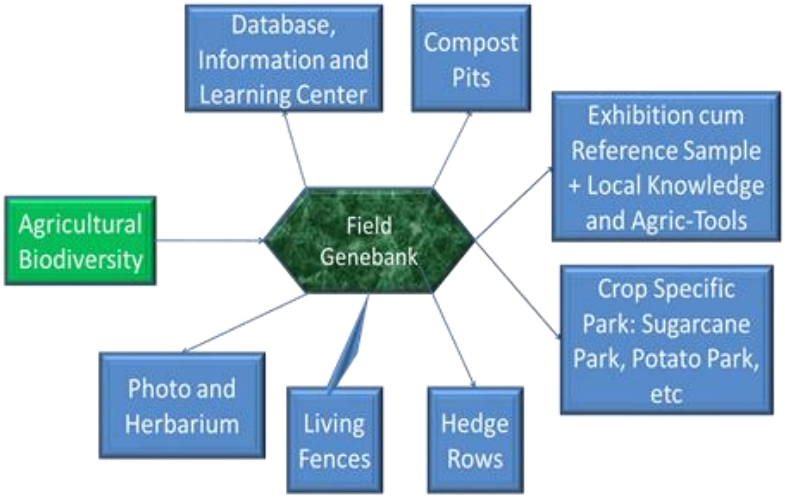

Figure 17. Components in Field Genebank.

Table 8. List of landraces/ accessions of crop species for display block in Khumaltar

Criteria for selecting accessions

- Unique, rare and endangered
- Local germplasm and some very new crop species
- Herb and short vine accessions
- Perennial and bushy type
- Vegetatively propagated
- More intraspecific diversity

Block	Crop	Nepali name	Landrace	Accession	Remarks
1.		Chyapi			
2.		Jaringo			
3.					
4.			Kalo anlu		
5.			Wild buckwheat		
6.			Rukh tamator		
7.					Unique seasonal
8.					Unique seasonal
9.					Unique seasonal
10.					
11.					
12.					
13.	Asparagus				
14.	Brinjal				
15.	Buckwheat		Bhate phaper		
16.	Cauliflower	Garve cauli			
17.	Chili pepper				
18.	Garlic				
19.	Garlic				
20.	Garlic		Bhote lasun		

21.	Ginger				
22.	Ground apple				
23.	Pepino				
24.	Proso millet				
25.	Strawberry				
26.	Sugarcane				
27.	Sweet potato				
28.	Taro		Hatti Pau		
29.	Taro		Dhude, Kalo Kaskalo		
30.	Tomato		Local tomato (yellow color)		
31.	Turmeric				
32.	Wild brinjal				

Table 9. List of landraces/ accessions of crop species for hedge row (conservation cum fencing)

Criteria

- Bushy, perennial
- Agricultural crops including crop wild relatives and wild edible plants
- Forage and fodder crops

SN	Crop	Nepali name	Landrace	Accession	Remarks
1.		Bihi			
2.					
3.	Cassava				
4.	Cotton				
5.	Mulberry				
6.		Siplikan			
7.					
8.					

Table 10. List of landraces/ accessions of crop species for Field Genebank in NAGRC, Khumaltar

Criteria

- Unique, rare and endangered
- Local germplasm and some very new crop species
- Perennial and bushy type
- Vegetatively propagated and recalcitrant crops
- Species representative
- Suitable in Kathmandu valley

SN	Crop	Nepali name	Landrace	Accession	Remarks
1.		Lapsi			
2.		Barro			
3.		Harro			
4.		Jamun			
5.		Timur			
6.					
7.					

8.	Apple				
9.	Apricot				
10.	Butter tree				
11.	Castor				
12.	Chayote				
13.	Cherry				
14.	Chestnut				
15.	Citron				
16.	Ginger				
17.	Grape				
18.	Guava				
19.	Large cardamom				
20.	Lemon				
21.	Lime				
22.	Myrobalan				
23.	Olive				
24.	Orange				
25.	Papaya				
26.	Peach				
27.	Pear				
28.	Persimmon				
29.	Plum				
30.	Pomegranate				
31.	Pumelo				
32.	Rough lemon				
33.	Sugarcane				
34.	Sweet almond				
35.	Sweet orange				
36.	Trifoliate				
37.	Turmeric				
38.	Walnut				
39.	Wood apple				
40.	Yam				

Community Genebank

Agricultural biodiversity can't be conserved without supporting farming communities, and conversely, farming communities can't be saved without saving agricultural biodiversity. Community Genebank is of two types, Community seed bank (CSB) and community field genebank (CFGB). As a part of conservation, NARC has been supporting on-farm conservation since 2001 by involving farmers and their genetic resources in research system. This resulted in the establishment of CSB in Kachorwa, Bara and Simariya, Sunsari. CSB is the system of conservation and utilization of local genetic resources, operated at local levels and run by the community (Joshi 2013). The purpose of CSB is to make available the seeds of all locally growing crop varieties to all farmers, which ultimately helps to conserve genetic resources in an evolutionary way along with associated traditional knowledge. Diversity fairs, Community Agro-Biodiversity Register (CABR), and diversity blocks are the major activities to collect and maintain the varieties in CSB. There are more than 115 community seed banks (**Figure** 4) in the country and Dalchoki CSB in Lalitpur is the first of its kind in Nepal established in 1994 (Joshi 2013). Field genebank at

community may be different types eg School Field GB, Community Mango Orchard, Village Level FGB, Crop specific parks, etc.

Table 11. Comparison between Genebank and Community Seed Bank

SN	Feature	CSB	Genebank
1	Environment of storage (Temp and RH)	Normal	Controlled
2	Diversity captured	Localized	National/ Global
3	Seed storage	Ordinary	Air tight
4	Seed moisture	Not determined	Determined and lowered
5	Uses of seeds	Direct production	Research, multiplication
6	Seed research and documentation	Minimum	Details
7	Storage period	1-2 years	More than 10 years
8	Seed distribution	Sell, exchange, loan (seed or money with seed)	Free distribution

Figure 18. Steps for establishing CSB.

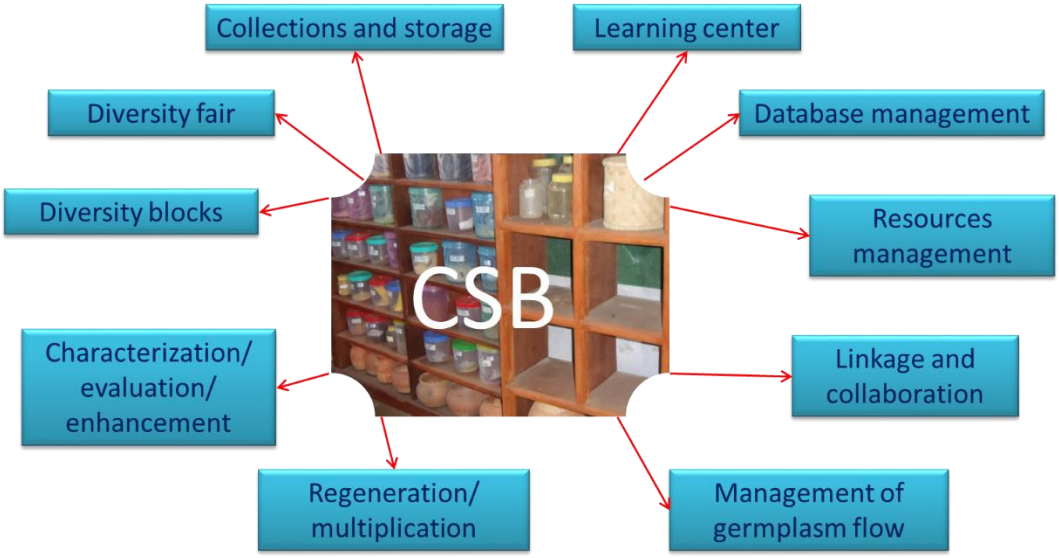

Figure 19. CSB activities and guidelines.

CSB management options

Banking

- Sale
- Exchange
- Seed loan
- Money along with seed loan
- Burrow
- Repository

Housing

- Reference samples
- Distribution samples
- Associated knowledge and traditional agri-tools
- Database: Agricultural biodiversity registers, CSB data (passport, characterization and distribution)
- Learning center

Landrace enhancement and conservation (LEC)

General Approaches

- Participatory Crop Improvement (Landrace enhancement, Landraces mixture and Landraces hybridization)
- Participatory Crop Conservation
- Farmers' network and exchange of seed and knowledge
- Data analysis and interpretation

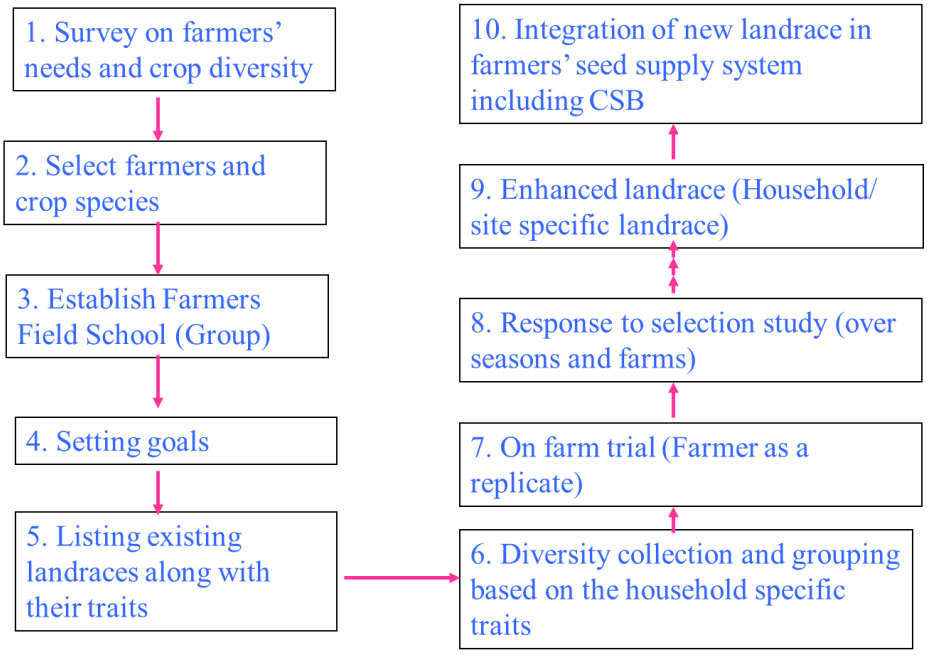

Figure 20. LEC step.

