Annual Report

2071/72 (2014/15)

Government of Nepal

Nepal Agricultural Research Council

National Agriculture Genetic Resources Centre (Genebank)

Khumaltar, Lalitpur, Nepal

2015

Agriculture is the basis of life, Lets' respect it

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Cover Page Photo

Diversity in panicles of fox tail millet (*Setaria italica* (L.) P. Beauvois)

Design and computer setting: Surendra K. Shrestha

FOREWORD

Agriculture is human act and human beings have chosen most important crops for cultivation to meet their daily needs of food, fiber, medicine, fuel and above all for survival from the dawn of civilization. These important plants are the gift of nature for which there is a need of their conservation, utilization, regeneration, and overall management of these crop plants not only for our present use but also for the well beings of future generations thereby they also could maintain their livelihood as was maintained by their forefather in a way the world is maintaining successfully as of now. Genebabk does the same work that of a bank does like depositing capitals, withdrawn, debited, credited, and re-deposited by the public as and when necessary in a continuum cycle. For banks money and capital assets are transacted whilst in Genebank seeds and genetic materials both animal and plant origins are collected, preserved, managed and regenerated. The difference between bank and Genebank is that the former deals with physical assets whereas the later deals with biological assets.

Since the inception of the National Agriculture Genetic Resource Center (NAGRC) alias Genebank at Khumaltar in 2010, this is the fifth such report published annually to document activities accomplished in each fiscal year. In this annual report also all technical, financial and administrative activities furnished during the fiscal year 2071/72 (2014/15) are summarized briefly.

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 make the report 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. This report will be incomplete if I missed to mention the hard and dedication done by the former chief of genebank Mr. MR Bhatta, and former scientist/admin/finance officer M Bhattarai, BR Rana Magar and BK Neupane, respectively. Financial support from AFACI, RDA, Korea; Bioversity Internation, 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 (NARC) is thankfully appreciated.

I am confident that activities summarized in this report will be valuable sources for researchers, administrators and planners to chalk out programs and activities in coming days as well. NAGRC (Genebank) welcomes constructive comments and suggestions to improve the quality of this publication in coming days ahead.

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Mina Nath Paudel, Ph D
Chief, NAGRC (Genebank), Khumaltar, Lalitpur

ABBREVIATIONS

ACR	Active Collection Room
AFACI	Asian Food and Agriculture Cooperation Initiative
APGR	Agricultural Plant Genetic Resources
ARS	Agriculture Research Station
BI	Bioversity International
CAT	Climate Analogue Tool
CBD	Convention on Biological Diversity
CBR	Community Biodiversity Register
CCAF	Climate Change for Agriculture and Food Security
CGIAR	Consultative Group of International Agricultural Research
CSB	Community Seed Bank
DNA	Deoxyribose Nucleic Acid
DoA	Department of Agriculture
FAO	Food and Agriculture Organization
GEF	Global Environmental Facility
GIS	Geographic Information System
GRPI	Genetic Resources Policy Initiatives
HCRP	Hill Crops Research Program
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
LoA	Letter of Agreement
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
NGLRP	National Grain Legume Research Program
NGO	Non-Governmental Organization
NPC	National Project Coordinator
NPM	National Project Manager
NIL	Near Isogenic Lines

NMRP	National Maize Research Program
PCR	Polymerase Chain Reaction
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PMC	Project Management Committee
PMU	Project Management Unit
PSC	Project Steering Committee
RAPD	Random Amplified Polymorphic DNA
RARS	Regional Agriculture Research Station
RDA	Rural Development Administration
RIL	Recombinant Inbred Lines
SQCC	Seed Quality Control Centre
UNEP	United Nations Environment Facility
VDC	Village Development Committee
WSV	World Seed Vault

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- सबैभन्दा धेरै बिविधता हुम्ला जिल्लाबाट (४३ वालीहरु) र त्यसपछि दाङ्गबाट ३९ र कैलालीबाट ३६ वालीका जातहरु संकलन गरिएको ।

- कृषि आनुवंशिक स्रोत संरक्षणको प्रमूख उद्देश्य वाली प्रजनन् कार्यमा यिनको उपयोग नै भएको हुँदा बिभिन्न कार्यालयहरु त्था प्रजनन् कर्ताको माग अनुसार नेपाल कृषि अनुसन्धान परिषद् अन्तर्गतका बिभिन्न महाशाखा, कार्यक्रम तथा केन्द्रहरु, बिभिन्न बिश्वविद्यालयहरु तथा कृषकहरुलाई समेत बिभिन्न १० वटा बालीका जम्मा २१८ वटा स्थानीय जातहरुको बीउ उपलब्ध गराईएको ।

- नेपाल कृषि अनुसन्धान परिषद् अन्तर्गत डोटी केन्दलाई ५० वटा भटमासका स्थानिय जातको बीउ उपलब्ध गराईएको ।

संरक्षण

पुनरोत्पादन तथा बीजबृद्धि

- बिभिन्न १९ वालीको १,३७६ वटा संकलन (accession) हरुको पुनरोत्पादन (regeneration) तथा बीजबृद्धि (seed multiplication) गरिएको ।

बिउ बैंक

- बिभिन्न २४ वटा वालीहरु (धान, मकै, कोदो, गहुँ, जौ, उवा, भटमास, बकुल्ला, खेसरी, मुसुरो, चिनो, कागुनो, सिमी, चम्सुर, भिण्डी, तोरी, रायो, मुला, फापर, धनिया, चम्सुर, लटटे, खुर्सानी, टियोसान्टि, कक्स फुट) को १३०३ जातका नमूनाहरु सफा गरी उमारशक्ति परीक्षण गरिएकोमा समग्रमा ५० % नमूनाहरुको उमारशक्ति ८५% भन्दा माथि रहेको ।

- बिभिन्न २६ वटा वालीहरुको १,२५१ जतहरुको नयाँ दर्ता गरी बीउलाई

मध्यमकालीन तथा दीर्घकालीन भण्डारण गरिएको ।

- त्यसैगरी २६१ वटा गहुँका तथा २५० वटा जौका जातहरुलाई क्रमशः CIMMYT तथा ICARDA को जीन बैंकमा सुरक्षित प्रतिलिपी भण्डारण गरिएको ।

फिल्ड जिन बैंक

- कम चिस्यानमा धेरै सुकाएर बीउ भण्डार गर्न नसकिने प्रजातिहरु (species having recalcitrant seeds) र वानस्पतिक प्रसारण हुने प्रजातिहरु (vegetatively propagated species) को संरक्षणको लागि केन्द्रको १५०० व.मी. क्षेत्रफलमा फिल्ड जिन बैंकको स्थापना भएको छ ।
- वीउ भण्डारण गर्न नसकिने बिभिन्न ३७ प्रजातिहरु फिल्ड जीन बैंकमा संरक्षण गरिएको छ ।
- फिल्ड जीन बैंकमा भएको जातहरुलाई उत्पादन लिए पछि संरक्षण गर्न अल्पकालिन संरक्षण कक्षको आधार बनेको छ ।
- कृषि अनुसन्धान केन्द्र, दैलेख र मालेपाटन, उखूबालि अनुसन्धान कार्यक्रम, जितपुर, र क्षेत्रिय कृषि अनुसन्धान केन्द्र, तरहरामा फिल्ड जिन बैंक स्थापना गरिएका ।

तन्तु बैंक

- तिन वटा बालीहरु (आलु, उखु तथा अलैंची) लाई तन्तु बैंकमा संरक्षण गरिएको छ र आलुको केहि तन्तु विरुवा वितरण गरिएको छ ।

डि.यन्.ए. बैंक

- बिभिन्न चार वटा बालीका १०१ जातहरु (अलैंचीका ६, स्कुसका ११, धानका ८२ र उखुका २) को बंशाणुगत चित्रण (DNA fingerprinting) गरी डि.यन्.ए. बैंकमा संरक्षण गरिएको ।

खेति स्थानिय संरक्षण (On-farm Conservation)

- कृषि जैबिक बिविधतालाई कृषकहरुकै खेतबारीमा संरक्षण गर्नको लागि ललितपुरको दलचोकी, सुनसरीको सिमरिया, वाराको कचोर्वा र कैलालीको गदरिया गरी ४ वटा सामुदायिक बीउ बैंकहरुको क्षमता अभिबृद्धिको लागि सहयोग गरिएको ।
- चार वटा सामुदायिक बीउ बैंकहरुलाई स्थानीय जातहरुको संकलन, संरक्षण तथा सुधार एवं फिल्ड जीन बैंक व्यवस्थापनको लागि प्राविधिक तथा आर्थिक सहयोग गरिएको ।

चरित्र चित्रण, मूल्यांकन तथा पूर्व वालि प्रजनन्

- बिशिष्ठ चरित्र चित्रण निर्देशिका (standard characterization descriptors) को प्रयोग गरेर यस केन्द्रमा जम्मा १४ वालीहरुको १,२३५ जातहरुको गुणात्मक तथा मात्रात्मक चरित्रहरुको बिश्लेषण तथा मूल्यांकन गरिएको ।
- पूर्व वालि प्रजनन् अर्न्तगत ५ वटा भिण्डि र ७ वटा खुर्सानिको जात परिक्षणको लागि छनौट गरिएको

आंकडा व्यवस्थापन

- पासपोर्ट डाटा संकलन फाराम को template तयार गरि पुरानो डाटालाई नयां ढाचाको फाराममा लगिएको छ ।
- आंकडा व्यवस्थापन सम्बन्धि तालिम आयोजना गरि दक्ष जनशक्ति तयार भएको ।
- संकलित जातहरुको पासपोर्ट डाटा व्यवस्थित गरिएको ।

EXECUTIVE SUMMARY

Collection and Distribution

- Exploration and collection of agricultural plant genetic resources are the regular activities of genebank. A total of 1628 samples of 43 different food crop species were collected from 19 districts during the year.
- The maximum diversity was collected from Humla (43 crops) followed by Dang (39 crops) and Kailali (36 crops).
- One of the main objectives of germplasm conservation in the gene bank is the utilization of this genetic material in plant breeding and related activities.
- Seeds of 218 local landraces of 10 crops were distributed to different offices and breeders (NARC divisions, programs and stations, Universities and farmers).
- Seeds of 50 soybean of Western and Far western region were distributed for seed multiplication for soybean mission programme to Doti station

Conservation

Regeneration and Multiplication

- A total 1,376 accessions of 19 different crops were regenerated and seed increased at NAGRC Khumatar.

Seed Bank

- Total 24 crop species (Soybean, , rayo, rice, maize, fingermillet, barley, wheat, prosomillet, Radish, Beans ,Buckwheat, Coriander, Cress, Wheat, Barley, Naked Barley, Prosomillet, Sorghum, Foxtail millet, Amaranthus, Broad leaf mustard, Chilli, Brinjal, Tomato, Teosante, Cock's foot) were cleaned and viability was estimated through germination test following the ISTA guidelines. More than 50 % of the accessions of the crops met were able to meet the genebank standard for germination (<85%) and were sent for conservation.
- Seeds of 1,251 accessions of 26 different crop species were conserved as new entries in active and base collections.
- Similarly, 261 accessions of wheat and 250 accessions of barley were safety

duplicated in CIMMYT and ICARDA genebanks, respectively.

Field Genebank

- Field gene bank has been established in 1500 m^2 for vegetatively propagated crops and crops with recalcitrant seeds established.
- 37 crops of recalcitrant types have been conserved in Khumal field genebank.
- Short term storage are partly constructed for conserving field genebank plant genetic resources after harvest.
- Field genebank in ARS, Malepatan and Dailekh, Sugarcane Research Program, Jeetpur and Regional Agricultural Research Station, Tarahara established.

Tissue Bank

- A total of 3 crop species (potato, sugarcane and cardamom) were conserved in tissue bank and some of potato plantlets were distributed for research.

DNA Bank

- DNA fingerprinting of 101 accessions of 3 crop species (6 cardamoms, 11 chayote, 82 rice and 2 sugarcane) was carried out and conserved in DNA Bank.

On-farm Conservation

- Genebank has supported four community seed banks located in Dalchowki, Simariya, Kachorwa and Gadhariya, for on-farm conservation of agro-biodiversity.
- Technical and financial assistance on collection of local landraces, conservation, improvement and field genebank management were provided to 4 CSBs.

Characterization, Evaluation and Pre-Breeding

- A total of 1,235 accessions of 14 different crops were characterized and evaluated using the descriptors developed by IPGRI and other concerned international institutions.
- Five accessions of okra and 7 accessions of chilli were selected as elite lines for evaluation in the coming year.

Database Management

- Passport format template developed and old passport data transferred to this format
- Capacity of Genebank staff on database management enhanced through training
- Passport data of collected accessions have been updated and maintained.

1. WORKING CONTEXT

Conservation and sustainable utilization of agricultural genetic resources is the mission of National Agriculture Genetic Resources Center (NAGRC). Therefore, its command area covers whole country including cultivated as well as wild areas. Local landraces are collected from the farms and other genetic resources from the different organizations. Total collections so far are given in Table 1. Collections are made based on the three agro-ecozones ie High Hill, Mid Hill and Tarai of the country. Priority is given to those areas which are far from the vehicle road and not collected previously. This year, germplasms were collected from 19 districts (Figure 1). Genebank has been collaborating with NARC stations, district agriculture offices, NGOs and Community Seed Banks for exploration, collections, regeneration and multiplication.

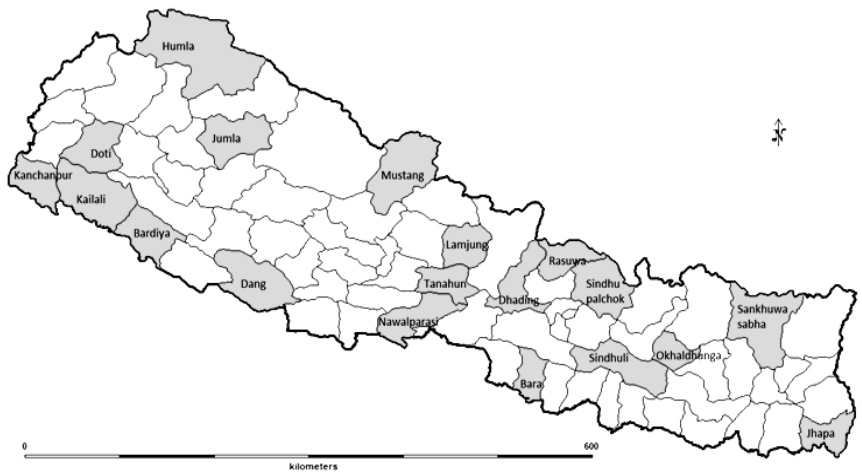


Figure 1. Germplasm collection districts (shaded) during 2014/15

While collecting, all kinds of agricultural genetic resources ie orthodox types, recalcitrant types and vegetatively propagated crop species are being collected along with passport descriptors. Some of the major problems associated during collections are:

- Many farmers are not interested to provide seed samples
- Diversity are not being captured due to very few seeds from farmers
- Collections are generally from farm store not from standing crops, due to which diversity in the collection could not be as it should be

- During collection, collectors always are facing difficulty on identifying the samples
- Difficulty on duplicates identification and possibility of collecting many duplicates

Collected germplasm are characterized and evaluated in Khumaltar and the collections which meet the Genebank standard are assigned accession number (permanent identification number). Database of each accession are maintained and made access to all. Considering conservation through utilization, genebank encourages all agriculturists to utilize landraces as much as possible. For the better management, conservation and utilization of agricultural genetic resources, all related stakeholders should be involved; therefore, Genebank has initiated to work with all stakeholders.

Table 1. APGR collections conserved in National Genebank

SN	Crop	Accessions, n	SN	Crop	Accessions, n
1	Rice	2400	**D.**	**Oilseeds**	**185**
2	Wheat	1700	31	Tomato	20
3	Barley	1230	32	Pumpkin	50
4	Maize	220	33	Okra	125
A.	**Cereals**	**5550**	34	Bitter gourd	15
5	Fingermillet	600	35	Sponge gourd	20
6	Foxtail millet	35	36	Barela	25
7	Proso millet	30	37	Lettuce	10
8	Pearl millet	5	38	Brinjal	25
9	Buckwheat	230	39	Cucumber	40
10	Amaranths	200	40	Leaf mustard	30
11	Sorghum	50	41	Coriander	25
B.	**Pseudocereals**	**1150**	42	Cress	30
12	Lentil	300	43	Chilli	100
13	Chickpea	300	44	Radish	50
14	Cowpea	150	**E.**	**Vegetables**	**565**
15	Grass pea	120	45	Taro	30
16	Pigeon pea	20	46	Yam	15
17	Field peas	125	47	Ginger	80
18	Beans	430	48	Turmeric	75
19	Rajma bean	20	49	Chayote	15
20	Broad bean	25	50	Potato	10
21	Soyabean	150	51	Sugarcane	6
22	Ricebean	40	52	Garlic	50
23	Horsegram	60	53	Fruit trees	20
24	Greengram	10	**F.**	**Field Gene Bank**	**301**
25	Blackgram	50	54	Others (miscellaneous)	1500
C.	**Pulses**	**1800**	**Total**		**11051**
26	Rapeseed/mustard	90			
27	Sarsoon	20			
28	Sesame	40			
29	Niger	15			
30	Linseed	20			

Note: Some of these accessions are under the process of conservation

2. INTRODUCTION

Nepal is rich in agro-biodiversity and national economy is based on the goods and services derived from these resources. Diverse agro-climatic environments with complex and varied farming systems, a broad mixture of ethnicity and races, varied socioeconomic settings, big differences in altitude and complex topography are the factors to create an array of micro-niches with huge agricultural diversity in the country. Three physiographic zones of Nepal, Tarai, Hill and Mountain experience a wide range of climate from tropical to temperate and arctic. The variation is mainly attributed to immense changes in elevation with the greatest range of altitude on earth, from 60 to 8848m. Prevailing of six seasons in Nepal indicate the unique climatic variation. Due to this variation across the country, diverse forms of genetic resources are being evolved and maintained.

Genetic resources are essential for sustainable development of human life. The nation holds less than 0.1% of earth's land mass, however, supports 2.2% of flowering plants, 1.4% of reptiles, 2.2% of fish, 8.5% of birds, 4.2% of butterflies and 4% of mammals. Out of about 410 angiosperm families in the world, 203 (almost 50%) are found in Nepal. The Biodiversity Profiles Project (1995) ranked Nepal as having the tenth richest flowering plant diversity in Asia and 31st on a world scale.

The plant products account for the majority portion of the global food supply. Globally, over 84% of human diet and nutrition comes from plants. In Asia and the Pacific, the Near East and Africa plants provide around 90% of the average human diet. However, human beings are dangerously relying on only a few crops species. Out of the 10,000 to 12,000 known edible plant species, only 150 to 200 are used by humans and three of them alone ie rice, wheat and maize contribute nearly 60% of calories and proteins that humans obtain from plants.

Meeting the expected increase in food demand is not an easy task. About half of the average global production increase in cereals that were achieved under the Green Revolution was attributable to plant breeding utilizing plant genetic resources. The other half came from altered agricultural practices such as the use of fertilizers, pesticides, irrigation and expansion of cultivated areas. Since the natural resources, on which agriculture rely, are finite and in some cases even declining, these agricultural practices cannot be

sustained over the long run. This suggests that the role of crop diversity and plant breeding will become even more important in the near future for achieving food security in a sustainable way. Indeed, over 70% of the required production increases by 2050 will have to come from higher yield and less than 10% can be expected from an expansion in arable land.

Crop genetic resources contain the essential building blocks that are critical to food security. They are the raw materials for genetic improvement of food crop species by plant breeders and farmers and are essential in maintaining sustainability of global food production system. Their availability is a fundamental requirement for achieving further productivity increase and higher nutritional values through plant breeding. Crop varieties that achieve significantly higher yields and that are able to withstand new diseases and extreme weather events will have to be developed. To develop a new variety, breeders may have to screen thousands of samples in search of a particular trait. For this, it is crucial to conserve the existing crop diversity and to allow agricultural researchers, breeders and farmers access to it. Plant genetic resources that are conserved in the gene bank can be used for:

- Safe conservation for future use
- Direct use for agricultural production
- Conservation of diversity in artificial environment
- Scientific use for experimental materials
- Genetic enhancement (pre-breeding)
- Breeding materials for the sustainable development
- Materials for repatriation

Broad genetic base of traditionally inherited cultivars and livestock breeds largely contributes to Nepal being among the world's most important areas for conservation. Nepal has biodiversity values that are of significance both nationally and internationally. Initiatives in last four decades for agricultural modernization and commercialization have led to gradual disappearance of traditional agriculture genetic resources and indigenous knowledge, skills and technologies. The nation is now experiencing the effects of ecosystem and diversity decline along with detrimental effects of climate change. Although hybrids and modern varieties have widely replaced landraces, remote northern parts of the country that are less influenced by exotics, because of harsh environments, may function as refuges for these threatened genetic resources. This necessitates the need for conservation and sustainable

use of agro-biodiversity that has potential to meet the present needs and aspirations of the future generations in the changed contest. Reasons for genetic erosion are quite diverse. Many traditional crop varieties were replaced by modern improved varieties brought about the significantly higher yield that were urgently needed to feed the growing population. According to the Food and Agriculture Organization of the United Nations (FAO), more than 75 % of global crop diversity has disappeared irrevocably over the 20th century (1900 to 2000). One of the most important reason for the loss of traditional seeds, and thereby the loss of genetic diversity, is the replacement of genetically diverse farmers' varieties with modern varieties.

A large number of wild relatives of important food crops are also likely to disappear over the next decades due to climate change and changes in agricultural practices. At the same time crops that have historically been cultivated especially well in a given region may no longer be of use and will have to be substituted by other crops. For example, in South Asia, climate change induced temperature rise may reduce wheat and rice productivity by 30% by the year 2030. It becomes clear that crop diversity, food security and climate change are closely linked in diverse and complex ways.

Realizing the significance of conservation and sustainable use of agro-biodiversity in national development and to meet the national obligation of implementing international agreements (the Convention on Biological Diversity, 1992 and International Treaty on Plant Genetic Resources for Food and Agriculture) the Government of Nepal and Nepal Agricultural Research Council has established the National Agriculture Genetic Resources Center (Genebank) in 2010 at Khumaltar (located at 1368 m altitude and 27^{o}40'N, 85^{o}20'E). The establishment of the center has become a milestone in conservation and sustainable use of agricultural genetic resources and ensuring the availability of the valuable genetic resources for prosperity. There are five units under the Genebank, namely Collection and Distribution Unit, Conservation Unit, Characterization and Evaluation Unit, Biotechnology Unit, and Documentation, Publication and Training Unit.

2.1. History

1937: Start of plant exploration missions undertaken by international organizations
1940: First collection and evaluation of indigenous plants materials by the then His Majesty's Government
1972: Establishment of Vegetable Development Division with emphasis for collections
1984: Establishment of Plant Genetic Resource Section in Agriculture Botany Division of NARC and actively involved in PGR exploration, collection and conservation activities
1986: Establishment of medium term ex-situ conservation
2003 Establishment of Community Seed bank
2010: Establishment of National Genebank (National Agriculture Genetic Resources Center)
2012: Establishment of Field Genebank and Community Field Genebank
2013: Tissue Bank and DNA Bank
2014: Establishment of Base Collection Room (BCR-I and BCR-II) of 100,000 accessions capacity with -18^{o}C for long-term seed conservation (50-100 years) at NAGRC

2.2. Mission

Conservation and sustainable use of agricultural genetic resources for sustained agricultural growth and livelihood.

2.3. Objectives

1. To explore, collect and conserve agricultural genetic resources for promoting sustainable use.
2. To manage and handle the agricultural genetic resources scientifically in the country according to the rules and regulations of genetic resources movement.
3. To identify the endangered, rare and unique genetic resources and give emphasis to conserve them
4. To create a single entry point to get access to agricultural genetic resources and associated data.
5. To locate the center of diversity of all economical crop species in the country.
6. To characterize and evaluate genetic resources and avail the resources to researchers, academicians, farmers, entrepreneurs and related stakeholders.

7. To screen genetic resources and identify markers associated with particular traits and develop elite lines through pre-breeding.
8. To manage database associated with each accession including passport, characterization, evaluation and traditional knowledge.

2.4. Conservation Strategies

Different conservation strategies have been considered so that they complement each other and help to conserve maximum diversity as much as possible. Ex-situ conservation preserves the genetic resources that have orthodox seeds in static condition. On-farm conservation which is also called dynamic conservation, complement the ex-situ conservation by continued cultivation of locally available crop varieties in farmers' field. In-situ conservation is useful to conserve the wild species and its relatives including wild edible plants. The Genebank has considered the following conservation strategies.

- Ex-situ conservation
  - Seed conservation as Seed Bank (Base collection and Active, or working collection for orthodox seeds)
  - In-vitro conservation (for recalcitrant seeds and vegetatively propagated crops)
    - Cryopreservation (Cryo Bank)
    - Cold storage (Tissue Bank)
  - Field Genebank (for recalcitrant seeds and vegetatively propagated crops)
  - DNA bank for all kinds of APGRs
- On-farm conservation (for locally available crop genetic resources) as Household Genebank and Community Genebank (seed and field genebank)
- In-situ conservation (for wild crop species and wild relatives)

2.5. Genetic Resources for Conservation

- Landraces
- Modern and obsolete varieties
- Breeding lines eg RILs, Genetic stocks, NILs, Differential lines
- Exotic genetic resources
- Wild and wild relatives of cultivated crop species
- Wild edible plants

These genetic resources are grouped as follows based on the economic values

1. Cereals
2. Millets
3. Pulses
4. Oil seeds
5. Vegetables
6. Spices
7. Fruits
8. Beverages
9. Fibers

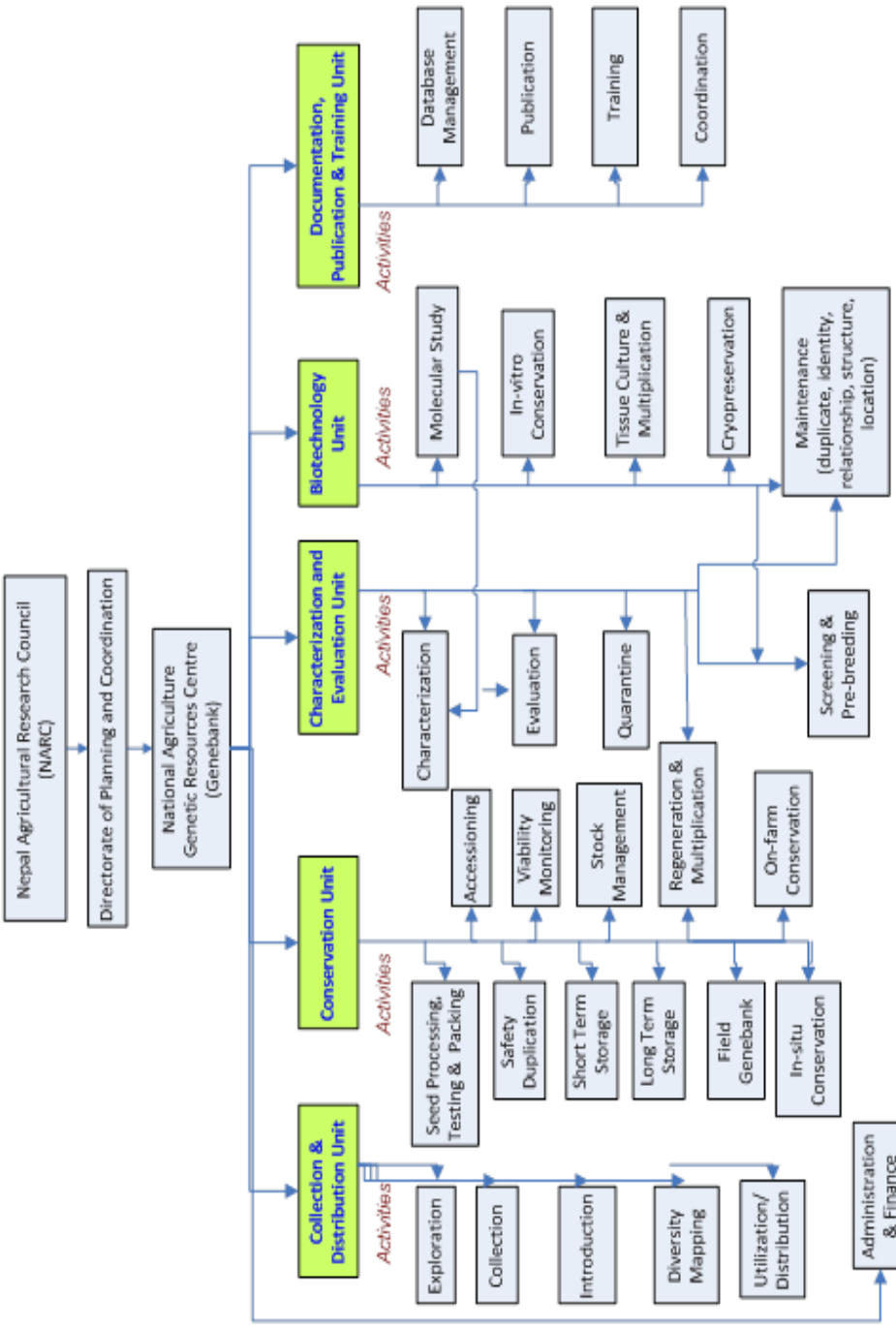
2.6. Regular Activities

- Exploration and collection
- Seed testing and processing
- Regeneration and multiplication
- Characterization and evaluation
- In-vitro culture
- Distribution and exchange of materials
- Registration
- Conservation
- Viability monitoring
- Genotyping
- Screening and pre-breeding
- Database management

2.7. Facilities Available in the Center

- **Long term storage:** Cold store room (called Base Collection Room, BCR) with -18^{o}C is functional which has capacity of storing about 100,000 accessions for 50-100 years.
- **Medium term storage:** Cold store room (called Active Collection Room, ACR) is functional which has capacity of storing about 50,000 accessions for 10-15 years.
- **Seed testing and processing lab:** Facilities are available for seed cleaning, viability testing, germination testing, seed drying and packing, characterization and evaluation.
- **In-vitro culture room:** Tissue culture room as well as in-vitro cold storage (Tissue Bank) facilities are available.
- **Molecular research lab:** Facility is available for DNA works and conservation (DNA Bank).
- **Field genebank:** A separate plot is allocated for field genebank. Field genebank will be extended along the road and around the office buildings and premises, other NARC's stations.
- **Experimental plot:** Field is available for diversity blocks, regeneration, multiplication, characterization and evaluation.
- **Database management:** Documentation facilities are available for passport, management, characterization, evaluation, pre-breeding and utilization data.