Household Genebank

Identification of agro-biodiversity rich farmers (also called custodian farmer) is the initial step to strengthen the Household Genebank (HGB). Farmers with Genebank mind have been identified and such farmers are maintaining crop genetic resources as seed bank and field genebank, collectively called Household Genebank. All genetic resources, in this system are maintained in their private land and house. Such farmer should be identified at least one in each agro-eco-zone and supported technically and financially.

Regeneration and multiplication

- Multiply if seeds are not enough following standard methodology.
- Collaborate with other research stations and community seed banks for regeneration and multiplication.
- Give suitable accessions to collaborators
- Record following field experimental methodology for each crops to regenerate, multiply, characterize and evaluate.
  - Plant spacing
  - Plot size
  - Plot spacing
  - Plot style
  - Required amount of seeds (@/ha)
  - 1000-seed weight, g
  - Seeding month
  - Harvesting month
  - Fertilizer
  - Seeding method
  - Irrigation

- Weeding
- Pollination

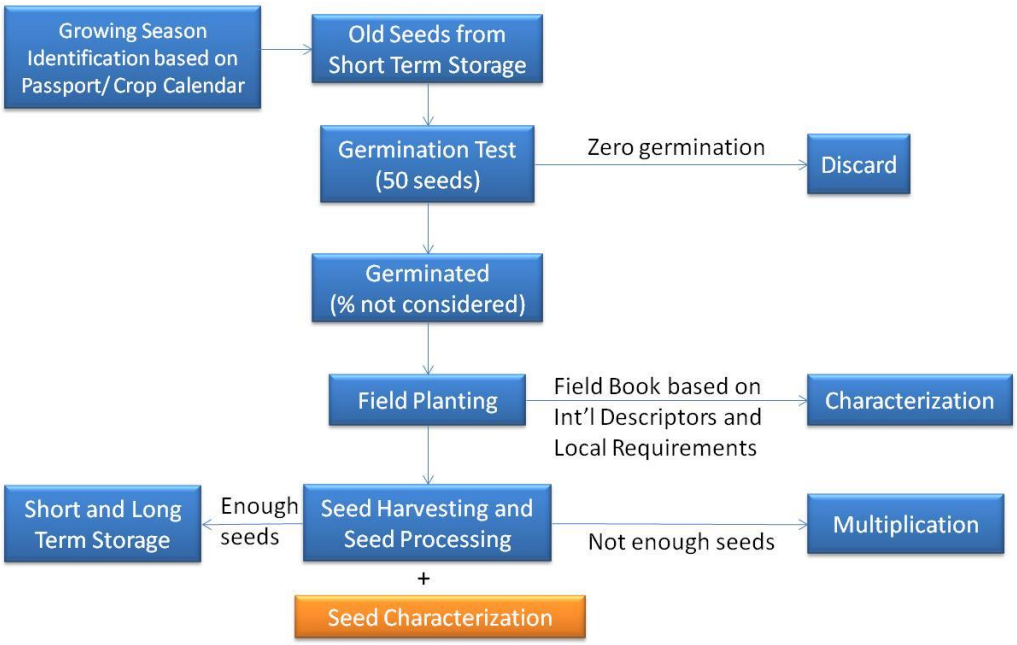

Figure 21. Steps followed during regenerating old collections.

Characterization and duplicates management

- Characterize each accessions based on the descriptors
- Both phenotypic and DNA markers need to use for characterization
- Enter data in Excel linking with accession number.
- Mention accession number, collection district and local name with characterization data.
- Describe methodology including site and year,
- Remove duplicates during collection, verification, regeneration, characterization and evaluation
- Consider both phenotypic and genotypic data to manage duplicates
- If there are duplicates, merge them

National Standard Crops Descriptors Abbreviations and Code

This is national standard abbreviation of descriptors (traits/characters) for crop characterization and evaluation. This is applicable to all working crop species in Nepal. Select abbreviation for any word from the phrases. N is number and write N if there is not written the word per or sign /. Do not write N if / is used for per. Add any other descriptors with suitable abbreviation.

Table 12. Code and abbreviation of phenotype based traits

SN	Character/ trait	Abbreviation
1.	Awn	Awn
2.	Awn color	AwnCl
3.	Color of inflorescence stalk	InflSkCl
4.	Color on the top of the kernel	TpKnCl
5.	Compactness of inflorescence	InflCom

SN	Character/ trait	Abbreviation
6.	Cotyledon (Seedling leaf) color	CoCl
7.	Date of emergence	DEm
8.	Date of first flowering	DFFl
9.	Date of first maturity	DFM
10.	Date to flowering	DFl
11.	Date to maturity	DM
12.	Degree of determination	DtmDg
13.	Dehulling	Dh
14.	Diseases	Dis
15.	Exerted length of panicle	PanExL
16.	Fertile spikelet number per panicle	FtlSpkN/Pan
17.	Fertile tiller number per hill	FtlTiN/Hl
18.	Flag leaf length of blade	FgLfBlL
19.	Flag leaf width of blade	FgLfBlW
20.	Flower abortion	FlAb
21.	Flower color	FlCl
22.	Flower morphology	FlMo
23.	Grain color	GrCl
24.	Grain length	GrL
25.	Grain shape	GrSh
26.	Grain surface	GrSf
27.	Grain uniformity	GrUn
28.	Grain width	GrW
29.	Grain yield per hill	GrYl/Hl
30.	Grain yield per plant	GrYl/Pl
31.	Grain yield per plot	GrYl/Pt
32.	Growth habit	GtHb
33.	Hill number per plot	HlN/Pt
34.	Hundred dehulled seed weight	HnDhSdWt
35.	Hundred grain weight	HnGrWt
36.	Hundred kernel weight	HnKnWt
37.	Immature seed edge color	ImSdEgCl
38.	Immature seed surface color	ImSdSfCl
39.	Inflorescence	Infl
40.	Insects	Ins
41.	Kernel coat color	KnCtCl
42.	Kernel length	KnL
43.	Kernel shape	KnSh
44.	Kernel size	KnSz
45.	Kernel surface	KnSf
46.	Kernel thickness	KnT
47.	Kernel uniformity	KnUn
48.	Kernel width	KnW
49.	Leaf blade length	LfBlL
50.	Leaf blade width	LfBlW
51.	Leaf color	LfCl
52.	Leaf flavor	LfFv
53.	Leaf margin color	LfMgCl
54.	Leaf number	LfN

SN	Character/ trait	Abbreviation
55.	Leaf pigmentation	LfPg
56.	Leaf sheath color	LfSthCl
57.	Leaf vein color	LfVCl
58.	Lemma and Palea color	LePaCl
59.	Length of brush hair	BrsHrL
60.	Length of cyme	CyL
61.	Length of internode	IntL
62.	Lodging resistance	LdgRes
63.	Lodging susceptibility	LdgSus
64.	Number	N
65.	Number of cymes per plants	Cy/Pl
66.	Number of flower clusters per cyme	FlCls/Cy
67.	Number of flower per cluster	Fl/Cls
68.	Number of flower per cyme	Fl/Cy
69.	Number of internodes	IntN
70.	Number of plant per plot	Pl/Pt
71.	Number of primary branch in inflorescence	PrBr/Infl
72.	Number of primary branches	PrBrN
73.	Number of primary branches in panicle	PrBr/Pan
74.	Number of ridges	RdN
75.	Number of secondary branches in panicle	SeBr/Pan
76.	Number of seed per plant	Sd/Pl
77.	Number of seeds per cluster	Sd/Cls
78.	Number of seeds per cyme	Sd/Cy
79.	Panicle length	PanL
80.	Panicle type	PanTy
81.	Pericarp color	PerCl
82.	Petiole color	PetCl
83.	Petiole length	PetL
84.	Phenotypic acceptance	PhAc
85.	Plant height	PlHt
86.	Scent	Sc
87.	Seed color	SdCl
88.	Seed length	SdL
89.	Seed shape	SdSh
90.	Seed surface	SdSf
91.	Seed width	SdW
92.	Seeding date	SdD
93.	Shape of upper surface of kernel	KnUpSfSh
94.	Shattering	Sht
95.	Single grain weight	SnGrWt
96.	Single kernel weight	SnKnWt
97.	Stem color	StCl
98.	Stem diameter	StDi
99.	Stem pigmentation	StPg
100.	Sterile spikelet per panicle	StlSpk/Pan
101.	Sterile tiller number per hill	StlTi/Hl
102.	Straw yield per hill	StrYl/Hl

SN	Character/ trait	Abbreviation
103.	Straw yield per plant	StrYl/Pl
104.	Straw yield per plot	StrYl/Pt
105.	Thousand seed weight	ThSdWt
106.	Threshability	Thsh
107.	Total number of cluster per plant	Cls/Pl
108.	Total number of flower per plants	Fl/Pl
109.	Transplanting date	TrplD
110.	Weeds	Wd

Evaluation and pre-breeding

- Evaluate using descriptors in replicated design
- Screen accessions in suitable environment both in field and lab using DNA markers
- Identify accessions that possess specific traits so that breeder can use them
- Develop and tag important genes by DNA markers
- Transfer some traits to develop elite lines
- Enhance landraces genetically
- Provide elite lines to breeders, students, and farmers

Descriptors

- Use passport descriptors developed by NAGRC
- Followings are the standard format for developing characterization and evaluation descriptors for crops <Buckwheat as a example>

General Format:

- <SN> <Trait> <abbreviation> <classes> <method, unit> <crop stage> <observation basis ie individual or plot>
- Seeding month in Kathmandu: Aswin
- Mode of pollination:
- Seed dormancy:
- Genetics: 2x=2n=

Descriptors and its measurements

Table 13. Format for developing characterization and evaluation descriptors

SN	Trait	Abbreviation	Classes	Method, unit	Crop stage	Observation basis	Remarks
A.	**Vegetative parts**						
1.	Leaf blade shape	LfBlSh	1. Ovate, 2. Hastate, 3. Sagittate, 4. Cordate, 5. Other	From middle part of the main stem,	At physiological maturity	Plot basis	
2.							
3.							
4.							

SN	Trait	Abbreviation	Classes	Method, unit	Crop stage	Observation basis	Remarks
B.	**Reproductive parts**						
1.	Number of flower clusters per cyme	FlCl/Cy		Count flower clusters from 3 cymes of each of 3 plants	When 75% of seeds turned brown	Individual plant basis	
2.							
3.							
4.							
C.	**Seeds, fruits and yield**						
1.	Seed length	SdL		From 5 seeds of each of 3 plants in mm	At maturity	Individual plant basis	
2.							
3.							
D.	**Biotic and abiotic stresses**						
1.	Insects	Ins	1. Very low or no visible sign, 3. Low, 5. Intermediate, 7. High, 9. Very high	List the name of insects and their damage intensity in percentage		Plot basis	Damage intensity
2.	Diseases	Dis	1. Very low or no visible sign, 3. Low, 5. Intermediate, 7. High, 9. Very high	List the name of diseases and their damage intensity in percentage		Plot basis	Damage intensity
3.	Weeds	Wd	1. Very low or no visible sign, 3. Low, 5. Intermediate, 7. High, 9. Very high	List the name of weeds and their occurrence		Plot basis	Occurrence
4.							
	Overall						
	Phenotypic Acceptance	PhA	1. Excellent, 2. Very Good, 3. Good, 4, Poor	Observe all traits in totality that are visible and	At physiological maturity	Plot basis	

SN	Trait	Abbreviation	Classes	Method, unit	Crop stage	Observation basis	Remarks
				useful for economic harvest			

E. Molecular markers

F. Post harvest traits

- <SN> <Trait> <abbreviation> <classes> <method, unit> <crop stage> <observation basis ie individual or plot>

G. Metrological data (weekly)

H. Definition and guides

- For separating branch and inflorescence consider leaf as present or absent
- For separating cluster use bract
- Study carefully descriptors and guidelines
- You can also measure other traits. Add new category if the given category is not enough
- Record data at right stage of crop
- Tag individual plant to measure
- Measure base on either individual, 3-5 parts of plant or plot basis
- Seed, grain and straw weight after sun dried. You can measure two times one just after harvest and other after sun dried

Use of GIS, CAT and Biotechnology

GIS and CAT for APGRs management

Software related to GIS to manage APGRs

- DIVA-GIS: http://www.diva-gis.org/
  - for mapping and geographic data analysis
- Maxent: http://www.cs.princeton.edu/~schapire/maxent/
  - for species habitat modeling
- FloraMap: http://dapa.ciat.cgiar.org/floramap/
  - for producing the predicted distribution or the areas of possible adaptation, for natural organisms when little or nothing is known of the detailed physiology of the organism
- CAT: http://www.ccafs-analogues.org/tool/
  - to identify areas that experience statistically similar climatic conditions, but which may be separated temporally and/or spatially.

Uses of GIS and CAT

- Distribution and collection maps
- Gap analysis to identify priorities for further collection
- Locating diversity rich areas, diversity and unique collection maps
- Extreme points of collections for unique landraces

- Identification of analogous areas to that of reference site
- Identify sites between which genetic materials can be shared
- Extinct from its habitat? Then return its original collection site from Genebank
- Classification of collections based on climatic adaptation
- Extract climate data for localities points
- Predict presence of species based on climate – using BIOCLIM or DOMIN models for either: Current climate (1970-2000) or Predicted future climate (2020/2050)

- **For managing agricultural plant genetic resources in Genebank**
  - Geo-referencing of all collections
  - Collection gap analysis
  - Matching sites identification for collections for major crops
  - Use of GIS and CAT tools for exchanging local landraces among community seed banks
  - Landrace adaptability study using GIS and CAT tools
  - Information generation for potential exchange of germplam in future within Nepal
  - Link other technologies with matching sites identified by GIS tools
  - GIS for selecting sites to establish Field Genebank
  - GIS to select appropriate farmers for Farmer Field Trial
- **For adaptation of crop diversity to climate changes**
  - Analyzing climate changes up to the present in 2 sites (Bara and Kaski) and the impacts of those changes on agricultural production
  - Identification of the future climate of reference sites in 2020 years
  - Identification of potential analogue sites of these reference sites
  - Verification of what crops are being grown in the analogue sites
  - Compare between reference and analogue sites for other factors, not available through climate analogue tool
  - Check what germplasm related to species and traits from the analogue sites is available through MLS and request germplasm
  - Identification of sites that will have climates in 2020 years that are like those in reference sites now

Biotechnology for APGRs management

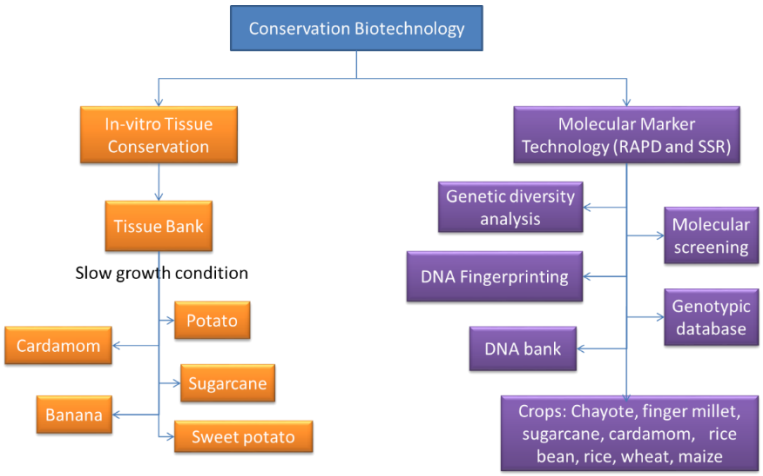

Figure 22. Biotechnology for Managing Agricultural Plant Genetic Resources.

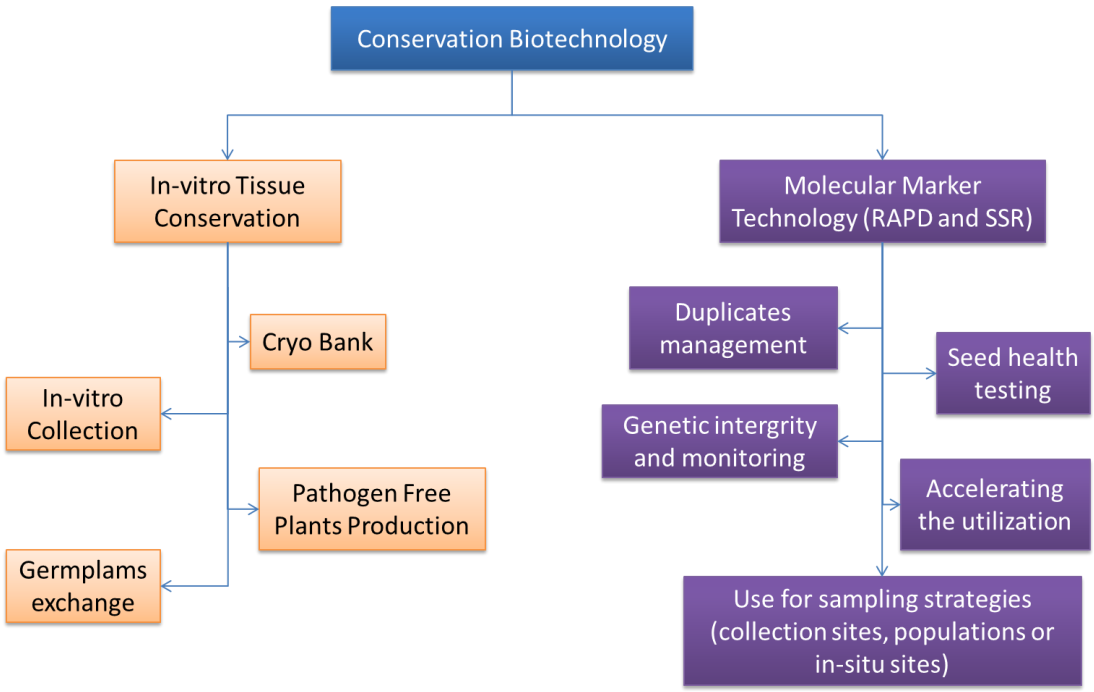

Figure 23. Potential application areas of biotechnology in APGRs conservation.

Documentation and database management

NAGRC operates a computerized documentation and database management system using MS Excel program. The database of all the germplasms including phenotype, genotype, photos and seed and plant herbarium is properly documented manually and also using MS Excel program each year.

- Use different Excel sheet for passport data in Seed bank, tissue bank, DNA bank, Field Genebank
- Maintain stock management data for each type of bank
- Record characterization data (including both phenotypic and genotypic) for each accessions
- Maintain evaluation/ pre-breeding data of each accession
- Maintain image bank recording images of each accessions and linking it with passport, characterization and evaluation data.
- Stock Management Data includes
  - Storage data
  - Distribution data
  - Regeneration data
  - Multiplication data
  - Viability monitoring data
- Use different data Format for Seed Lab, Conservation Lab, Biotech Lab and Field
- Group data as follows.
  - Orthodox Germplasm
    - Passport
    - Characterization
    - Evaluation/ Pre-breeding
    - Image bank

- Non-Orthodox Germplasm
  - Passport
  - Characterization
  - Evaluation/ Pre-breeding
  - Image bank
    - Accessions
    - Unique APGR
    - Important APGR
    - Fields
    - Unidentified APGR

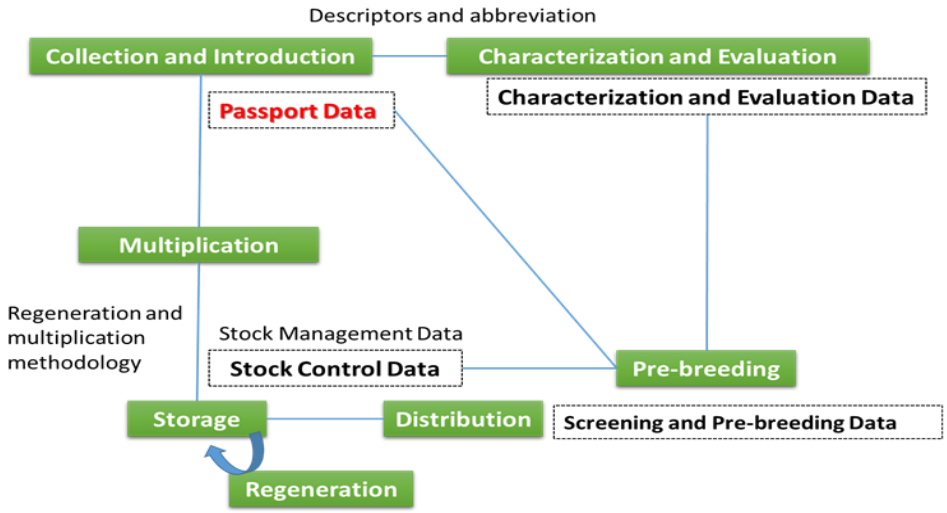

Figure 24. Inter-linkage among databases and activities.