2.8. Organization Structure



3. RESEARCH HIGHLIGHTS

3.1. Collection and Distribution

Major activities under this unit are exploration, collection, introduction, diversity mapping and distribution.

3.1.1. Collection

Exploration and collection of plant genetic resources are the regular activities of genebank. Exploration and collection mission was organized in close collaboration with other research stations of NARC and district agricultural development offices. The multi crops germplasm were collected from various districts of Nepal (Figure 1) with the following activities:

- Preparation for multi crop collection mission
- Interaction meetings with the extension workers
- Group meeting with the farmers
- Random sampling from different locations of the districts covered
- Collecting samples by farmer's interview from his/her farm house/stores/fields

Exploration and collection reference guidelines were drafted and discussed among the Genebank personnel. A total of 1628 samples of 43 different food crop species were collected during the year (Figure 2). The maximum diversity was collected from Humla (43 crops) followed by Dang (39 crops) and Kailali (36 crops).

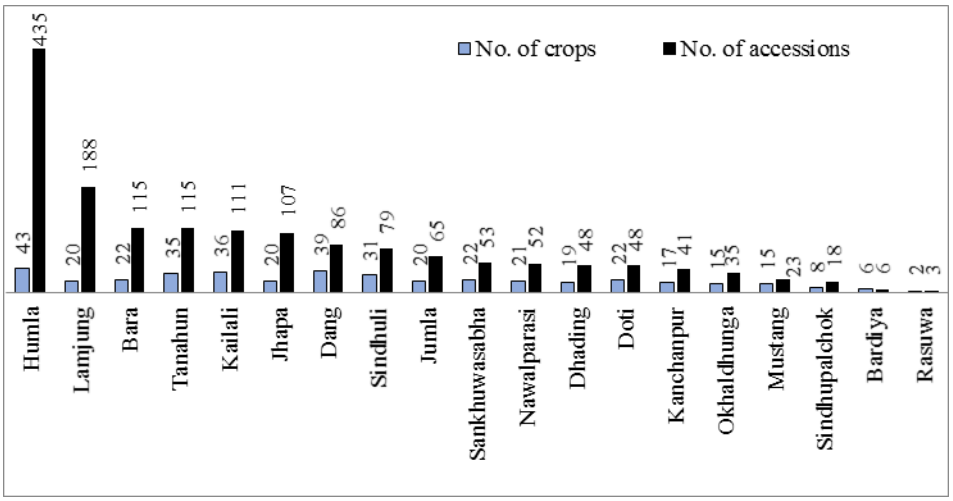


Figure 2. Number of collections from different districts during 2014/15

3.1.2. Distribution

One of the main objectives of germplasm conservation in the gene bank is the utilization of this genetic material in plant breeding and related activities. Seeds of the different accessions are supplied in response to the requests from the breeders and other research workers. Seeds of 218 local landraces of 10 crops were supplied in response to the requests from the researchers of 4 NARC offices, 2 Universities and a farmer; for research, studies and sustainable utilization of the germplasm (Table 1). Seeds are distributed only from the active collections.

Table 2. Distribution of germplasm for research/study purpose during this year

SN	Crop	Accessions, n	Research Program/Institute
1	Rice	40	Scientists of ABD, Khumaltar
2	Soybean	20	Scientists of ABD, Khumaltar
3	Rice	4	Students of IAAS, Lamjung
4	Maize	8	Scientists of RARS, Lumle
5	Finger millet	25	Students of AFU, Rampur
6	Barley	100	Students of AFU, Rampur
7	Naked barley	10	Farmer of Kavre
8	Potato	2	Scientists of NPRP, Khumaltar
9	Tomato	2	Scientists of ARS, Malepatan
10	Brinjal	2	Scientists of ARS, Malepatan
11	Chilli	5	Scientists of ARS, Malepatan
Total: 10 crops		218	4 NARC offices, 2 Universities, a farmer

3.2. Conservation

3.2.1. Seed Bank

Under this Unit, major activities are seed processing, testing and packing, accessioning, safety duplication, viability monitoring, short term conservation, long term conservation, stock management, regeneration and multiplication, field gene bank, in-situ conservation and on-farm conservation.

Seeds of 1251 accessions of 26 different crop species were conserved as new entries in active, base and duplicate collections (Figure 3). Besides these, 261 accessions of wheat and 250 accessions of barley were safety duplicated in CIMMYT and ICARDA genebank, respectively.

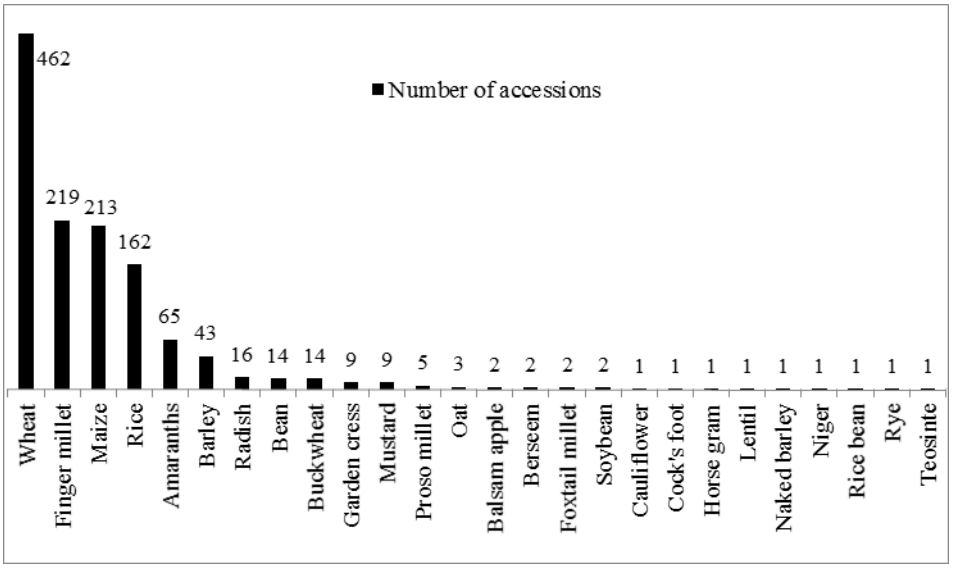


Figure 3. Number of accessions of different crops added in medium and long term storage during 2014-2015

3.2.2. Field Genebank

Field genebank is essential for those crops species having recalcitrant seeds for conservation, characterization, evaluation and utilization. In addition to such type of crops, vegetatively propagated and apomictic crop species are also conserved. Prioritizing the crop species is the initial step for establishing the field genebank. Instead of allocating separate field, we can use government's farm around the road and office buildings, community farms, botanical garden, culturally protected and heritage sites. In future, collaboration will be extended to community, heritage site and culturally protected areas to establish the field genebank.

While plants in the field genebank can be readily characterized and evaluated, the establishment and maintenance of field genebank is faced with many problems. These include the requirement of extensive land area and much labor and the danger of losing the germplasm due to pests, diseases and natural disasters. Further, owing to the high costs involved, it is possible to conserve in a field genebank only a small fraction of the total diversity.

Since there is a high risk of losing accessions it is advisable to maintain replicates of accessions in other locations, raising the cost further. Therefore, NAGRC has planned to establish Field Genebank across the country. The NAGRC has established Field Genebank at Khumaltar, called Khumal Field Genebank. Similarly four field genebanks has been established in ARS Jeetpur focusing to sugarcane diversity, RARS Tarahara giving due attention to mango diversity, ARS Kapurkot focusing to ginger and turmeric diversity and ARS, Malepatan focusing taro and coffee diversity.

Different species of fruits eg pomegranate, bhogate, avocado, orange, sweet orange, bimiro, seto jyamir, kalo jyamir, trifoliate, peach and plum are being maintained in the Khumal Field Genebank. Total crop list in Khumal Field Genebank is listed in (Table 3). Some of these accessions including 37 accessions of garlic have been characterized both phenotypically and genotypically.

Table 3. List of crops and total accessions maintained in Khumal Field Genebank

SN	Crop	Accession, n
1.	Apple	2
2.	Banana	1
3.	Belliric myrobalan	1
4.	Bojho	1
5.	Cardamom	2
6.	Chayote	7
7.	Cinnamon	3
8.	Elephant foot	2
9.	Emblic myrobalan	1
10.	Ginger	64
11.	Guava	3
12.	Jaitun	1
13.	Jujube	1
14.	Litchi	1
15.	Mandarin orange	6
16.	Mango	2
17.	Mulberry	3
18.	Muntala	2
19.	Papaya	1
20.	Peach	3
21.	Pear	1
22.	Pepino	1
23.	Persimmon	3
24.	Plum	2
25.	Pomegranate	2
26.	Potato	14
27.	Pummelo	4

SN	Crop	Accession, n
28.	Rosemerry	1
29.	Sapota	1
30.	Sugarcane	7
31.	Sweet orange	2
32.	Taro	44
33.	Timur	1
34.	Trifoliate orange	1
35.	Turmeric	80
36.	Walnut	1
37.	Wood apple	2

CSBs also provided such plant genetic resources for conservation in Khumal Field Genebank. Short Term Storage has been constructed for storing crop harvest from field genebank. Technical support has also been provided to different communities and NGOs for establishing field genebank. Request letter from NARC and MoAD has been circulated to all concerned offices for establishing field genebank by collecting plant genetic resources from their command areas.

Figure 4. Field- genebank in Genebank Complex, Khumaltar

3.2.3. On-farm Conservation

Agro-biodiversity needs to conserve at different levels ie farm, community, national and international to safeguard present and future food security. Custodian farmers and farming communities of diversity hot spot areas of the country need to be supported to conserve local crop varieties and indigenous knowledge.

Agricultural biodiversity can't be conserved without supporting farming communities, and conversely, farming communities can't be saved without saving agricultural diversity. Farmers are the key players for sustaining diversity. As a part of conservation, NARC has been supporting on-farm conservation since 2001 by involving farmers and their genetic resources in researches. This resulted in the establishment of Community Seed Bank (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. 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. The options of planting materials provided by CSB to the farmers are considered important to increase the total production at the household level. Diversity Fairs, Community Biodiversity Register (CBR), and Diversity Blocks are the major activities to collect and maintain the varieties in CSBs. These are also the experimental units where, selection can be imposed to identify the better genotypes. CSB is considered an economical way of conserving genetic resources; therefore, this center is helping community seed banks involved in conservation activities through training, material support, involving in different Genebank activities, etc.

Community Seed Bank of Gadhariya, Kailali; Dalchowki, Lalitpur; Kachorwa, Bara and Simariya, Siraha have been supported in different aspects eg collection techniques, passport format, field genebank concept, selection, materials supply, etc. Seeds of different crop species from Community Seed Banks have been collected and conserved in the Genebank. Genebank team has regularly participated in meetings; workshops related to CSB and encouraged farming community for on-farm conservation and sustainable utilization. Seeds from 17 Community Seed Banks of 14 districts have been handed to National Genebank this year.

Under the on-farm conservation, Household Genebank concept has been in practice. Identification of agro-biodiversity rich farmers (also called custodian farmer) is the initial step to strengthen the Household Genebank. 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.

3.2.4. Regeneration and Multiplication

Regeneration and seed increase of the accessions with limited quantity of seed are the regular activities of regeneration unit. During the year 2071/72, a total of 1376 accessions of 19 different crops were regenerated (Figure 4) and multiplied at NAGRC, Khumaltar. Accessions were harvested after physiological maturity. Harvested seeds were threshed, dried and processed for registration and storage as necessary.

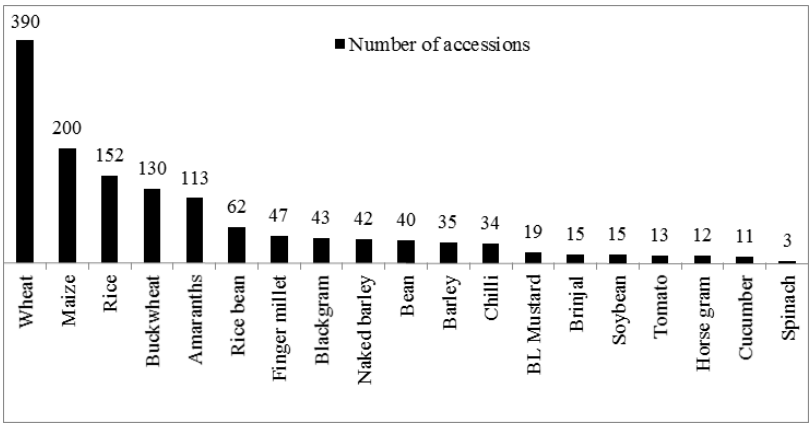


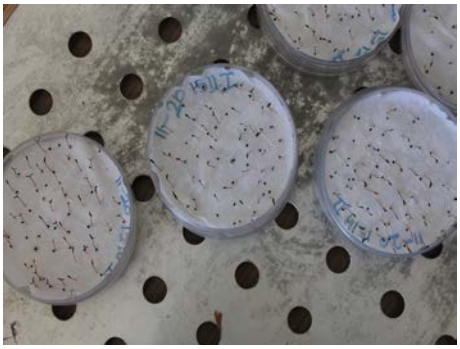
Figure 5. Number of accessions of various crops regenerated during 2014-2015

3.2.5. Seed Testing and Processing

Seed viability and seed health are two qualities of seed which is monitored by periodic germination test. Seed viability is very important for the longevity of seed and seed longevity is most important aspect especially in gene banks. Seed laboratory plays a vital role in NAGRC which guides the majority of the consecutive activities like regeneration, conservation and utilization. Seed processing laboratory of NAGRC is accredited to ISTA and works principally on ISTA rules and SQCC Central Seed Testing Laboratory guidelines. This laboratory has been operative since the establishment of Gene Bank and is extensively focusing on seed viability testing.

A total of 1783 accessions of 24 crop species (soybean, , rayo, rice, maize, finger millet, barley, wheat, proso millet, radish, beans, buckwheat, coriander, cress, wheat, barley, naked barley, proso millet, sorghum, foxtail millet, amaranths, broad leaf mustard, chilli, brinjal, tomato, teosante, cock's

foot) were cleaned and viability was observed through germination test following the ISTA guidelines. More than 70% of the accessions of the crops were able to meet the genebank standard for germination (<85%) and were sent for conservation (Table 4).



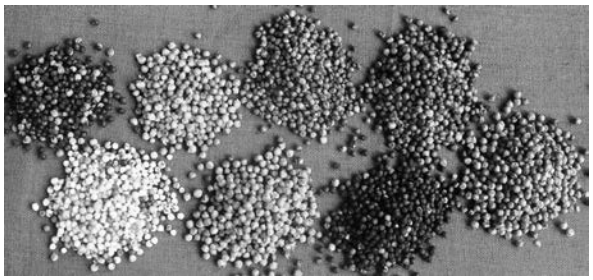


Table 4. Crop accessions and their germination test

SN	Crop	Test Method	Total no of accessions	Germination %							Range (Germ %)	No of Accs meeting std germination
				0-30	30-40	40-50	50-60	60-70	70-80	80-100		
1	Buckwheat	BP	49	2	3	0	1	2	7	34	0-100	31
2	Lentil	BP	2	0	0	0	0	0	0	2	98-99	2
3	Finger millet	TP	101		1	1	2	1	1	95	32-100	89
4	Niger	TP	1	0	0	0	0	0	0	1	100	1
5	Rice	BP	132	0	0	0	0	0	2	130	76-100	125
6	Coriander	TP	17	5	1	3	2	1	2	2	5-100	1
7	Radish	BP	26	0	0	0	0	3	0	23	66-100	21
8	Cress	TP	10	0	0	0	0	0	0	10	97-100	10
9	Wheat	BP	842	1	3	6	26	62	118	625	22-100	549
10	Barley	BP	42	1	0	0	0	0	2	39	0-100	32
11	Naked barley	BP	56	1		2	2	0	5	46	0-100	39
12	Proso millet	TP	8	1	0	0	1	1	0	5	5-98	4
13	Sorghum	TP/BP	3	0	0	0	0	1	0	2	73-90	1
14	Soybean	BP	3	0	0	0	0	0	0	3	83-98	2
15	Foxtail millet	TP	3	0	0	0	1	0	0	2	60-90	2
16	Amaranths	TP	282	0	0	0	0	0	0	282	85-100	282
17	Bean	BP	54		1				2	51	35-100	47
18	Broad leaf mustard	TP	24	0	0	0	0	0	0	24	85-100	24
19	Chilly	TP	30	2					2	26	40-100	25
20	Brinjal	TP	8			1				7	50-100	6
21	Tomato	TP	10							10	89-100	10
22	Maize	BP	78				2	2	2	69	52-100	69
23	Teosante	BP	1								99	1
24	Cock's foot	TP	1							1	98	1
			1783									1374

3.2.6. Maintenance of Diversity Block

Development and maintenance of diversity block is an important regular activity of the genebank. Different seasonal and perennial crop species diversity has been maintained in front of the genebank complex. Distinct local as well as improved varieties maintained on diversity block are: cereals/pseudo cereals (rice, wheat, barley, naked barley, maize, buckwheat, finger millet, proso millet, foxtail millet, quinoa, sorghum, amaranths, etc), pulses (black gram, horse gram, chickpea, lentil, soybean, rice bean, etc), seasonal vegetables (cauliflower, cabbage, broccoli, broad leaf mustard, lettuce, swiss chard, eggplant, tomato, okra, peas, french bean, broad bean, garden cress, asparagus, summer squash, bitter gourd, etc), annual and perennial root and tuber crops (radish, carrot, potato, sweet potato, taro, yam, ground apple, etc) spices (coriander, chilly, onion, garlic, ginger, turmeric, mint, fenugreek, perilla, stevia, etc) and sugarcane. This diversity block serves as the study blocks for different visitors (farmers, researchers, development workers, students, media persons, etc). Diversity block represents the distinct and unique variability present in a species as well as the richness of all types of species (species producing orthodox, intermediate and recalcitrant seeds as well as vegetatively propagated seasonal, annual and perennial crop species).

3.3. Characterization, Evaluation and Pre-breeding

The major activities under this unit are characterization, evaluation, quarantine, screening, pre-breeding and maintenance (duplicate, identity, relationship and structure). Regeneration and multiplication activities are generally linked with characterization and evaluation. During the year 2071/72, total of 1235 accessions of 14 different crop species namely wheat, rice, maize, finger millet, barley, naked barley, amaranths, buckwheat, beans, okra, chilli, radish, garlic and brinjal were characterized and evaluated at NAGRC, Khumaltar (Figure 5).

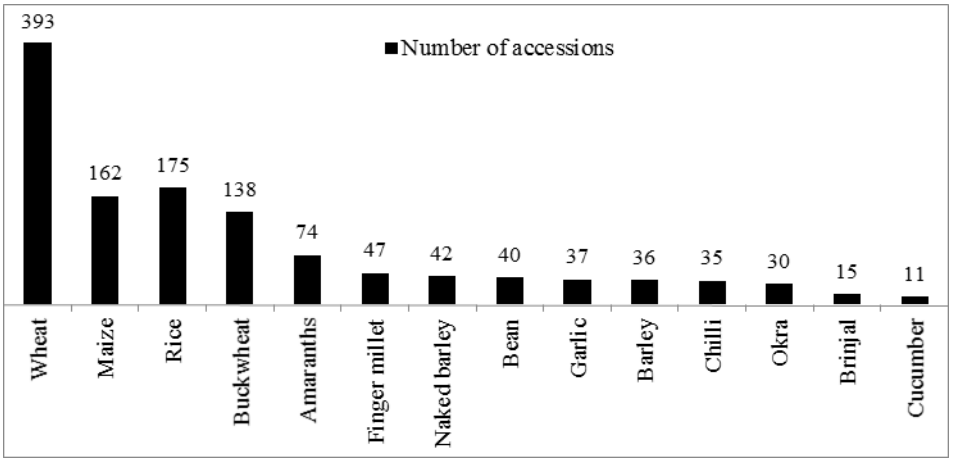


Figure 6. Number of accessions of different crops characterized during 2014-2015

3.3.1. Amaranths

Summary of different quantitative and qualitative traits of 66 amaranths accessions were presented in below the table no. 5 and 6.

Table 5. Descriptive statistics of amaranths accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Days to emergence	66	13	6	8	2.05
Days to heading	66	106	51	81	12.75
Days to flowering	66	160	90	113	15.31
Plant height (cm)	66	289	97	188	33.02
Main inflorescence length (cm)	66	91	16	57	14.46

Table 6. Descriptors states of amaranths accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Stem pubescence	66	None (3), Low (63)
Leaf shape	66	Lanceolate (29), Elliptical (20), Cuneate (1), Ovatainate (14), Rhombic (2)
Leaf margin	66	Entire (2), Undulate (64)
Inflorescence color	66	Yellow (28), Green (15), Pink (15), Red (8)
Inflorescence density index	66	Lax (2), Intermediate (58), Dense (6)
Terminal inflorescence attitude	66	Erect (40), Drooping (26)

3.3.2. Barley

Summary of different quantitative and qualitative traits of 36 barley accessions were presented in below the table no. 7 and 8.

Table 7. Descriptive statistics of barley accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Days to emergence	36	10	7	8.3	1.37
Days to heading	36	129	97	109.1	9.22
Days to flowering	36	133	101	117.1	9.68
Days to maturity	36	155	137	145.1	5.69
Plant height (cm)	36	130	87	107.3	9.88

Table 8. Descriptors states of barley accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Growth habit	36	Prostrate (9), Intermediate (15), Erect (12)
Stem pigmentation	36	Green (23), Purple-basal only (13), Purple (3)
Auricle pigmentation	36	Green (9), Pale purple (26), Dark purple (1)
Spike density	36	Lax (20), Intermediate (14), Dense (2)
Lemma awn/hood	35	Awnletted (3), Awned (32)
Lemma awn barbs	36	Smooth (1), Intermediate (8), Rough (27)
Glume color	36	White (1), Yellow (32), Brown (3)
Awn color	36	Amber (11), Yellow (21), Brown (4)
Lodging	36	Low (20), Medium (8), High (8)

3.3.3. Buckwheat

Summary of different quantitative and qualitative traits of 138 buckwheat accessions were presented in below the table no. 9 and 10.

Table 9. Descriptive statistics of buckwheat accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Days to flowering	137	84	71	78	3.38
Days to maturity	137	107	78	96	5.71
Plant height (cm)	127	134	47	86	22.29
Number of internodes	127	16	11	14	1.16

Table 10. Descriptors states of buckwheat accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Stem color	135	Green (133), Red (2)
Leaf color	135	Green (135)
Lodging susceptibility	135	Very resistant (104), Intermediate (30), Very susceptible (1)
Degree of determination	135	Indeterminate (13), Intermediate (67), Determinate (55)
Leaf pigmentation	127	Yes (14), No (113)
Stem pigmentation	130	Yes (117), No (13)
Flower color	129	Greenish yellow (129)
Threshability	137	Easy to thresh (137)

3.3.4. Finger millet

Summary of different quantitative and qualitative traits of 47 finger millet accessions were presented in below the table no. 11 and 12.

Table 11. Descriptive statistics of finger millet accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Emergence days	47	10	4	6.6	1.38
Heading days	47	109	60	89.3	14.06
Flowering days	47	116	67	94.7	13.85
Maturity days	47	166	111	142.2	17.58
Blade length of flag leaf (cm)	47	40.7	18.1	24.3	4.90
Blade with of flag leaf (cm)	47	1.3	0.7	0.9	0.17
Leaf blade length (cm)	47	47.7	25.9	33.7	5.61
Leaf blade width (cm)	47	1.3	0.7	0.9	0.17
Leaf sheath length (mm)	47	4.4	2.1	2.8	0.50
Ear exertion (cm)	47	19.0	6.4	11.7	2.62
Productive tillers	47	3.5	1.3	2.6	0.49
Plant height (cm)	47	103.8	65.2	85.6	9.49

Table 12. Descriptors states and frequency of finger millet accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Growth habit	47	Erect (47)
Plant pigmentation	47	Pigmented (12), Not pigmented (35)
Ear shape	47	Open (8), Semi-compact (39)
Ear size	47	Large (1), Intermediate (36), Small (10)
Spike shattering	47	Absent (34), Present (13)

3.3.5. Maize

Summary of different quantitative and qualitative traits of 162 maize accessions were presented in below the table no. 13 and 14.

Table 13. Descriptive statistics of maize accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Days of emergence	162	24	6	10	2.78
Days of tasseling	162	101	37	66	10.21
Days of silking	162	103	46	72	9.98
Days to maturity	160	151	89	118	11.90
Ear height (cm)	161	225	33	128	43.63
Plant height (cm)	161	349	114	239	51.52
Ear length (cm)	153	20	7	15.4	2.04
Kernel length (mm)	158	11	2.4	9.7	1.03
Kernel width (mm)	158	12	1.4	9.4	1.32
Ear diameter (cm)	153	15	7	12.6	1.26
Number of leaves above uppermost ear	162	7	4	5.5	0.69

Table 14. Descriptors states and frequency of maize accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Husk cover	161	Poor (16), Intermediate (139), Good (6)
Kernel type	158	Dent (5), Semi-dent (18), Semi-flint (39), Flint (82), Pop (12), Sweet (2)
Kernel colour	158	White (51), Yellow (63), Purple (4), Brown (2), Orange (28), White cap (7), Red (2)

3.3.6. Naked barley

Summary of different quantitative and qualitative traits of 42 naked barley accessions were presented in below the table no. 15 and 16.

Table 15. Descriptive statistics of naked barley accessions in different quantitative traits

Quantitative trait	Count	Minimum	Maximum	Mean	SD
Days to emergence	41	13	7	8.4	1.30
Days to heading	41	127	83	101.9	9.61
Days to flowering	41	132	90	108.8	8.31
Days to maturity	41	165	132	140.5	5.90
Plant height (cm)	41	132	86	108.6	10.82

Table 16. Descriptors states and frequency of naked barley accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Growth habit	36	Prostrate (2), Intermediate (11), Erect (18)
Stem pigmentation	36	Green (21), Purple-basal only (16), Purple (4)
Auricle pigmentation	36	Green (10), Pale purple (29), Dark purple (2)
Spike density	36	Lax (5), Intermediate (28), Dense (8)
Lemma awn/hood	35	Awnletted (3), Awned (31), Sessile hoods (5), Elevated hoods (2)
Lemma awn barbs	36	Smooth (2), Intermediate (9), Rough (30)
Glume color	36	White (11), Yellow (18), Brown (11), Black (1)
Awn color	36	Amber (3), Yellow (19), Brown (18), Black (1)
Lodging	36	Low (31), Medium (9), High (1)

3.3.7. Rice

Summary of different quantitative and qualitative traits of 175 rice accessions were presented in below the table 17 and 18.