- Keep database in the following categories
  - Electronic file
  - Hard copy file (Register/ Print copy)
  - Released variety file
  - Field genebank
  - General collections file
  - Crop wise file
- Study both Nepali and English format of passport
- Check the spelling in case of roman words
- Follow standard format, style and coding
- Do not say just local
- Follow Decimal degrees format (6 digits after decimal point) for latitude (2 digits before decimal point, DD.DDDDDD) and longitude (3 digits before decimal point, DDD.DDDDDD) eg latitude = , longitude =
- Georeferencing can be determined by GPS, from map, gazetteer or software
- Type landrace name in Nepali
- Enter data in Excel Template (all data in excel?)

- Passport format either Nepali or English version can be used and they are accessible from www.genebank-narc.gov.np. Data management system for Seed Bank, Tissue Bank, Field Genebank and DNA bank will be separately.
- Give priority to minimize the error in the database, to have complete information following the standard coding, abbreviation, style and format
- Accurate, reliable, complete and up-to-date (ARCU) is the basic motto during data management.
- Complete passport data is necessary to consider for conservation in Genebank, however, if it is not complete but the materials are very useful, the minimum passport data are determined. These are farmer/donor name, crop name, local name, collection site (district and VDC) and unique look.
- Collection number is used during processing in the Genebank ie before getting accession number and then accession number after assigning this number to each collection.
- Prefix NGRC is used for orthodox crop collections (Seed Bank) and NGRV for non-orthodox collections (Field Genebank and Tissue Bank) in accession number.
- During handling in the Genebank activities, collection district, crop name and local name are also used.
- NAGRC propose to develop national standard descriptors, abbreviations, coding and data recording format for each crop.
- Consider **Figure** 21 for activity and output of each accessions

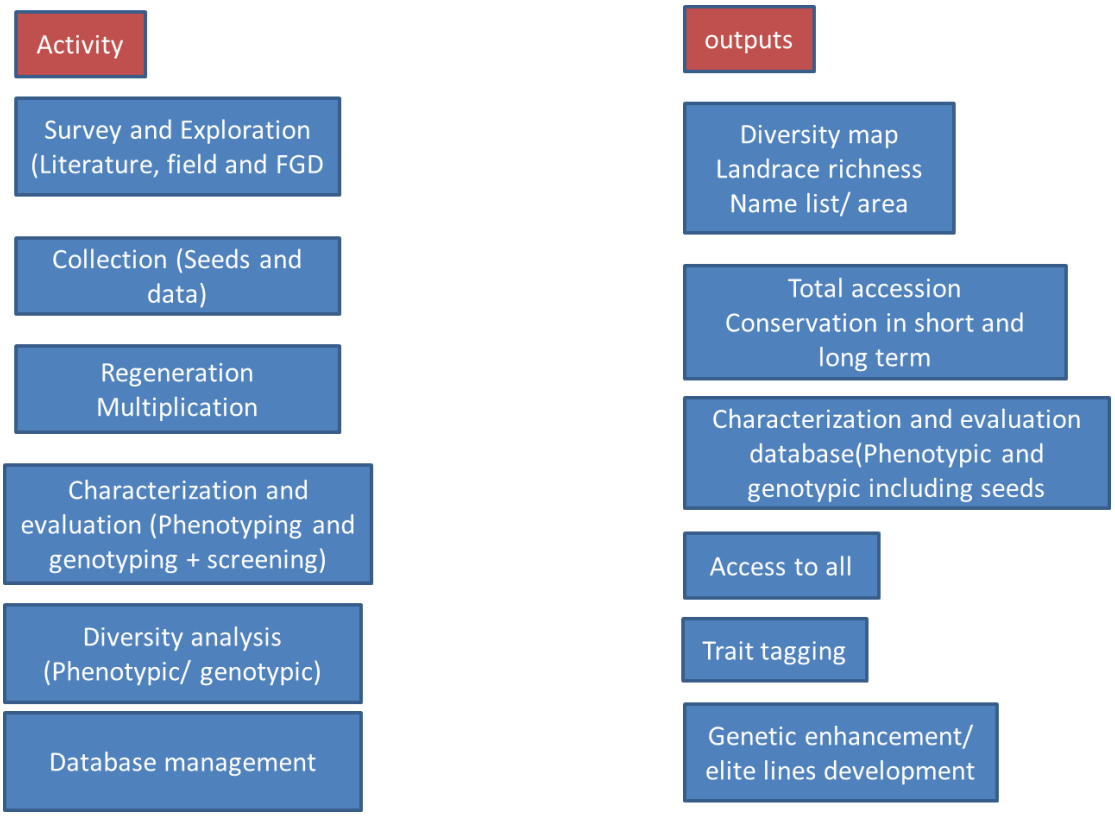

Figure 25. Activities and putouts for each accession.

Table 14. Passport data template in Excel

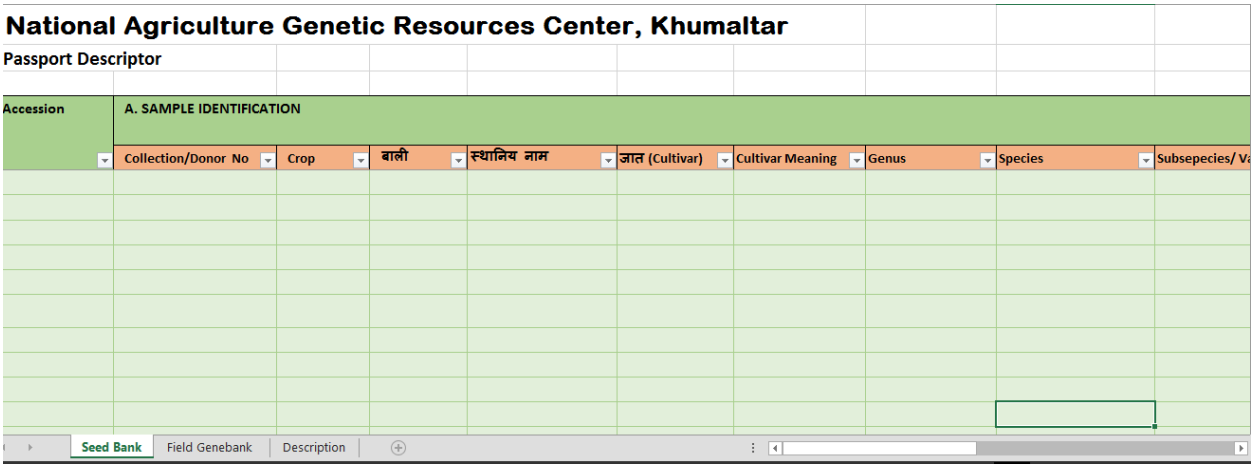

Table 15. Stok Management Data: A. Medium Term Storage

				Germination								
Accession	Crop	बालि (Cultivar)	District	2015	2020	Moisture, %	Amount, g	Location				
				45	78			Room	Rack	Shelf	Tray	Container
							different file					
Label	Regeneration Year	Multiplication Year	Storage Date	Distribution			Remaining amount, g			observation at certain interval		
				Date	Amount, g	Receiver						
				20,152								

Repeated work?, Distribution?, Released?, Study manual and other guidelines?

DNA Bank Data Book

- Store DNA samples of accessions of different crop species in DNA Bank and keep record as mentioned in **Table** 8.

Table 16. DNA bank data

SN	Crop	Collection no	Accession no	Var/ landrace	Location of DNA	Conc, ng/µl	Amount, µl	Stored year

Note: Location: Fridge number, (A, B, C…) - Shelf number (A1, A2, A3…) – Tube rack number (A1R1, A1R2, A1R3… – Tube number (either collection number or accession number) (eg A-A1-A1R1-Tube number)

GRIN-Global (Germplasm Resources Information Network)

- Developed by the USDA, is recognized internationally as a superior genebank information management system
- Provide the world's crop genebanks with a powerful, flexible, easy-to-use global plant genetic resource information management system

Genesys-Global portal (http://www.genesys-pgr.org)

- To provide users with improved access to the millions of accessions held in genebanks worldwide
- Allows individuals to query accessions of interest according to simple criteria and keywords
- Compiles the data from SINGER, EURISCO and GRIN

Germplasm utilization and distribution

- Provide samples free of cost to all Nepalese people.
- Use accessions for research, production, study, repatriation and exchange
- Send accessions abroad after having SMTA
- Receiver should send request letter to get the germplasm from NAGRC
- Small amount of seeds with passport and other information will be provided keeping records.

Distributed list

- Record and maintain different files of distributed accessions

Nepal Annex-1 Crops

- Maintain separate file for Nepalese APGRs included under MLS of ITPGRFA

Safety duplicates and backup accessions

- Maintain separate file of safety duplicates and backup accessions

Policy and strategy on germplasm conservation and utilization

Table 17. Policy and strategy related to APGRs

क्रस	ऐन, निति नियम तथा मार्गदर्शनहरु	Policy, strategy, vision	कृषि आनुवंशिक श्रोतको ब्यबस्था
National			
१	बीउ बिजन ऐन २०४५	Seed Act 1988 (Amend. 2008)	स्थानिय जातहरुको सूचिकृतको व्यवस्था
४	बीउ बिजन नियमावली २०५४	Seed Regulation 1997	स्थानिय जातहरुको सूचिकृतको व्यवस्था
५	राष्ट्रिय बीउ बिजन नीति २०५६	National Seed Policy 1999	कृषि जैविक विविधताको संरक्षण, नयां जातप्रतिको अधिकार
६	स्थानिय निकाय ऐन २०५६	Local Governance Act 1999	स्थानिय निकायलाई स्थानिय स्रोतहरुको संरक्षण, सम्बर्द्धन एवं सदुपयोग गर्ने अधिकार
८	राष्ट्रिय सिमसार निति २०६०	National Wetland Policy 2003	जलथर तथा सिमसार क्षेत्रको जैविक विविधताको संरक्षण, सम्बर्द्धन एवं दिगो प्रयोग गर्ने

क्रस	ऐन, निति नियम तथा मार्गदर्शनहरु	Policy, strategy, vision	कृषि आनुवंशिक श्रोतको व्यबस्था
९	राष्ट्रिय कृषि निति २०६१	National Agriculture Policy 2004	प्राकृतिक स्रोत, वातावरण र जैविक विविधताको संरक्षण, सम्र्वद्धन एवं सदुपयोग गर्ने
१०	जैविक सुरक्षा नियमवालि २०६२	Biosafety Guidelines 2005	जैविक प्रविधि वाट हुन सक्ने खतरा
११	कृषि जैविक विविधता नीति २०६३ (संशोधन २०७१	Agricultural Biodiversity Policy 2007 (Rev. 2014)	जैविक विविधताको संरक्षण, सम्वर्द्धन एवं सदुपयोग गर्ने
१२	राष्ट्रिय कृषि प्रसार रणनिति २०६४	Nepal Agriculture Extension Strategy 2007	जैविक विविधताको संरक्षण एवं सदुपयोग
१४	जैविक सुरक्षा नियमवालि २०६४	National Biosafety Policy 2007	जैविक प्रविधि वाट हुन सक्ने खतर
१७	बिष बर्षे अबधारण	NARC's Strategic Vision for Agriculture Research 2011-2030	प्राकृतिक स्रोत तथा जैविक विविधताको संरक्षण, स्थानिय ज्ञान सिप र स्रोतको महत्व
१९	बिउ संबन्धित परिकल्पना	Seed Vision 2025	स्थानिय बिउहरुको सुरक्षा, संरक्षण
२०	वालिविरुवा जातको सुरक्षा तथा कृषकको अधिकार २०६२	Plants Variety Protection and Farmers' Right Legislation 2005, draft	जातको सुरक्षा तथा कृषकको अधिकार संबन्धि
२१	आनुवंशिक स्रोत (पहुँच, उपयोग र लाभको बाँडफाँड) ऐन	Access to Genetic Resources and Benefit Sharing (AGRBS) Bill 2002, draft	आनुवंशिक स्रोत, पदार्थ तथा सो को उपयोग संबन्धी परम्परागत ज्ञानको संरक्षण, सम्वर्द्धन र दिगो उपयोग गर्न, त्यस्ता स्रोत, पदार्थ र परम्परागत ज्ञानमा पहुँच, उपयोग तथा निर्यातबाट सिर्जित लाभको समन्यायिक बाँडफाँड गर्न, त्यस्ता स्रोत, पदार्थ तथा परम्परागत ज्ञानको संरक्षण गर्दै आएका आदिवासी जनजाति लगायतका स्थानीय समुदायको परम्परागत ज्ञान, सीप, खोज, प्रविधि र अभ्यास सम्बन्धी हक हितको संरक्षण गर्न
२२	राष्टिय जैविक विविधता रणनिति तथा कार्ययोजना	National Biodiversity Strategy and Action Plan 2014-2020	▪ Collect and conserve genetic materials of at least 75 percent of the commonly cultivated crop and horticulture species, by 2020 ▪ Applying holistic and integrated approach to conservation of agrobiodiversity
२३	कृषि विकास रणनिति	Agriculture Development Strategy 2015-2035	Strengthening collection, classification, and assessment of diversified bio resources relevant to agriculture, and support scientific report/ documentation
International			
1.	जैविक विविधता महासन्धि	Convention on Biological Diversity (CBD) 1992	▪ Countries have Sovereign Rights to legislate, manage, exploit and control access to their natural resources, including PGRFA ▪ International binding law ▪ Nepal has been a signatory to the CBD in June 1992 and ratified it in November 1993 ▪ Objective: Conservation of biological diversity, the sustainable use of its components and the equitable sharing of the benefits arising out of the utilization of genetic resources
2.	खाद्य तथा कृषिका लागि वानस्पतिक आनुवंशिक स्रोत सम्बन्धि अन्तराष्ट्रिय	International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) 2004	▪ Created a multilateral system of access and benefit sharing with respect to PGRFA ▪ Aims at the conservation and sustainable

ऋस	ऐन, निति नियम तथा मार्गदर्शनहरु	Policy, strategy, vision	कृषि आनुवंशिक श्रोतको ब्यबस्था
	सन्धि		use of PGRFA and the fair and equitable sharing of benefits arising out of their use in harmony with Convention on Biological Diversity ▪ SMTA of the ITPGRFA would bind the recipients of these PGRFA that are in public domains in certain conditions and would require that recipient to pass on these obligations to any subsequent recipient ▪ Brings PGRFA into public domain, that are covered by multilateral systems and calls for facilitated access ▪ CG center have agreed not to seek any IPR over designated germplams and information

Germplasm flow

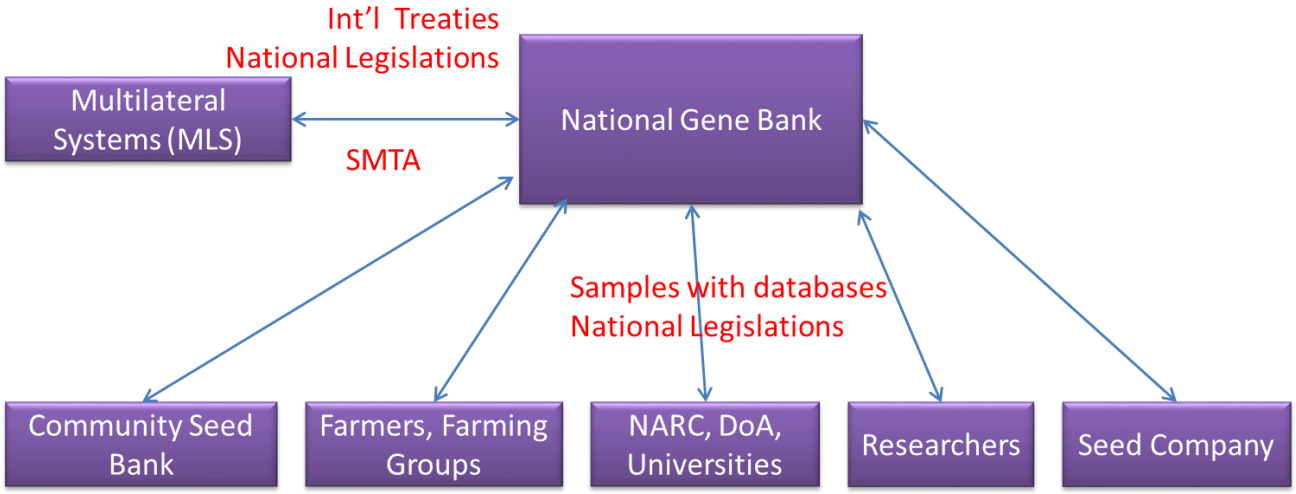

Figure 26. Expected germplasm flow mechanism.

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Appendices

1. Crop code

Use following crop code as suffice in collection number. This code is equally useful for labeling and can be used in other activities.

- **Collection number format:** <Initials of collector>-<Last two digit of collection year (English calendar)>-<Serial number of collections followed by crop code)
- **Example** of Collection Number of Buckwheat and Chayote by Bal K. Joshi in 2013: BKJ-13-01BW, BKJ-13-02CY

SN	Crop	Code	नेपाली
	Cereals		
1.	Amaranth	AM	लट्टे, मार्से
2.	Barley	BY	जौ
3.	Buckwheat	BW	फापर (मिठे, तिते)
4.	Maize	MZ	मकै
5.	Naked Barley	NB	उवा, करु
6.	Rice	RI	धान
7.	Wheat	WH	गहुँ
	Millets		
1.	Barnyard Millet	BM	सांवा
2.	Finger Millet	FM	कोदो
3.	Foxtail Millet	FoM	कागुनो
4.	Little Millet	LM	कुर्कि
5.	Paspalum	PsP	कोदि
6.	Pearl Millet	PM	बाजरा
7.	Proso Millet	PrM	चीनु
8.	Sorghum	SG	जुनेलो
	Sugar and Starch Crops		
1.	Cassava	CS	सिमलतरुल
2.	Potato	PO	आलु
3.	Sugar Beet, Beet Root	SB	चुकन्दर
4.	Sugarcane	SC	उखु
5.	Sweet Potato	SP	सखरखण्ड
	Pulses		
1.	Bean, French Bean	BN	सिमी
2.	Black Gram	BG	मास
3.	Chickpea	CP	चना
4.	Cluster Bean	CtB	झुप्पे सिमी
5.	Cowpea	CoP	बोडी
6.	Faba (Broad) Bean	FB	बकुला
7.	Grass Pea	GrP	खेसरी
8.	Green Gram, Mung Bean	GrG	मुंग
9.	Horse Gram	HG	गहत
10.	Kidney Bean	KB	राज्मा
11.	Lentil	LN	मसुरो
12.	Pea	PE	केराउ
13.	Pigeon Pea	PP	रहर
14.	Rice Bean	RB	मस्यांग, सिल्दुङ, गुरास
15.	Soybean	SY	भटमास