Table 17. Descriptive statistics of rice accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Average	SD
Heading days	175	160	60	109.2	23.61
Flowering days	175	189	106	156.5	19.70
Maturity days	175	159	40	90.8	28.02
Plant height (cm)	175	34.2	13.0	21.1	3.18
Panicle length (cm)	175	47.4	11.6	33.1	6.59
Leaf length (cm)	175	1.6	0.6	0.9	0.16
Leaf width (cm)	175	2.7	0.6	1.3	0.34
Ligule length (cm)	175	249	42	98.1	34.97
No of seed/panicle	175	10.4	2.8	8.2	1.19
Grain length (mm)	175	3.9	1.8	2.7	0.38
Grain width (mm)	175	160	60	109.2	23.61

Table 18. Descriptor states and frequency of rice accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (Frequency)
Ligule color	175	White (175)
Ligule shape	175	2-Cleft (175)
Leaf blade pubescence	175	Glabrous (59), Intermediate (95), Pubescent (21)
Basal leaf sheath color	175	Green (71), Green with purple lines (70), Light purple (32), Purple (2)
Leaf angle (Below flag leaf)	175	Erect (64), Intermediate (96), Descending (2), Horizontal (13)
Flag leaf angle	175	Erect (89), Intermediate (46), Descending (13), Horizontal (27)
Collar color	175	Pale green (174), Purple (1)
Culm angle	175	Erect (7), Intermediate (137), Open (28), Spreading (3)
Internodes color	175	Green (68), Light gold (102), Purple lines (3), Purple (2)
Panicle type	175	Compact (56), Intermediate (88), Open (31)
Secondary branching	175	Absent (5), Light (88), Clustering (37), Heavy (45)
Panicle exertion	175	Enclosed (64), Just exerted (33), Partly exerted (15), Moderately well exerted (63)
Panicle axis	175	Straight (16), Droopy (159)
Panicle shattering	175	Very low (109), Low (52), Moderate (13), High (1)
Threshability	175	Easy (52), Intermediate (79), Difficult (44)
Awning	175	Absent (152), Present (23)

3.3.8. Wheat

Summary of different quantitative and qualitative traits of 393 wheat accessions were presented in below the table 19 and 20.

Table 19. Descriptive statistics of wheat accessions in different quantitative traits

Quantitative trait	Count	Maximum	Minimum	Mean	SD
Days to emergeme	393	15	7	10.7	1.83
Days to heading	393	147	95	112.3	6.33
Days to flowering	393	154	99	118.4	6.29
Days to maturity	393	189	138	162.2	9.95
Plant height (cm)	393	141	50	95.4	12.62
Spike length (cm)	393	12.8	6.2	9.1	1.19
Spike breadth (mm)	393	13.4	5.6	8.4	1.05
1000 seed wt (gm)	393	72.0	19.1	41.0	7.87

Table 20. Descriptors states and frequency of wheat accessions in different qualitative traits

Qualitative trait	Count	Descriptors states (frequency)
Growth habit	393	Spring (363), Facultative/Intermediate (30)
Tillering capacity	393	Low (126), Medium (216), High (51)
Spike density	393	Lax (98), Intermediate (229), Dense (62), Very dense (4)
Awning	393	Awnless (3), Awnletted/Short awns (58), Awned/Conspicuous awns (332)
Glume color	393	White (141), Red to brown (216), Purple to black (36)
Glume hairiness	393	Absent (109), Low (226), High (58)
Seed color	393	White (261), Amber (54), Red (78)
Seed size	393	Small (79), Intermediate (275), Large (39)

3.3.9. Okra

Total of 25 accessions of okra was planted for seed multiplication and characterization during the month of first week of Baisakh. The recommended package of practice was taken up and each plot was caged with agro net to avoid contamination and virus prevalence. About 46.6% of the accessions were of 160-170cm tall, 40% bear the first flower in the second node, 24% was with the stem diameter of 22-30 centimeter, and 45.8% were with greenish pink stem color. More than half (65%) of the accessions were with the leaves with medium lobbing depth. The fruit diameter varied from 22-23 cm, 23-24 cm, 24-25 and 26-27 cm and each possessed 20% of total accessions. Constriction at the fruit base were absent in most of the accessions (95.2%). Around 92% of the accessions had green fruits and remaining 8% were with yellowish green fruit, 86% of accessions had 21-22 cm fruit length, 52% were with 22-23 mm fruit width or diameter.

Table 21. Characterization of 25 accessions of Okra

SN	Descriptor	Descriptor state								Range
		Frequency								
1	**Plant height (cm)**	100-120	120-130	130-140 6.7%	140-150 20%	150-160 6.7%	160-170 46.6%	170-180 20%	180-190	**131.7-179.1**
2	**Stem no. nodes (1st flower)**	1 (5%)	2 (40%)	3 (25%)	4 (15%)	5	6 (15%)	7	8	**1-6**
3	**Stem diameter (cm)**	15-16 (17.2%)	16-17	17-18 (6.8%)	18-19 (17.2%)	19-20 (17.2%)	20-21 (6.8%)	21-22 (10.3)	22-30 (24.1%)	**15.27-29.07**
4	**Stem colour**	Green (12.5%)	Green red (37.5%)	Purple (4.2%)	Greenish pink (45.8%)					
5	**Lobbing depth**	Shallow (15%)	Medium (65%)	Strong (20%)						
6	**Fruit diameter (mm)**	20-21 (8%)	21-22 (8%)	22-23 (20%)	23-24 (20%)	24-25 (20%)	25-26 (8%)	26-27 (20%)	27-28 (12%)	**21.43-29.87**
7	**Fruit constriction at base**	Absent (95.2%)	Weak (4.72%)	Strongly 0						
8	**Fruit colour**	Yellow green (8%)	Green (92%)	Green with red	Red					
9	**Fruit length (cm)**	15-16 (8.6%)	16-17 (13%)	17-18 (13%)	18-19 (17.4%)	19-20 (13%)	20-21 (21.7%)	21-22 (86%)	>23 (8.6%)	**14.1-54.8**
10	**Fruit width (mm)**	21-22 (12.5%)	22-23 (52%)	23-24 (12.5%)	24-25 (12.5%)	25-26 (12.5%)	26-27 (16.7%)	27-30 (12.5%)		

3.3.10. Chilli

A total of 35 accessions of chilli were seeded during the month of Chaitra and transplanted after a month for seed multiplication and characterization. The recommended package of practice was followed and IPGRI descriptors and NIAS genebank descriptors were used for characterization. About 29.4% of accessions were with 80-90 cm height followed by 26.4% with 90-100 cm. Majority of accessions (88.6%) possessed 1 flower per axil and 45% were with intermediate flower position. All the accessions possessed green fruits with 78.4% intermediate green color. Total of 63.9% had elongated fruit shape and 54.3% were with high pungency followed by 45.7% with medium pungency. About 88.6% of the accessions were without and 11.4% with shortened internode. The fruit length ranged from 8.72-21.21 cm with 15.7% accessions possessed 20-30 cm and 70-80 cm fruit length each whereas majority (35.5%) were with 1.5-2 g fruit weight. Among 35 accessions, four were Akabare chili type whereas remaining 31 were normal chili types.

Under the pre-breeding of chili, 7 accessions (C5025, C3683, C5023, C4902, C4905, C3755, C4066) were selected as elite lines based on the plant vigor, fruit size, shape, pungency, and fruit bearing.

Table 22. Characterization of 35 accessions of Chilli

SN	Description	Descriptor state									Range
		Frequency									
1	Plant height (cm)	30-40	40-50 (2.9%)	50-60 (5.9%)	60-70 (5.9%)	70-80 (11.8%)	80-90 (29.4%)	90-100 (26.5%)	100-110 (14.7%)	110-120 (2.9%)	120-130	**45.9-113**
2	No. flower/ Axil	1 (88.6%)	1,2 (5.7%)	1,2,3 (5.7%)	1,3,4							**1-3**
3	Flower position	Pendant (28.6%)	Intermediate (45.7%)	Erect (25.7%)								
4	Fruit colour	Light green (13.5%)	Intermediate (78.4%)	Dark (8.1%)								
5	Fruit shape	Elongate (63.9%)	Almost round (2.6%)	Triangular (21.6%)	Campanulate (0%)	Blocky (13.2%)						
6	Capsaicin	Very pungent (54.3%)	Pungent (45.7%)	No pungency								
7	Shortened internode	Present (11.4%)	Absent (88.6%)									
8	Fruit length (cm)	10-20 (5.3%)	20-30 (15.7%)	30-40 (13.1%)	40-50 (18.4%)	50-60 (13.1%)	60-70 (13.1%)	70-80 (15.7%)	80-90 (7.89%)			**20.74-92.08**
9	Fruit diameter (mm)	8-9 (5.26%)	9-10 (21.1%)	10-11 (16%)	11-12 (23.68%)	12-13 (7.89%)	13-14 (0%)	14-15 (5.26%)	17-18 (7.89%)	18-19 (5.26%)	19-25 (7.89%)	**8.72-21.21**
10	Fruit weight (gm)	1.5-2 (35.5%)	2-2.5 (12.9%)	2.5-3 (3.2%)	3-3.5 (22.6%)	3.5-4 (12.9%)	4-4.5 (3.2%)	4.5-5	5-5.5 (9.7%)	5.5-6		**1.2-5.57**

3.3.11. Garlic

Total of 35 accessions of garlic were planted during the third week of Kartik as field genebank. The recommended package of practice was followed and IPGRI descriptors and NIAS genebank descriptors were used for characterization. About 48.6% were with height between 60-70 cm, 67.6% were leaf length between 30-40 cm and 48.6%, were leaf width between 2-2.5 cm. About 51.4% were with intermediate waxiness of leaf and 78.3% were with leaf thickness between 1-1.5 mm. In terms of number of clover plant, 35.1% consisted of number of cloves between 25-30, 43.2% were with single clove weight 1-1.5 gm followed by 37.8% with 1.5-2 gm. The leaf shaft length ranged from 4.2-10.31 cm with 18.9% was between 6-6.5 cm followed by 16.2% between 6.5-7 cm. The shape of the mature dry bulb were flat, flat globe, rhomboid, broad oval, globe, ovate. Majority (37%) consisted of rhomboid and globe mixture whereas 24.3% consisted of flat globe and broad oval mixture.

Table 23. Characterization of 37 accessions of garlic

SN	Descriptor	Descriptor state									Range
		Frequency									
1	Plant height (cm)	40-50 (2.7%)	50-60 (24.6%)	60-70 (48.6%)	70-80 (21.6%)	80-90 (2.7%)	90-100				**49.2-86.2**
2	Leaf length (cm)	20-30 (21.6%)	30-40 (67.6%)	40-50 (5.4%)	50-60 (5.4%)	60-70	70-80	80-90	90-100		**(21.9-55.4)**
3	Leaf width (cm)	1-1.5 (10.8%)	1.5-2 (40.5%)	2-2.5 (48.6%)	2.5-3	3-3.5	3.5-4	4-4.5	4.5-5	5-5.5	**(1.2-2.7)**
4	Waxiness	Less (37.8%)	Inter (51.4%)	High (10.8%)							
5	Leaf thickness (mm)	1-1.5 (78.5%)	1.5-2 (21.6%)	2-2.5	2.5-3	3-3.5	3.5-4	4-4.5			**(1.06-1.97)**
6	Shaft length (cm)	4-4.5 (10.8%)	4.5-5 (13.5%)	5-5.5 (10.8%)	5.5-6 (8.1%)	6-6.5 (18.92%)	6.5-7 (16.2%)	7-7.5 (8.1%)	7.5-8 (5.4%)	8-10 (8.1%)	**(4.2-10.31)**
7	Mature dry bulb shape*	2,4 (24.3%)	2,4,5 (8.1%)	4,5 (37%)	4 (13.5%	2,5 (5.4%)	1,2,4,5 (8.1%)	3,4 (2.7%)	(2,4,5,7) (2.7%)		
8	No. of cloves	10-15 (5.4%)	15-20 (16.2%)	20-25 (27%)	25-30 (35.1%)	30-35 (10.8%)	35-40 (	40-45	45-50		**(13-35)**
9	Wt. of cloves (gm)	0.5-1 (10.8%)	1-1.5 (43.2%)	1.5-2 (37.8%)	2-2.5 (8.1%)	2.5-3	3-3.5				**(0.78-2.46)**

Note: Mature bulb shape: 1- flat, 2-flat globe, 3-rhomboid, 4-broad oval, 5- globe, 7-ovate

3.3.12. Beans

A total of 46 accessions of bean collections were planted following the recommended package of practice for characterization and seed multiplication. The crop planting was carried out during third week of Shrawan. Majority of accessions (47.8%) were determinant and bush type followed by 32.6% were indeterminate bush with erect branches, 19.6% were indeterminate bush with prostrate branches. About 67% were with single pod per cluster with the range of 1- 3 pods per cluster. The pod length ranged from 100-17 cm with 32.6% possessing 120-130 cm and pod width ranged from 10.0-17.08 mm with 43.4% possessing 10-11 mm pod width. Almost 49% were with dark purple flowers, 91% were with light green mature pod color, 51.06% possessed 5-6 locules per pod and 39.13% had single seed weight of 0.2-0.3 g.

Under the pre-breeding, one bean (C4760) was identified as an elite line in terms of yield and good bean quality (white with light grey coat).

Table 24. Characterization of 46 accessions of beans

S N	Descriptor	Descriptor state							Range
		Frequency							
1	**Plant type**	Det bush (47.8%)	Indet bush (32.6%)	Indet bush with prostrate branch (19.6%)					
2	**No. of pods/cluster**	1 (67%)	2 (66%)	3 (7%)					1-3
3	**Pod length**	100-120 (22.3%)	120-130 (32.6%)	130-140 (17.39%)	140-150 (10.9%)	150-160 (2.17%)	160-170 (4.34%)	170-180 (2.17%)	100.2-177.1
4	**Pod width (mm)**	10-11 (43.47%)	11-12 (30.43%)	12-13 (19.56%)	13-14 (4.34%)	14-15	15-16	16-17 (2.17%)	10.02-17.08
5	**Flower colour**	White (35%)	Light pink (3%)	Light purple (13%)	Dark purple (49%)				
6	**Mature pod colour**	Light Green (91%)	Dark green (9%)						
7	**Locules per pod**	4-5 (12.7%)	5-6 (51.06%)	6-7 (21.27%)	7-8 (10.63%)	8-9	9-10 (4.25%)		(4-9)
8	**Seed weight (gm)**	0.1-0.2	0.2-0.3 (39.13%)	0.3-0.4 (34.78%)	0.4-0.5 (10.86%)	0.5-0.6 (13.04%)	0.6-0.7	0.7-0.8 (2.17%)	(0.21-0.59)

3.4. Biotechnology

Sustainable management of APGR requires a multipronged approach and biotechnological tools can contribute significantly for the management and sustainable utilization of APGR. In addition, advances in biotechnology are occurring at a rapid pace and provide novel opportunities for more effective and efficient management of APGR. Biotechnology applications must be integrated with ongoing conventional conservation activities. Advances in biotechnology (conservation biotechnology) have generated new opportunities for APGR conservation and utilization. Techniques like in-vitro culture and cryopreservation have made it easy to collect and conserve genetic resources, especially of species that are difficult to conserve as seeds. Tissue culture methods are now widely applied for elimination of systemic diseases such as viruses for safe exchange of germplasms. While technologies like enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR) have provided tools that are more sensitive and pathogen specific for seed health testing. Molecular markers are increasingly used for screening of germplasm to study genetic diversity, identify redundancies in the collections, test accession stability and integrity, and resolve taxonomic relationships. The technology is also accelerating the utilization of APGR.