SN	Crop	Code	नेपाली
16.	Vetch	VT	कुटिल कोसा
17.	Field Pea	FP	सानो केराउ, कला
18.	Azuki Bean		
19.	Hycinth Bean		
20.	Sword Bean		टाटे, तरवारे सिमी
21.	Double Bean		असारे सिमी
22.	Field Bean		हिउदे सिमी
23.	French Bean		सिमी
	Oilseed Crops		
1.	Artichoke	AC	गने सूर्यमुखि
2.	Broadleaf Mustard	BdM	रायो
3.	Castor	CA	अँडिर
4.	Coconut	CoN	नरिवल
5.	Groundnut	GN	बदाम
6.	Linseed	LS	आलस
7.	Mustard, Rapeseed	MT	तोरी
8.	Niger	NG	फिलिंगो, झुसेतिल
9.	Perilla	PeR	सिलाम, तिल्खुरो
10.	Safflower	SF	कुसुम
11.	Sarson	SaS	सरस्यूं
12.	Sesame	SS	तिल
13.	Sunflower	SN	सुर्यमुखी
	Vegetables		
1.	Ash Gourd	AG	कुभिण्डो
2.	Yam Elephant		ओल
3.	Asparagus	ApG	कुरिलो
4.	Loquat		लौकट
5.	Balsam Apple	BA	बरेला, करेला, चुच्चे करेला
6.	Bitter Apple	BiA	इन्द्राणि
7.	Bitter Gourd	BD	तिते करेला, करेला
8.	Bottle Gourd	BoG	लौका
9.	Brinjal	BJ	भण्टा
10.	Broccoli	BR	ब्रोकाउली
11.	Brussels Sprout	BrS	
12.	Cabbage	CB	बन्दा
13.	Carrot	CR	गांजर
14.	Cauliflower	CF	फुलगोबी, काउली
15.	Chathel Gourd	CG	चटेल, झुसे करेला
16.	Chayote	CY	स्कुस, ठुलो करेला
17.	Chenopodium, Goosefoot, Dogtooth, Lamb's Quarter	GF	बेथे
18.	Garden Cress	GC	चमसुर
19.	Cucumber	CC	कांक्रो
20.	Dasheen	DS	गांवा
21.	Drumstick	DM	सजिवन
22.	Horse Chestnut	HC	करु, पांग्रो
23.	Knol-Khol	KK	ग्याठ गोभि
24.	Lettuce	LT	जिरिको साग
25.	Okra	OK	भिण्डी, रामतोरिया

SN	Crop	Code	नेपाली
26.	Pointed Gourd	PoG	परवल
27.	Pumpkin	PK	फर्सि, कद्दु
28.	Radish	RD	मुला, चोता
29.	Ridge Gourd	RG	तिराई, पाटे धिरोला
30.	Snake Gourd	SnG	चिचिण्डो
31.	Spinach	SnP	पालुंगो
32.	Sponge Gourd	SpG	घिरौंला
33.	Taro	TR	पिंडालु
34.	Tomato	TM	गोलभेडा, टमाटार
35.	Turnip	TN	सलगम
36.	Water Cress	WC	सिमसाग
37.	Yam	YM	तरुल
	Fruits		
1.	Almond	AL	कागजि बदाम
2.	Apple	AP	स्याउ
3.	Apricot	AT	खुर्पानि
4.	Banana	BaN	केरा
5.	Bread Fruit, Bullock's Heart	BF	रामफल
6.	Butter Tree	BT	चिउरि
7.	Cashew Nut	CN	काजु
8.	Cherry	ChR	पैंयू, चेरी
9.	Chestnut	ChN	कटुस
10.	Citron	CT	बिमिरो
11.	Custard Apple	CtA	सिताफल, सरिफा
12.	Date	DT	छोहोरा, खजुरा
13.	Grape	GP	अङ्गुर, दाख
14.	Guava	GV	अम्बा
15.	Hazel Nut	HN	दाते ओखर
16.	Indian Plum	IP	वयर
17.	Jack Fruit	JF	कटहर
18.	Lemon	LE	निबुवा, ज्यामिर
19.	Lime	LI	कागति
20.	Litchi	LiC	लिचि
21.	Mandarin, Orange	MD	सुन्तला
22.	Mango	MG	आंप
23.	Mulberry	MB	किम्बु
24.	Musk Melon	MM	खरबुजा
25.	Myrobalan, Indian Gooseberry	MY	अमला
26.	Nepalese Hog Plum	NH	लप्सि
27.	Olive	OL	जैतुन
28.	Papaya	PY	मेंवा
29.	Peach	PH	आरु
30.	Pear	PR	नासपति
31.	Persimon	PS	हलुवाबेद
32.	Pineapple	PA	भुइकटहर
33.	Plum	PL	आलु बखडा
34.	Pomegranate	PG	अनार
35.	Pumelo	PU	भोगटे, चखत्रो, संखत्रो
36.	Rough Lemon	RL	काठे ज्यामिर

SN	Crop	Code	नेपाली
37.	Sour Orange	SO	अमिलो सुन्तला
38.	Strawberry		भूइकाफल
39.	Sweet Lime	SL	चाक्सि
40.	Sweet Orange	SwO	मौसम, जुनार
41.	Trifoliate Orange	TO	तिनपाते
42.	Walnut	WN	ओखर
43.	Water Chestnut	WaC	सिंगडा
44.	Water Melon	WM	तरबुजा
45.	Wood Apple	WA	बेल
	Spices		
1.	Aniseed	AS	सौंप
2.	Basil	BS	बार्वरि
3.	Bell (Sweet) Pepper	BP	भेडे खुर्सानी
4.	Betel Leaf	BL	पान
5.	Betel (Areca) Nut	BtN	सुपारि
6.	Black Cumin	BK	काल जिरा
7.	Black Pepper, Pepper	BkP	मरिच
8.	Cardamom	CM	सुकुमेल
9.	Celery	CL	सेलरि
10.	Chilly	CI	खुर्सानी
11.	Chinese Leek	ChL	डुण्डु
12.	Cinnamon, Bay Leaf	CiN	दालचिनि, तेजपात
13.	Clove	CV	ल्वाङ
14.	Coriander	CD	धनिया
15.	Cumin	CU	जीरा
16.	Fennel	FN	सौफ
17.	Fenugreek	FG	मेथी
18.	Garlic	GR	लसुन
19.	Ginger	GG	अदुवा
20.	Asafoetida	HI	हिंग
21.	Large Cardamom	LC	अलैंचि
22.	Leek	LK	डुण्डु, छ्यापी
23.	Long Pepper	LP	पिप्ला
24.	Lovage, Omum	LV	ज्वानो
25.	Mint (Field, Garden)	MN	पूदिना
26.	Nepal Aromatic Garlic	NaG	जिम्बु
27.	Nutmeg	NM	जाइफल
28.	Onion	ON	प्याज
29.	Saffron	SfR	केसर
30.	Sacred Basil	SaB	तुलसि
31.	Shallot	ST	छ्यापी
32.	Tamarind	TD	ईम्लि, अमिलि
33.	Turmeric	TC	बेसार, हलेदो
	Beverages		
1.	Coffee	CE	कफि
2.	Tea	TA	ाचिया
	Fibers		
2.	Cotton	CN	कपास
4.	Hemp	HP	भाङ्ग, गाजा

SN	Crop	Code	नेपाली
1.	Jute	JT	जुट
6.	Sunhemp	SH	सनाई
	Forages		
1.	Oat	OT	जै
	Others		
1.	Tobacco	TB	काँचपात
2.	Indian Hemp	IH	भांग

2. Sample size

Thousand seed weight and amount of seed requied for base and active collections

SN	Crop	Seed size	1000-gr wt, g	Required seed weight, g			Remarks
				Base	Active	Total	
1.	Amaranth	S	0.7	4	4	8	
2.	Ash pumpkin	M	70	70	70	150	
3.	Beetroot	S	10.5-20	40-80	40-80	80-160	
4.	Bitter gourd	M-L	60-170	60-170	60-170	120-340	
5.	Black gram	M	35-54	140-220	140-220	280-440	
6.	Bottle gourd	M-L	130-150	130-150	130-150	260-300	
7.	Cabbage	S	3	20	20	40	
8.	Capsicum	S	3.5-6.5	21-39	21-39	42-78	
9.	Carrot	S	0.5-3.2	2-13	2-13	4-26	
10.	Cauliflower	S	3	20	20	40	
11.	Chickpea	M-L	300-500	600-1000	600-1000	1200-2000	
12.	Chilli	S	3.5-6.5	21-39	21-39	42-78	
13.	Chinese cabbage	S	1.5	10	10	20	
14.	Cluster bean	M	29	116	115	232	
15.	Common bean	S	100-250	100-1250	100-1250	200-2500	
16.	Cowpea	M	100-120	400-480	400-480	800-960	
17.	Cucumber	S	5.5-25	30-150	30-150	60-300	
18.	Eggplant	S	3-4.5	40-53	30-35	70-80	
19.	Finger millet	S	2-2.8	10-15	20-25	30-40	
20.	Foxtail millet	S	2-3.5	10-15	20-30	30-45	
21.	Green gram	M	24-76	100-310	100-310	200-620	
22.	Groundnut	L	500-1000	500-1000	500-1000	1000-2000	
23.	Horese gram	M	29-34	119-136	120-135	239-273	
24.	Hyacinth bean	M	250	500	500	1000	
25.	Jack bean	L	800-4000	250-1000	250-1000	500-2000	
26.	Kang kung	M	40-47	80-94	80-94	160-188	
27.	Kekiri	S	5.5-25	30-150	30-150	60-300	
28.	Knol-kohl	S	3	20	20	40	
29.	Kodo millet	S	4.5	20	40	60	
30.	Leek	S	2.5	15	15	30	
31.	Lentil	M	20-50	80-200	80-200	160-400	
32.	Lettuce	S	0.6-1.3	3-6.5	3-6.5	6-13	
33.	Lima bean	L	500-2000	250-1000	250-1000	500-2000	
34.	Little millet	S	3.7	20	30	50	
35.	Luffa	M	90-100	180-205	180-205	360-412	
36.	Maize	L	290-330	580-660	1740-1780	2320-2640	

SN	Crop	Seed size	1000-gr wt, g	Required seed weight, g			Remarks
				Base	Active	Total	
37.	Melon	M	5.5-25	10-50	10-50	20-100	
38.	Mustard	S	1.5	20	20	40	
39.	Okra	M	45-60	225-300	225-300	550-600	
40.	Onion	S	2.5-4	15-25	15-25	30-50	
41.	Pea	M-L	90-330	360-1320	180-660	540-1980	
42.	Pearl millet	S	5-7.5	26-37	42-60	70-100	
43.	Pigeonpea	M	70-200	280-800	280-800	560-1600	
44.	Proso millet	S	3-5.5	15-30	25-45	40-75	
45.	Pumpkin	M	35-300	21-200	21-200	42-400	
46.	Radish	S	7.1-15	42-90	42-90	84-180	
47.	Rice	M	15-20	60-160	120-320	180-480	
48.	Ricebean	L	100-120	200-240	200-240	400-480	
49.	Sesame	S	3	24	24	36	
50.	Snake gourd	M	194	195	195	388	
51.	Sorghum	M	17	70	140	210	
52.	Soybean	M-L	100-670	200-1340	200-1340	400-2680	
53.	Sward bean	L	800-4000	250-1000	250-1000	500-2000	
54.	Tomato	S	2.5	30	20	50	
55.	Turnip	S	1.9-2.5	12-15	12-15	24-30	
56.	Velvet bean	l	500	1000	1000	2000	
57.	Water melon	M	70-180	42-108	42-108	84-216	
58.	Winged bean	L	250-500	500-1000	500-1000	1000-2000	
59.	Yard long bean	L	100-120	240	240	480	

3. Crop calendar

क्रप क्यालेण्डर (Crop Calendar)

सिनं	वालि	अंग्रेजी नाम	सेचनकिया	विउ दर (केजी/हे)	मलखाद (केजी/हे)	लगाउने दुरी (सेमी)	वाली लगाउने समय		
							तराई	पहाड	उच्च पहाड
१	धान	Rice	स्वयं सेचन	५०-६०	१००:३०:३०	२० × १०	जेठअसार	वैशाखजेठ	चैत्रवैशाख
२	मकै	Maize	पर सेचन	२०-२५	६०:३०:३०	६० × २५	जेठअसार	वैशाखजेठ	फागुन-चैत्र
३	गहु	Wheat	स्वयं सेचन	१००-१२०	६०:५०:२५	२० × १५	कार्तिक-मंसीर	कार्तिक-मंसीर	चैत्रवैशाख
४	जौ	Barley	स्वयं सेचन	७५-१००	३०:२०:१०	२५ × ०५	अशोज-कार्तिक	कार्तिक-मंसीर	अशोज-कार्तिक
५	उवा	Naked Barley	स्वयं सेचन	७५-१००	३०:२०:१०	२५ × ०५	-	-	फागुन-चैत्र
६	कोदो	Finger Millet	स्वयं सेचन	८-१०	२०:१०:१०	२५ × १०	असार-साउन	जेठअसार	बैशाख-जेठ
७	जुनेलो	Sorghum	स्वयं सेचन	१२ - १५	१००:५०:४०	४५ × १५	असार-साउन	जेठअसार	-
८	बाजरा	Pearl Millet	पर सेचन	४-५	१००:५०:४०	४५ × १५	असार-साउन	जेठअसार	-
९	सांवा	Barnyard Millet	स्वयं सेचन	८-१०	४०:३०:२०	२५ × १०	असार-साउन	जेठअसार	बैशाख-जेठ

सिनं	वालि	अंग्रेजी नाम	सेचनकिया	विउ दर (केजी/हे)	मलखाद (केजी/हे)	लगाउने दुरी (सेमी)	वाली लगाउने समय		
							तराई	पहाड	उच्च पहाड
१०	कागुनो	Foxtail Millet	स्वयं सेचन	८-१०	६०:४०:३०	३० × १०	जेठअसार	वैशाखजेठ	चैत्रवैशाख
११	चीनु	Proso Millet	स्वयं सेचन	८-१०	६०:३०:२०	२५ × ०८	असार-साउन	जेठअसार	बैशाख-जेठ
१२	लट्टे	Amaranth	स्वयं सेचन	१.५-२	५०:३०:३०	५० × २०	जेठअसार	वैशाखजेठ	बैशाख-जेठ
१३	फापर	Buckwheat	पर सेचन	२५-३०	३०:२०:१०	३० × ०५	भाद्र-असोज	असार-साउन	बैशाख-जेठ
१४	मास	Black Gram	स्वयं सेचन	१२ - १५	२०:२०:२०	४५ × १०	साउन-भाद्र	असार-साउन	-
१५	मुंग	Green Gram	स्वयं सेचन	१२ - १५	२०:२०:२०	४५ × १०	साउन-भाद्र	फागुन-चैत्र	-
१६	रहर	Pigeon Pea	स्वयं सेचन	२०-२५	२०:४०:३०	७५ × २०	जेठअसार	वैशाखजेठ	-
१७	मसुरो	Lentil	स्वयं सेचन	५०-६०	२०:२०:२०	२५ × २०	अशोज-कार्तिक	कार्तिक-मंसीर	-
१८	चना	Chickpea	स्वयं सेचन	८०-८५	२०:४०:२०	४० × १०	अशोज-कार्तिक	कार्तिक-मंसीर	-
१९	केराउ	Pea	स्वयं सेचन	४०-५०	१५:४०:१०	६० × ६०	अशोज-कार्तिक	माघ-फागुन	बैशाख-जेठ
२०	बोडी	Cowpea	स्वयं सेचन	२०-२५	२०:४०:३०	७० × ७०	भाद्र-असोज	माघ-फागुन	चैत्रवैशाख
२१	सीमी	Bean	स्वयं सेचन	१००-१२५	१५:४०:१०	१२० × ५०	असोज-मंसीर	फागुन-साउन	फागुन-असार
२२	बकुला	Broad Bean	स्वयं सेचन	७०-१००	५०:१००:५०	६० × ३०	अशोज-कार्तिक	भाद्र-असोज	चैत्रवैशाख
२३	मस्यांग	Rice Bean	स्वयं सेचन	१२ - १५	२०:२०:२०	४५ × १०	-	असार-साउन	-
२४	गहत	Horse Gram	स्वयं सेचन	१८-२०	२०:२०:२०	३० × १०	साउन-भाद्र	असार-साउन	-
२५	खेसरी	Grasspea	स्वयं सेचन	३०-३५	२०:२०:२०	३५ × १०	अशोज-कार्तिक	-	-
२६	भटमास	Soybean	स्वयं सेचन	७०-८०	१०:४०:३०	५० × ०५	जेठअसार	चैत्रवैशाख	-
२७	तोरी	Mustard	पर सेचन	८-१०	६०:४०:२०	३० × १०	भाद्र-असोज	भाद्र-असोज	-
२८	सरस्यूं	Sarsyun	पर सेचन	८-१०	८०:४०:४०	४५ × १५	अशोज-कार्तिक	अशोज-कार्तिक	-
२९	रायो	Broad Leaf Mustard	पर सेचन	८-१०	६०:४०:२०	४५ × ३०	असोज-मंसीर	भाद्र-मंसीर	फागुन-बैशाख
३०	तिल	Sesame	स्वयं सेचन	४-५	६०:४०:२०	४५ × १५	असार-साउन	जेठअसार	-
३१	आलस	Linseed	स्वयं सेचन	३५-४०	६०:३०:२०	३० × १०	अशोज-कार्तिक	-	-
३२	फिलिंगा/ झुसेतिल	Niger	स्वयं सेचन	८-१०	४०:४०:२०	३० × १०	साउन-भाद्र	साउन-भाद्र	-
३३	सिलाम	Perilla	स्वयं सेचन	८-१०	४०:४०:२०	३० × १०	साउन-भाद्र	साउन-भाद्र	-
३४	बदाम	Groundnut	स्वयं	८०-१००	४०:६०:२०	४० × १५	जेठअसार	चैत्रवैशाख	-

सिनं	वालि	अंग्रेजी नाम	सेचनकिया	विउ दर (केजी/हे)	मलखाद (केजी/हे)	लगाउने दुरी (सेमी)	वाली लगाउने समय		
							तराई	पहाड	उच्च पहाड
			सेचन						
३५	सुर्यमुखी	Sunflower	पर सेचन	५-१०	६०:४०:२०	४५ × २५	असार-असोज	अशोज-कार्तिक	-
३६	अंडेल	Castor	पर सेचन	१८-२०	६०:४०:४०	६० × ३०	असार-साउन	फागुन-चैत	-
३७	कुसुम	Safflower	पर सेचन	१५-२०	४५:४०:२०	४५ × १५	अशोज-कार्तिक	-	-
३८	आलु	Potato	स्वयं सेचन	२००००-३००००	७०:५०:४०	६० × २०	असोज-मंसीर	पुस-माघ	फागुन-चैत
३९	भाण्टा	Brinjal	पर सेचन	०.६-१	२००:१५०:५०	६० × ४५	अशोज-कार्तिक	चैत्र-असार	जेठ-साउन
४०	गोलभेडा	Tomato	पर सेचन	०.२-०.५	२००:२००:१००	६० × ४५	भाद्र-कार्तिक	फागुन-भाद्र	चैत्र-जेठ
४१	खुर्सानी	Chilly	स्वयं सेचन	०.२-०.५	१००:१००:१००	६० × ४५	भाद्र-असोज	माघ-फागुन	चैत्र-वैशाख
४२	भिण्डी	Okra	पर सेचन	५-१०	२००:१८०:६०	५० × ३०	माघ-जेठ	फागुन-भाद्र	बैशाख-जेठ
४३	फुलगोवी	Cauliflower	पर सेचन	०.५-१	२००:१२०:८०	६० × ४५	भाद्र-असोज	साउन-भाद्र	माघ-साउन
४४	बन्दा	Cabbage	पर सेचन	०.५-१	२००:१२०:८०	६० × ४५	अशोज-कार्तिक	साउन-मंसीर	जेठ-साउन
४५	ब्रोकाउली	Brocauli	पर सेचन	०.१-०.२	२००:१२०:८०	६० × ४५	अशोज-कार्तिक	भाद्र-असोज	जेठ-साउन
४६	सलगम	Turnip	पर सेचन	५-८	५०:४०:३०	३० × ३०	असोज-मंसीर	साउन-मंसीर	जेठ-साउन
४७	मुला	Radish	पर सेचन	५-१०	२००:१८०:६०	२० × २०	भाद्र-कार्तिक	साउन-कार्तिक	जेठ-साउन
४८	चमसुर	Garden Cress	पर सेचन	१०-१५	८०:४०:४०	२० × २	असोज-मंसीर	भाद्र-माघ	फागुन-बैशाख
४९	गांजर	Carrot	पर सेचन	५-८	१००:१००:१००	३० × १०	असोज-कार्तिक	भाद्र-मंसीर	जेठ-साउन
५०	पालुंगो	Spinach	पर सेचन	१०-१५	१२०:८०:४०	२० × २	असोज-कार्तिक	भाद्र-माघ	बैशाख-साउन
५१	कुरिलो	Asparagus	पर सेचन	०.५-१	२००:१८०:६०	१०० × ६०	जेठ-साउन	फागुन-भाद्र	-
५२	सकरखण्ड	Sweet Potato	पर सेचन	१०००० लहराटुका	७५:५०:७५	४५ × ४५	असोज-कार्तिक	जेठ-भाद्र	जेठ-असार
५३	कांक्रो	Cucumber	पर सेचन	१.५-२	१५०:५०:१००	७५ × ७५	पुस-माघ	साउन-असोज	जेठ-साउन
५४	फर्सि	Pumpkin	पर सेचन	०.२-०.५	२००:१८०:६०	१०० × १००	माघ-जेठ	फागुन-चैत	बैशाख-जेठ
५५	लौका	Bottle Gourd	पर सेचन	१-२	४०:२०:२०	२०० × २००	माघ-जेठ	फागुन-चैत	बैशाख-जेठ
५६	घिरौंला	Sponge Gourd	पर सेचन	१-२	४०:२०:२०	३०० × ३००	माघ-जेठ	फागुन-जेठ	बैशाख-जेठ
५७	चिचिण्डो	Snake Gourd	पर सेचन	१-२	४०:२०:२०	३०० × ३००	माघ-जेठ	फागुन-जेठ	बैशाख-जेठ
५८	करेला	Bitter Gourd	पर सेचन	२-२.५	२००:१२०:६०	१५० × १००	माघ-जेठ	फागुन-चैत	बैशाख-जेठ
५९	परवल	Pointed Gourd	पर सेचन	२-२.५	२००:१२०:६०	१५० × १००	माघ-जेड	फागुन-चैत	बैशाख-जेठ