In the past, conservation efforts have been mainly focused on orthodox seeds eg rice, maize, wheat, soybean, mustard, chilli, etc and conservation methods are well established for such crops. There are also a number of other important crops that are sterile or produce recalcitrant seeds or do not easily produce seeds, or seed is highly heterozygous and clonal propagation is preferred to conserve. Examples are banana, sweet potato, citrus, mango, sugarcane, cassava, yam, potato and taro, etc. These species are usually conserved in Field Genebanks. Although Field Genebank provides easy access to material for use, they are at the risk of destruction by natural calamities, pests and diseases. Safety duplicates of the living collections are therefore, needed to establish using alternate strategies of conservation and biotechnology has contributed significantly by providing complementary in-vitro conservation options through tissue culture techniques.

DNA markers on the other hand are very effective to manage all kinds of APGR including orthodox, non orthodox seed crops and vegetatively propagated crops. Utilization of conserved materials is also being accelerated through the advances made in biotechnology. NAGRC has utilized in-vitro tissue culture and molecular marker technologies to conserve and utilize APGR in the country.

The major activities of Biotechnology Unit are molecular characterization and evaluation, in-vitro conservation, tissue culture and multiplication, screening and pre-breeding, and maintenance (duplicate, identity, relationships, structure, location). This unit has following two laboratories to support the plant genetic resources conservation and utilization. Current activities under these two labs are depicted in the flow diagram (Figure 6).

1. Molecular Research Lab
2. Tissue Culture Lab

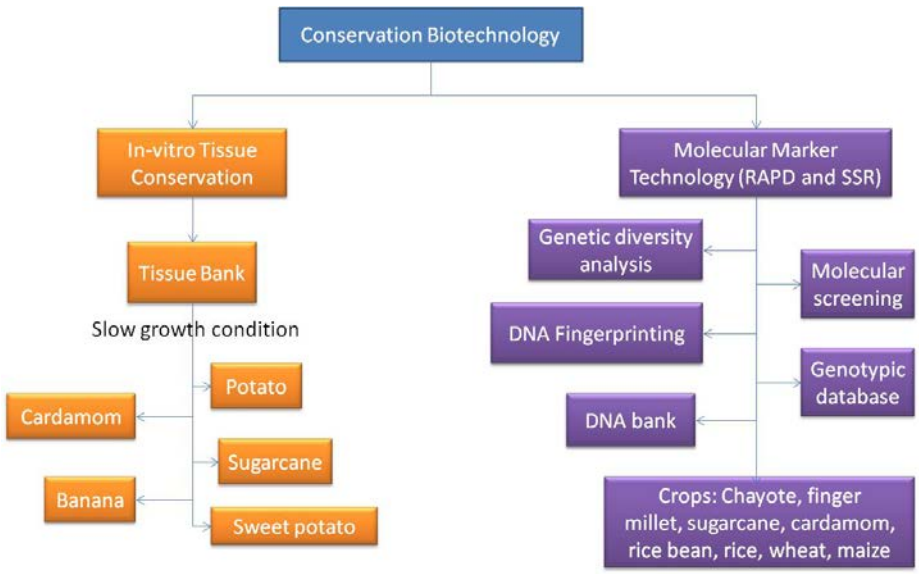


Figure 7. Flow diagram of current activities in Biotechnology Lab.

3.4.1. Molecular Research Lab

This lab is established especially for genotyping the accessions preserved under the Genebank. Followings are the major activities to be carried out under this lab.

- Genotyping/ Fingerprinting/ Characterization
- Evaluation/ Screening
- Gene Tagging/ Genetic Structure
- Diversity/ Relationship Study
- Duplication/ Identification Study

Molecular markers technology (RAPD and SSR)

Molecular marker technology has been applied for generating DNA finger printings, analyzing genetic diversity, characterizing germplasms, establishing DNA bank using RAPD and SSR markers in NAGRC. Genotypic database are being linked with other data eg phenotypic data, passport data and use data. These activities have also been carried out in collaboration with different breeding institutes and universities.

DNA finger printing: DNA finger printing of landraces is being considered important ownership document. Such information will be very useful for dispute settlement. We have focused to develop DNA finger printings of indigenous crops. Currently RAPD and SSR profiles of chayote, finger millet, sugarcane, maize, wheat, rice and cardamom have been developed. Molecular markers have been employed for fingerprinting, verification of accession identity and genetic contamination in many genebanks around the globe.

Screening for a particular trait: Under the pre-breeding program, NAGRC has focused on screening the collections using linked DNA markers with economic traits eg drought tolerance in rice and maize (Figure 8), submergence tolerance in rice, blast resistance in rice, quality protein in maize, rust resistance in wheat. Most of these screening works are under the process and is planned to expand to other crops. Molecular screening results will be provided to breeders and will collaborate if necessary for marker assisted selection. It allows identification of unique genotypes of special importance to genebanks and breeders.

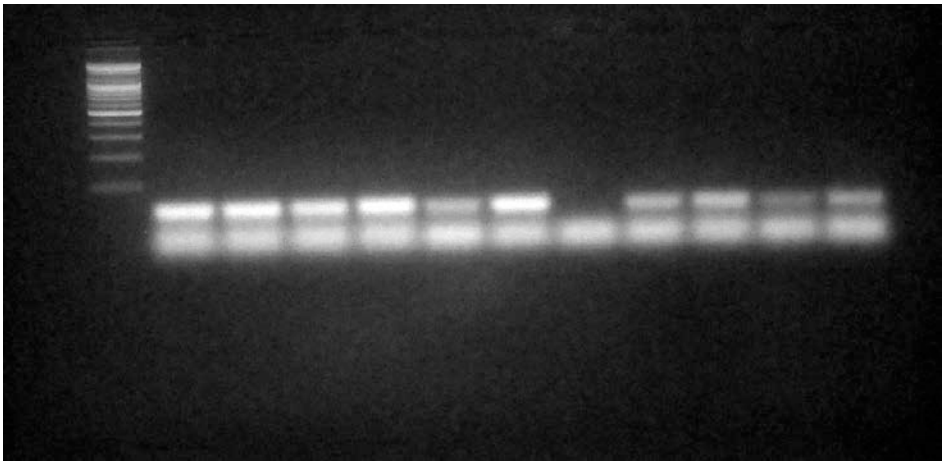


Figure 8. DNA profile of maize accessions using drought resistance marker, BNLG2190.

DNA Bank: DNA Bank, as a part of the Genebank is a repository of DNA, usually for research. The DNA Bank is conserving the different kinds of DNA extracted from the genetic resources 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.

Molecular Research Lab in NAGRC, focuses on identification, genetic diversity analysis and genes and QTLs tagging and mapping. During molecular research, DNA is generally extracted from young growing leaves. The DNA extraction protocol includes a standard CTAB-chloroform extraction with ethanol precipitation and washing, followed by cleaning with ethidium bromide gradient. After genotyping, remaining DNA is quantified and conserved ex-situ at Deep Fridge (Figure 9). Part of DNA will be distributed on request for further research and study. DNA Bank was started from 2013 by conserving the DNA of 11 accessions of chayote in NAGRC, Khumaltar (Table 25) and its database is also maintained. Due to earthquake, some of DNA samples and reagents got damaged.

Table 25. Crops and number of accessions of which DNA are being conserved in DNA bank of National Genebank, Khumaltar

SN	Crop	Number of accessions	DNA conc, ng/µl	Volume, µl
1.	Cardamom	6	100	100
2.	Chayote	11	800	100
3.	Rice	82	50	150
4.	Sugarcane	2	100	150

The DNA can be utilized for several applications, viz. characterizing the source material, understanding genetic and evolutionary relationships between taxa, functional analysis of genes, comparative genomics and plant breeding. However, at present there is not a technology to raise plants from DNA and DNA banks cannot replace conventional seed genebanks, in-vitro repositories or cryobanks. Hence, DNA bank is considered a complementary conservation strategy that together with other conservation strategies leads to an optimum and sustainable use of genetic diversity. Another potential area of DNA bank is exchange of genetic resources. It will be a lot easier to exchange genetic resources as DNA samples, rather than seed or vegetative propagules. Trans-boundary movement of seed and other planting material requires time consuming inspection and certification for freedom from pests and diseases. Exchanging DNA samples, on the other hand, avoids the need for time consuming and costly certification procedures.

Figure 9. DNA Bank in NAGRC

Genotypic database: Database of each accession conserved in the Genebank is being maintained. All kinds of databases, ie passport,

characterization and evaluation, stock management, phenotypic and genotypic have been maintained. These are very useful for maintenance and utilization of APGR. After genotypic study, all kinds of genotypic data are being maintained. Currently NAGRC has genotypic database of chayote, wheat, maize, finger millet and sugarcane.

3.4.2. Tissue Culture Lab

This lab is set for in-vitro conservation of those crop species other than orthodox seeds. Two main activities under this lab are i. In-vitro tissue conservation and ii. Multiplication and distribution. Cold store room is available for storing in-vitro grown plantlets.

Orthodox seed can easily be dried and stored at low temperature for many years. Recalcitrant seeds and vegetatively propagated crops need alternatives for long term conservation. In-vitro tissue conservation has been considered widely. This technique is very effective for conserving those crop species, which either produce recalcitrant seeds or does not produce any seeds. Plantlets can be kept in test tubes on nutrient medium for indefinite periods of time by transferring at regular interval. It requires little space for preservation of a large number of crop landraces. Plantlets are maintained in an environment free of pests or pathogens and can easily be kept free from viruses, insect parasites, fungi or bacteria. It also protects against dangers of natural environmental hazards. It offers the availability of nucleus stock to multiply a large number of plants rapidly. It minimizes the obstacles generally imposed by quarantine systems on the movement of live plants. Because of such advantages, in-vitro tissue culture has been initiated in NAGRC with the following objectives: Development of Tissue Bank and Cryobank, Conservation of plantlets of vegetatively propagated crop species and species with recalcitrant seeds, through in-vitro (shoot tip) culture in cold storage (medium term conservation), Cryopreservation of vegetatively propagated crop species and species with recalcitrant seeds through shoot tip culture (Long term conservation) and Multiplication and distribution of in-vitro cultured plantlets.

Tissue bank of 3 crops (6 potato accessions, 2 sugarcane accessions and 1 accession of cardamom) has been developed and it is being maintained

at slow growth condition (Figure 10). Explants were from shoot tip. Slow growth procedures allow clonal plant material to be held for 1-15 years under tissue culture conditions with periodic sub-culturing, depending on species. In-vitro plantlets of 2 potato accessions had been given to NPRP, Khumaltar for research.

Regeneration and successful propagation of genetically stable plantlets from cultures are prerequisites for any in-vitro conservation effort. Protocols for clonal multiplication are well established for several species. Generally, organized cultures such as shoots are used for slow growth storage since undifferentiated tissues such as callus are more vulnerable to somaclonal variation. This lab is doing experiment on sand rooting for in-vitro tissue plantlets.

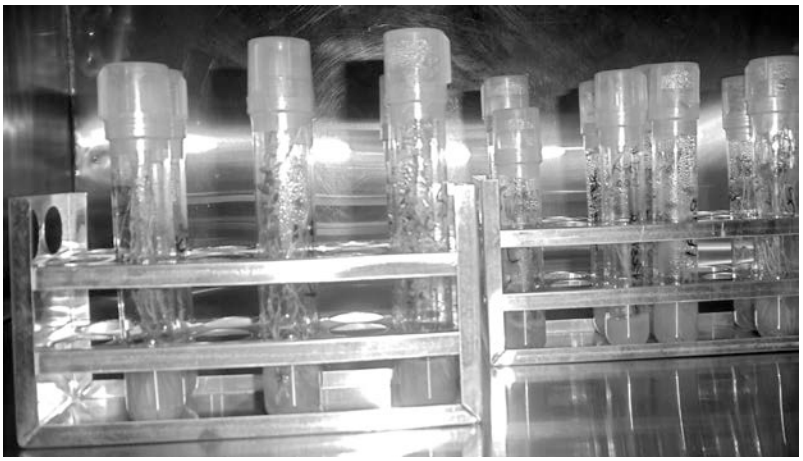


Figure 10. In-vitro potato plantlets

Potential Application

Currently NAGRC has limited application of biotechnology for APGR conservation and utilization. This is due to limited man power and financial support. However, following areas (Figure 11) under in-vitro tissue conservation and molecular marker technology has been explored as potential application of biotechnology for better managing APGR in the country.

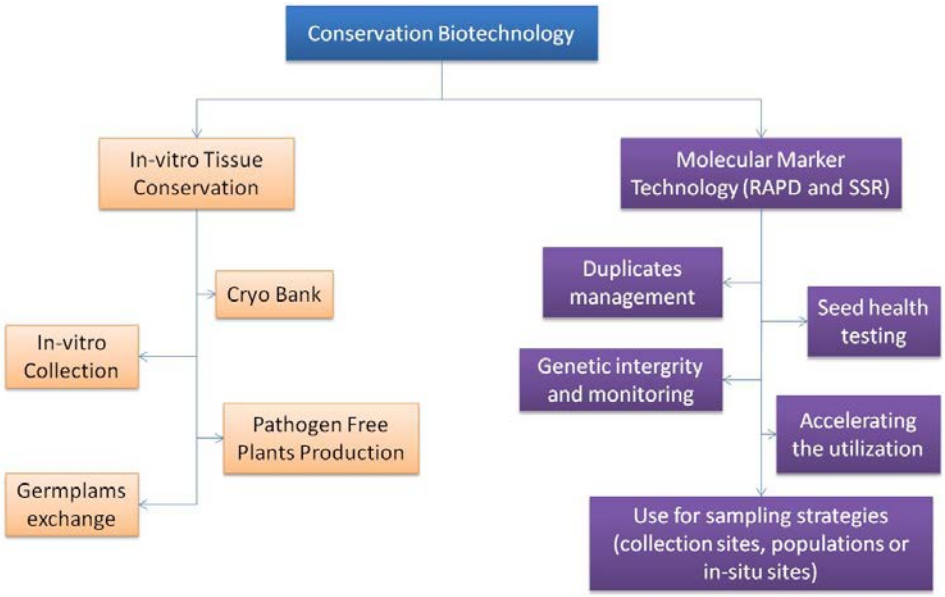


Figure 11. Flow diagram of future activities in Biotechnology Lab

3.5. Documentation, Publication and Training

The activities of Documentation, Publication and Training Unit are database management, publication, training and coordination. A large number of information is acquired and generated under genetic resources conservation programs. Therefore, development of an efficient documentation system is essential to facilitate optimal conservation, easy access and efficient utilization of agricultural plant genetic resources. Such a system should be able to store and supply accurate, reliable and up-to-date information. NAGRC operates a computerized documentation and database management system using MS Excel program (Figure 12). 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. The information is generally disseminated through annual reports, technical papers and visitors to the Genebank.