सिनं	वालि	अंग्रेजी नाम	सेचनकिया	विउ दर (केजी/हे)	मलखाद (केजी/हे)	लगाउने दुरी (सेमी)	वाली लगाउने समय		
							तराई	पहाड	उच्च पहाड
६०	तरबुजा	Water Melon	पर सेचन	५-८	६०:४०:४०	२०० × १००	पुस-फागुन	-	-
६१	खरबुजा	Musk Melon	पर सेचन	५-८	६०:४०:४०	२०० × १००	पुस-फागुन	-	-
६२	कुभिण्डो	Ash Gourd	पर सेचन	१-२	४०:२०:२०	२०० × २००	माघ-जेठ	फागुन-चैत	-
६३	बरेला	Balsam Apple	पर सेचन	२-२.५	२००:१२०:६०	१५० × १००	माघ-जेठ	फागुन-चैत	-
६४	बेसार	Turmeric	वानस्पतिक	२०००-३०००	१००:६०:६०	४५ × २५	चैत्र-वैशाख	चैत्र-वैशाख	चैत्र-वैशाख
६५	अदुवा	Ginger	वानस्पतिक	४०००-६०००	३०:३०:६०	३० × ३०	फागुन-चैत	फागुन-चैत	फागुन-चैत
६६	जीरा	Cumin	पर सेचन	२०-२५	३०:३०:२०	३० × २	असोज-कार्तिक	-	-
६७	धनिया	Coriander	पर सेचन	२४-४५	३०:३०:२०	३० × २	असोज-कार्तिक	असोज-कार्तिक	
६८	ज्वानो	Lovage	पर सेचन	२०-२५	३०:३०:२०	३० × २	असोज-कार्तिक	असोज-कार्तिक	
६९	मेथी	Fenugreek	स्वयं सेचन	२५-३०	४०:३०:२०	३० × २	असोज-मंसीर	भाद्र-मंसीर	फागुन-बैशाख
७०	सौंफ	Fennel	पर सेचन	२०-२५	३०:३०:२०	३० × २	असोज-मंसीर	भाद्र-मंसीर	
७१	लसुन	Garlic	वानस्पतिक	५००-८००	१००:४५:६०	१५ × १५	असोज-कार्तिक	भाद्र-मंसीर	बैशाख-जेठ
७२	प्याज	Onion	पर सेचन	१०-१५	१२०:१००:१००	१५ × १०	मंसीर-पुस	पुस-माघ	-
७३	जुट	Jute	पर सेचन	६-८	६०:३०:३०	३० × ०५	फागुन-चैत	-	-
७४	कपास	Cotton	पर सेचन	१५-२०	६०:४०:२०	६० × ३०	बैशाख-जेठ	-	-

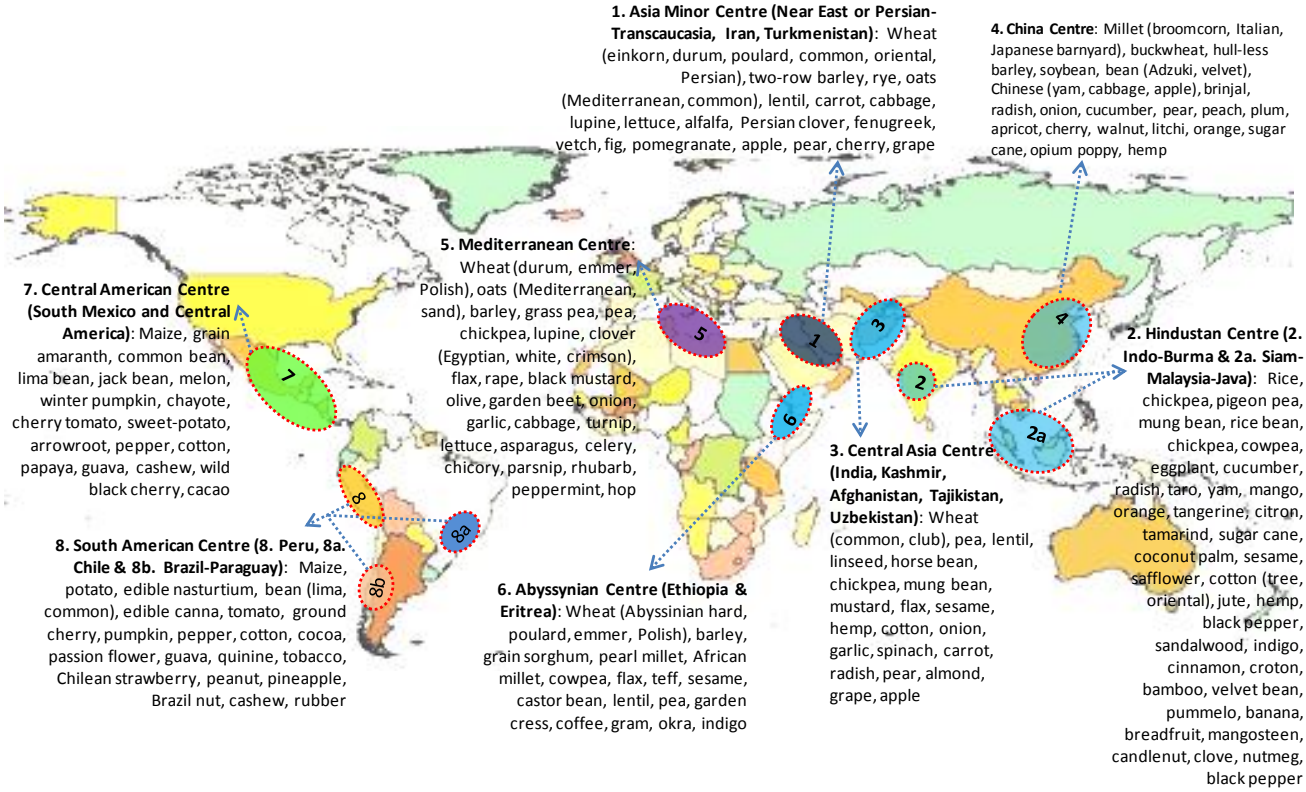
श्रोत: १. कृषि डायरी, २०६९ २. नेपालका वालीनाली र तिनको दिगो खेती, साझा प्रकाशन, २०६६, नर बहादुर साउंद

4. Safety measure

- A genebank should have a risk management strategy in place that includes *inter alia* measures against power cut, fire, flooding and earthquakes.
- A genebank should employ the requisite staff to fulfil all the routine responsibilities to ensure that the genebank can acquire, conserve and distribute germplasm according to the standards.
- Staff should have adequate training acquired through certified training and/or on- the-job training and training needs should be analyzed. Genebank personnel should be aware of and trained in safety procedures to minimize risks to the germplasm. The genebank facilities should be constructed so as to withstand natural disasters, such as hurricanes, cyclones, earthquakes, or floods that are known to occur in the location where the genebank has been built.
- Storage facilities should be protected with standard security facilities such as fences, alarm systems, security doors and any other system that helps to shield the genebank from burglars and other intruders. Security of the seed collections in the genebank will be enhanced by allowing entry strictly to authorized personnel into the actual storage facilities.
- Protective clothing should be provided and used in the storage area. Adequate precautions should be taken and safety equipment, including alarms and devices to open doors from inside drying rooms and refrigerated rooms, should be installed.

- Refrigeration will almost certainly be reliant on electrical power and it is, therefore, necessary that the power supply is adequate and reliable. Failure in power supply can result in complete loss of genebank accessions. Consideration should be given to the provision of a backup generator that automatically cuts in when the main power supply fails. This will require stockpiling adequate amounts of fuel to run the generator during power cuts.
- Monitoring devices for temperature should be available in the drying and storage rooms to track the actual parameters against time. It should be considered whether it is better to store seed without refrigeration if refrigeration is inherently unreliable. If refrigeration is to be used to conserve germplasm, it must meet necessary standards, as unreliable refrigeration can be far more damaging than non-refrigerated storage.
- If refrigeration and/or electric power are unreliable, a facility can be built in the soil at a depth of 10–20¹m, where temperature can be averaged at 10¹°C. This could be attractive in several tropical regions under no risk of flooding. Drying should be well carried out however, and seeds should be kept in properly sealed vials.
- Fire alarm and fire-fighting equipment is required in the genebank. Most fires begin from faulty electrical circuits and periodic checks should be made on the electrical circuitry to ensure compliance with safety standards. Fire-fighting equipment will include extinguishers and fire blankets. For areas a£ected by thunderstorms, a lightning rod should be fitted to the genebank.

5. Vavilov's center of origin



Index