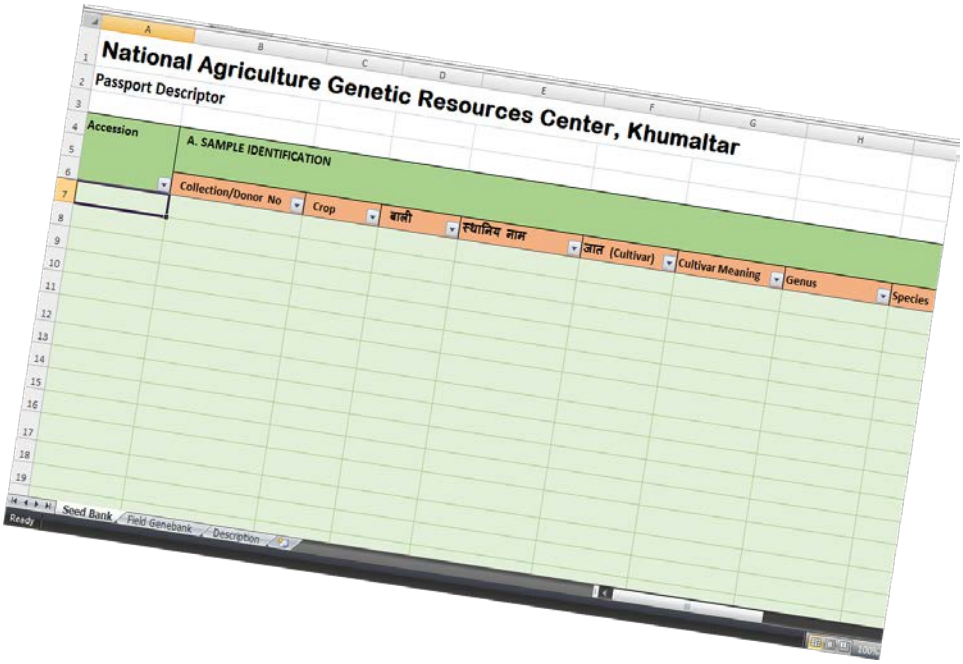


Figure 12. Passport template in Excel.

Passport format template (Figure 12) has been developed in excel. Old passports are under the process of transferring in this template. Data management system for Seed Bank, Tissue Bank, Field Genebank and DNA bank has been developed. Database management has also been advanced through the use of GIS and CAT.

Priority is given 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. Passport data handling system has been systematized.

Identification of the germplasms is very important in the Genebank. Standard labeling of each germplasm has been set and it will ease for handling germplasms. 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 (Filed 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. Characterization and evaluation descriptors for buckwheat have been developed. Crop code and collection number format has been drafted. Similarly methodology for regeneration and multiplication of each crop has also been started to finalize and document. Publication and training in this fiscal year are given in Annex.

3.6. Special Research Projects

3.6.1. Strengthening National Capacities to Implement the International Treaty on Plant Genetic Resources for Food and Agriculture (GRPI-2)

This special project commonly called Genetic Resources Policy Initiatives-2 (GRPI-2) was financially supported by Bioversity International, Rome and implemented jointly by MoAD, LIBIRD and NAGRC. This project is completed this year and its major achievements and findings are given below.

- Many policies, legal and institutional frameworks provide limited incentives (recognition and evidence of ownership of genetic resources) for their conservation, exchange, value addition and wider use.
- Bio-piracy of genetic resources and traditional knowledge and possible lack of fair and equitable benefit sharing due to inadequate information are perceived disincentives for researchers, farmers and private sectors to share PGRFA in MLS.
- Most of the breeders, researchers, farmers, policy makers are not well aware of ITPGRFA and MLS provisions including incentives and disincentives to put their material in MLS.
- One window system is considered the most appropriate system for Nepal to exchange PGR through multilateral system.
- Farmers' consent needs to be received while including in-situ/ on-farm materials in the Nepal Annex 1 and afterward sharing those materials in and outside country.

- Enabling policy environment does not exist in Nepal to implement ITPGRFA.
- Agrobiodiversity policy 2007 has been revised in accordance with the provisions of ITPGRFA
- NBSAP 2014-2020 has considered strategic implementation of ITPGRFA in harmony with CBD
- New instrument i.e. agrobiodiversity conservation and utilization act including regulations were drafted for implementation of ITPGRFA.
- About 68% of key stakeholders believe that the IT is beneficial for Nepal and about 59% indicated the same for the MLS.
- Lower capacity developing countries like Nepal will generate fewer benefits relative to their genetic resource contribution, as compared to higher capacity countries.
- Multiple key players are LI-BIRD, BI, NARC, MoAD, SAWTEE and FAO in the overall policy network. LI-BIRD, NARC and MoAD are the top three organizations that provide scientific expertise resources to multiple organizations.
- A total of 145 species are being found major for food security in Nepal. There are 35 crops and 29 forage species (total 134 species) in IT Annex 1 considered as major for global food security. Global crop gene pool consists of IT Annex-1 and accessions available through GeneSys, NIAS, AVRDC, EURISCO and GRIN-USDA. National Crop Gene Pool consists of major 145 species of food and forage crops, 551 released and registered varieties.
- A total of 3624 accessions of 32 food and 8 forage crops have been listed for the inclusions under MLS (Nepal Annex 1 Crops). Among these accessions, 226 are released varieties, 1987 are accessions safely duplicated in CG Banks, 1403 are similar accessions with foreign genebanks and 8 are forages.
- More than 12 countries have conserved Nepalese agricultural plant genetic resources totaling about more than 23,600 accessions. Nepalese accessions under the Global Crop Gene Pool are 12489 in GeneSys, 11702 in CG Banks, 850 in AVRDC, 4136 in NIAS, 3510 in URISCO and some in GRIN-USDA. About 0.37% of total accessions (4644604) in Global Crop Gene Pool is Nepalese accessions (17475).
- A total of 31 varieties of 18 crops were developed based on the local landraces in Nepal.

- Strong research and development along with good collaboration with different organizations are the major factors to be able to develop more farmers' friendly varieties.
- There are more than 100 organizations working on APGR in Nepal. National genebank (NAGRC) is now playing vital role in germplasm flow within country.
- There is no restriction for germplasms exchange within country. But for commercializing the variety, it should be either registered or released under the National Seed Board. The varieties developed in India and China are being increasingly registered and commercialized in the country.
- Breeding programs and seed suppliers are independently collecting APGR from within country as well from CG centers, India and China. Generally SMTA is adopted to take the materials from CG centers.
- The NWRP receives more than 1000 genotypes, NRRP 1400 and NPRP 50 genotypes yearly.
- Free and easy access of advanced lines are the major factor that influence the germplasms flows.
- About 73% of the released varieties in the country are being originated outside the country and 27% of them were originated in Nepal. Around 80% of total released varieties of wheat, potato and lentil were originated outside the country.
- A total of 47 ancestors (landraces) originated in 12 different countries were used to develop 20 mid and high hills cultivars and a total of 35 ancestors originated in 11 different countries were used to develop 28 Tarai rice cultivars. 13 landraces originated in 8 different countries were used to develop Khumal-4 rice variety.
- Only exotic ancestors were used to develop all 35 modern wheat varieties. A total of 89 ancestors originated in 22 different countries were used to develop these cultivars. The origin of most of the ancestors for Nepalese wheat cultivars were from USA (13%), India (13%), France (12%), Argentina (6%), and Italy (6%).
- Only exotic parents have been used to develop 8 modern varieties of potato in Nepal. The maximum numbers of ancestors used in developing these potato varieties were from Germany.
- Eleven varieties of lentil have been released so far and only one variety was bred in Nepal.
- Nepal is dependent about 95 to 100% on foreign germplasms for varietal development. Dependency will be increased further on

outsourcing APGR because of climate change (heat, drought submergence cold) and diseases of major economic importance.

- The genetic resources incorporated (50% national genes and 50% foreign genes) in Khumal-4 annually provides benefits of about Rs 1.05 billion per annum at the current price and adoption level of 2010-2012 level.
- Non-monetary benefits from Khumal-4 are increased production stability brought by its relatively better disease resistance and non-lodging nature including its suitability for growing subsequent crops due to its relatively shorter duration.
- The maximum temperature is changing by 0.045^{o}C per year and minimum temperature by 0.054^{o}C in Kaski. In Bara, the maximum temperature was increased by 0.009^{o}C per year where as minimum temperature was by 0.039^{o}C.
- Increasing trend in total production as well as productivity could not be observed.
- Rainfall was found negatively correlated with production parameters in Kaski district. Maximum temperature was significantly and negatively correlated with production and productivity
- A total of 2,839 rice accessions from different parts of Nepal are already taken in the global gene pool or public domain and these will be very useful in future due to change in climate.
- Mostly current analogue sites of Begnas, Kaski were found in East Asia and some part of South India. Future analogous sites of Begnas are in the lower regions of Manang, upper regions of Lamjung and Kaski and far-western upper regions of Gorkha districts.
- There were 13 rice landraces found suitable from Genesys database for Kachorwa site in 2020.
- Farmers have become aware of international policies and are ready to share their genetic materials with the national genebank. Regarding sharing materials with someone from outside the country, farmers have given mixed responses.
- None of policy documents have explicitly mentioned the need and strategies for linking in-situ/on-farm with ex-situ or CSBs with national genebank.
- CSB has been spelled out in many national documents and it perceived that CSB will be effective to implement the activities envisaged in different policy and legislation.

- Non-monetary benefits include germplasm based and non-germplasm based technologies.
- The transfer of PGR related technologies is often on an *ad hoc* basis.
- South-to-South and horizontal technology transfers are preferred due to their lower costs of transfer and faster diffusion as well as better adaptation to local context as compared to north-south and vertical transfers.
- Germplasm-based technology transfer is easier and faster. But it requires non-germplasm based technology for sustained transfer.
- The flow of associated non-germplasm based technologies from National Research Organization to private and farmers' cooperatives is very low.

3.6.2. Morphological and Molecular Characterization of Selected Rice and Buckwheat Collections to Promote Use (2^{nd} Phase IMPGR)

This project is the second phase of Integrated Management System of Plant Genetic Resources funded by AFACI, RDA, Korea.

After the establishment of Genebank and with support from RDA, Korea and others, many advances have been made and APGR are being effectively conserved in different kinds of Banks, eg Seed Bank, Tissue Bank, Field Genebank. A large number of diversity have been created and maintained in both crops over the years and locations. Some of them along with other crops landraces are being conserved in National Genebank during first phase of this IMPGR project. Use of local crop diversity is very limited in the breeding programs of Nepal. This is partly due to lack of pre-breeding works for example characterization and evaluation both at phenotypic and genotypic levels, genes tagging, elite lines development and genetic enhancement. It is therefore, now very important to explore the potential of these collections for improving the agricultural production system. This project is conceptualized for enhancing utilization of two major crops, ie rice and buckwheat through characterization at both phenotypic and genotypic levels and by developing some pre-breeding lines with the following specific objectives.

- To characterize 150 accessions of rice and 50 accessions of buckwheat (both common and tartary buckwheat) germplasms at phenotypic and genotypic levels.
- To provide elite lines to researchers and farmers
- To share the conserved and characterized information along with germplasms with breeders, farmers and researchers.
- To strengthen national capacity for undertaking efficient and effective characterization of APGR
- To manage duplicate accessions of these two crops.
- To document research findings.

AFACI, Korea and participated countries have evaluated the projects in each country. IMPGR project implemented by NAGRC was recognized as most outstanding project and awarded cash prize for further using in APGR conservation and utilization.

A total 75 accessions rice and 50 accessions of Tite buckwheat were selected from Genebank database using passport and preliminary characterization database. Main target in rice are to screen for blast resistance, drought tolerance, cold tolerance, submergence tolerance, maturity, quality (aroma and fine grain), high grain yield, growth traits, etc. In buckwheat, we have focused on identifying loose husk, powdery mildew resistance, high grain yielder, bold grains, etc in addition to growth traits. Selected accessions of both crops were evaluated phenotypically and are under the process of evaluation at genotypic levels along with diversity assessment. For genotyping rice accessions, more than 100 primers have been identified. These accessions were selected based on the local names, collection sites, grain size and grain color.

In this spring season a total of 138 accessions of Tite buckwheat were preliminary characterized in Genebank complex. There were distinct variations in plant height, seed color, seed size, seed shape, stem and leaf pigmentation, maturity period, number of branches, etc.

Figure 13. Very early and dwarf landrace of Tite buckwheat, evaluated in Genebank Complex, Khumaltar 2015

Genebank personnel have been capacited on passport database management through one day discussion meeting in Genebank. There were 9 participants. Passport template has been developed and shared for exercise and use. Now previous passport database has been transformed in new passport template.

Genebank has initiated to establish Field Genebank in different NARC stations. These stations will conserve all recalcitrant seed crops and vegetatively propagated crops on-station available in their command areas. A field with representative diversity of agriculture in the station will be a single window that anyone can see the regional APGR in a single field and be a source of germplasm for all researchers and farmers. Being a new concept, it is necessary to provide the training to the personnel who will lead the Field Genebank in research station.

National Agriculture Genetic Resources Center (Genebank) therefore organized training on Field Genebank Establishment and Management from 2-4 Feb 2015 in National Genebank, Khumaltar, with the goal of conserving agricultural plant genetic resources near to the farming communities, making access to APGR and getting scientific information. The main objectives of the training were:

- Enhance the capacity of agricultural researchers on establishing and managing Field Genebank
- Understand the management and accessioning system of APGR
- Prepare the list of crops available in the command areas and database for field genebank
- Initiate the field genebank in different NARC stations
- Systematize the germplasms maintenance and agricultural research

This training was oriented more towards practical for identifying non-orthodox and vegetatively propagated crops, establishing field genebank and enhancing the utilization. Participants would able at least to identify the crops available in their working areas suitable for and to establish the field genebank. Approaches followed in the training were interactive lecture, discussion, individual and group exercise, field and lab visit. Different reading materials were also provided. Detail guidelines for establishing field genebank were provided and discussed. Certificate along with official letter to all participating offices were given to each trainee. All trainees have mentioned to establish the Field Genebank in their respective office. Director, Crop and Horticulture has also send directives to all NARC stations for establishing the Field Genebank after the training. Executive Director and Directors (Crop and Horticulture, Planning and Coordination) from the NARC were also emphasized to materialize the concept during opening session.

Training was coordinated by Dr Bal K. Joshi and facilitated by Madan R. Bhatta, Deepa Singh and Krishna H. Ghimire. There were total 16 participants from different research stations of NARC (ARS, Malepatan; RARS, Tarahara; ARS, Kapurkot; ARS, Pakhribas; HCRP, Kabre; HRD, Khumaltar; SRP, Jeetpur; RARS, Parwanipur; RARS, Nepalgunj; RARS, Doti; Genebank, Khumaltar; FPRD, Khumaltar), NGO (Parivartan Nepal, Hetauda), Community Seed Bank, Dalchowki and Natural History Museum, Soyambu (Figure 14). Trainees were very glad and appreciated over the knowledge and skill provided during the training. One of the messages during the training was let's think agricultural biodiversity in agricultural problems.

Figure 14. Participants of Field Genebank training, 2015 in NAGRC

3.6.3. Integrating Traditional Crop Genetic Diversity into Technology: Using a Biodiversity Portfolio Approach to Buffer against Unpredictable Environmental Change in the Nepal Himalayas (GEF On-farm Project)

This project is financially supported by Bioversity International, Rome and jointly organized by LIBIRD, NAGRC and BI, Nepal. HCRP, Kavre and ARS, Jumla have also actively involved in this project, which is implemented in four districts, ie Humla, Jumla, Lamjung and Dolakha.

Capacity enhancement: Between 1-5 May 2014 a project orientation workshop was held for 39 participants in Pokhara. This allowed participants and facilitators to exchange experiences and to enhance understanding of effective approaches towards the conservation and sustainable use of crop genetic resources in mountain agriculture. The learning process allowed participants to develop a common understanding on the project concept/rationale/approaches.

A training workshop on Use of Crop Genetic Diversity to Control Pests and Diseases in Support of Sustainable Agriculture, Disease and Pest Management was held in Charikot, Dolakha (10-14 September 2014).

The objective of the training workshop was to impart knowledge and practical skills to identify and manage important diseases and pests, as well as to enhance diversity of target mountain crops. The workshop was attended by 30 participants from key project partners (NARC, DoA, and LIBIRD) and site officers from project sites.

An additional training on Participatory Crop Improvement (PCI) and Seed System was held at NAGRC, Khumaltar (16-18 September 2014). The objective of this training workshop was to convey theoretical and practical skills and knowledge to project partners and staff for implementation of field activities on participatory crop improvement and seed system enhancement. The workshop was attended by 26 participants

Project partners from NARC (Senior Scientist and Project Coordinator) and LI-BIRD (Socio-economist at the department of Social Research and Policy Advocacy for Inclusive Impacts) participated to the training workshop "Introduction to policy analysis for agricultural development", held at Bioversity HQ (Rome) from 10 to 14 November 2014. This learning event, led by Professors from the University of Washington Evans School of Publics Affairs and Colby College, focused on: Stakeholder Identification and Policy Goals; Data Collection for Policy Analysis and Development and Communication of Policy Recommendations.

A training program on Diversity Kits and Crowdsourcing was organized on 29-30 June, 2015 in Pokhara with the objectives of applications of crowdsourcing approach in variety evaluation and dissemination in Nepal. All together 28 participants from NARC, LIBIRD, DoA and Bioversity were attended the program.

Strengthening the multiplication and supply of important local varieties from the national Gene bank to farmers' field*:* 125 accessions of Amaranth landraces were multiplied in Hill Crop Research Program (HCRP) and sent to the farming communities of project site to be made available to small holder farmers, so as to increase productive gain and maintain ecosystem resilience. Similarly, the seeds of seven landraces of local rice (Sugandha, Barkhe-3 accessions, Salidhan and Hansaraj) were multiplied and distributed in project sites for the same

purpose. These activities contributed to strengthen the multiplication and supply of important local varieties from the Gene bank to farmers' fields.

Diversity Fairs: Diversity fairs were conducted in Chippra VDC of Humla district on 22 November 2014 and Ghanapokhara VDC of Lamjung district on December 10, 2014. The main objective was to assess the extent of diversity within the mandate crops in the project districts as well as collect germplasm for the National Genebank. The fair also aimed to raise awareness of the mandate crop diversity in the working site, as well as to gather germplasm and associated traditional knowledge from multiple VDCs employing partner organizations.

In Humla diversity fairs, farmer organizations from 15 VDCs had been invited to participate and showcase their diversity of mountain crops. Despite the difficult terrain and lack of regular communication services, 14 VDCs participated to the event (over 800 individual participants). In total, 835 samples of seed and planting materials (includes both mandate and non-mandate crops) were brought by the participants, with the highest number (105) coming from Saya VDC. The lowest number of samples came from Muchu VDC (13), which is also the VDC with the largest portion of land at elevations above 4500 masl.

In Lamjung, diversity fair was conducted at the VDC level in coordination with Conservation Area Management Committee (CAMC) of the Annapurna Conservation Area Project (ACAP), Ghanpokhara, and local communities. Mothers' (women) groups and local farmers' groups from each ward of the VDC were mobilized and approached as participant in the fair. The motive of fair was to raise awareness on local diversity, especially focussing projects mandate crop and collect first hand information on local genetic resources and associated traditional knowledge. In total, 36 rice varieties, among which 9 were said to be cold tolerant varieties, 12 finger millet, 5 foxtail millet, 9 beans, 1 buckwheat, 3 amaranths and 1 each of barley and naked barley has been recorded.

Diversity Fair in Jumla was organized on May 6-7, 2015 in collaboration with DADO and other district level stakeholders.

Baseline Survey: The household baseline survey questionnaire was prepared and revised. The survey was completed in Chippra VDC of Humla in November 2014. All together 72 individual households were surveyed. The survey data are under processing. Similarly, the household baseline survey in Jumla, Dolakha and Lamjung were completed. The preliminary analysis of survey data has also been completed.

Naked Barley Trial: Naked barley mother trials (8 test varieties and 1 farmer variety) were set up in and dispatched along with the activity protocol to four project sites. The test varieties were from the National Genebank. Site staff received orientation on the trial designs and trials were planted at all sites. Similarly, a mother trail of 13 accessions of amaranths (3 replication) was initiated in Lamjung and Dolakha to identify best performing variety regarding grain and leaf yield, collect farmer's feedback on new varieties from at least 3 districts, to raise awareness.

Diversity block: A diversity block of 7 mandate crops in each project sites were established with diverse landraces from Genebank and materials from farmers' fields. Project mandated crops (Rice, finger millet, foxtail millet, proso millet, amaranths, buckwheat, beans) were demonstrated in diversity block. A total of 270 cultivars of 7 crops made available to farmers in 2015 from various sources in Diversity Blocks. Out of which 163 landraces are made available from national Genebank, 102 traditional cultivars from farmers' fields and 5 improved varieties from NARC research centres.

Diversity kits: A set of Diversity Kits consisted of 00 kits of each crops; rice (10 landraces), amaranths (10 landraces) and finger millet (10 landraces) was provided to the 4 project sites. The kits were also distributed to the farmers. Diversity kits have been modified in some sites reducing number of farmers by merging the kits.

Up-scaling locally implemented initiatives that enhance the availability of quality seeds and other planting materials: Preliminary interaction has been initiated with the local community based seed actors (eg DISSPRO, CBSP, Community Seed Banks). Seeds are being tested

and upscaled through IRD, formal system, diversity kit for beans, rice and finger millet.

Research has also been initiated on crop varietal mixtures, relation of genetic diversity with pollination level, diversity status between released varieties and landraces.

4. TECHNOLOGY TRANSFER AND SERVICES

- 550 accessions of different crops were distributed to different researchers, students and farmers.
- Two plantlets of potato (Kalo anlu) in test tube provided to NPRP.
- Four community seed banks were supported technically on seed conservation and establishment and management of field genebank.
- Free consultation services were provided to more than 150 clients (farmers, researchers, students and internet users).
- Provided accession number to 70 accessions which were requested by different organization and space for storage with black box system provided for researchers.
- Seed testing of 31 samples received from SQCC and private companies.
- Statistical analysis for NARC researchers and students of AFU and IAAS
- Provided resource person in different trainings (statistics, plant breeding, post plant breeding, research methodology, seed science, on-farm conservation, NUS writeshop and data analysis, GIS and CAT, etc)
- Molecular lab facility and technical support to IAAS students, Fishery Research Division, Biotechnology Division (quantified 2000 DNA samples using nanodrop), Commercial Crops Research Division and Animal Breeding Division
- Descriptors for different crops were provided to researchers.
- Provided resource person on characterization of summer crops for variety release

5. OTHER ACHIEVEMENTS

- Glass house has been established.
- Short term storage is partly build for recalcitrant type seed crops and vegetatively propagated crops.

6. BUDGET AND EXPENDITURE

- A sum of NRs 1,97,98,000 was received for FY 2071/072 from NARC. Among which NRs 1,83,01,120 was expended during the period and NRs 14,96,880 is balanced (Annex 6.1).

7. KEY PROBLEMS

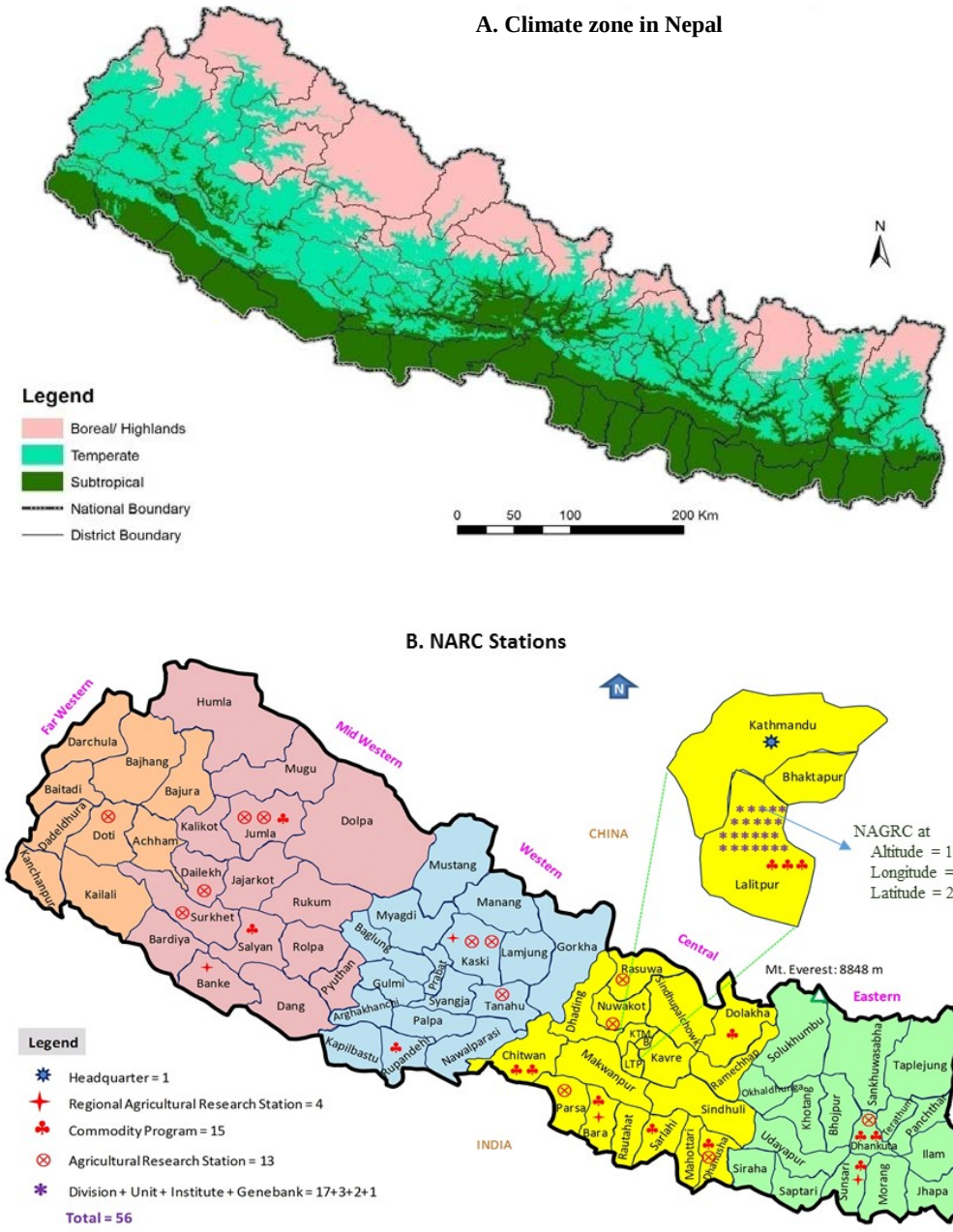
- Diversity are not being captured due to very few seeds from farmers
- Collections are generally from farm store not from standing crops
- Difficulty on identifying the samples and on duplicates identification and possibility of collecting many duplicates
- Difficulty to regenerate and multiply cross pollinated crop species
- Poor utilization of indigenous APGR in breeding and research
- Difficulty on marking sampling sites and sampling method
- Insect pest and disease problems in seeds
- Seed setting problem during regeneration and non-viability of old collections
- No system of accessioning germplasm before doing research
- Lack of systematic governance mechanism of APGR in the country
- Lack of screen house facility
- Limited technical manpower and financial support
- Many pathological problems including problems in soil
- Regeneration fields are not well drained
- Land for Genebank activities are not enough
- Need strong collaboration with organization located across the country

8. WAY FORWARD

- Develop guidelines for APGR flows and collections
- Participate in ITPGRFA-MLS and make access to accessions available under MLS to researchers, breeders and farmers
- Construction of screen house
- Establishment of sub field genebank in all NARC stations, farms of DoA and offices of District Agriculture Development Offices
- Need to initiate cryopreservation (Cryo Bank)
- Need to initiate conservation of microorganism, animal and aqua genetic resources
- Establishment of accessioning system and research advances based on accession

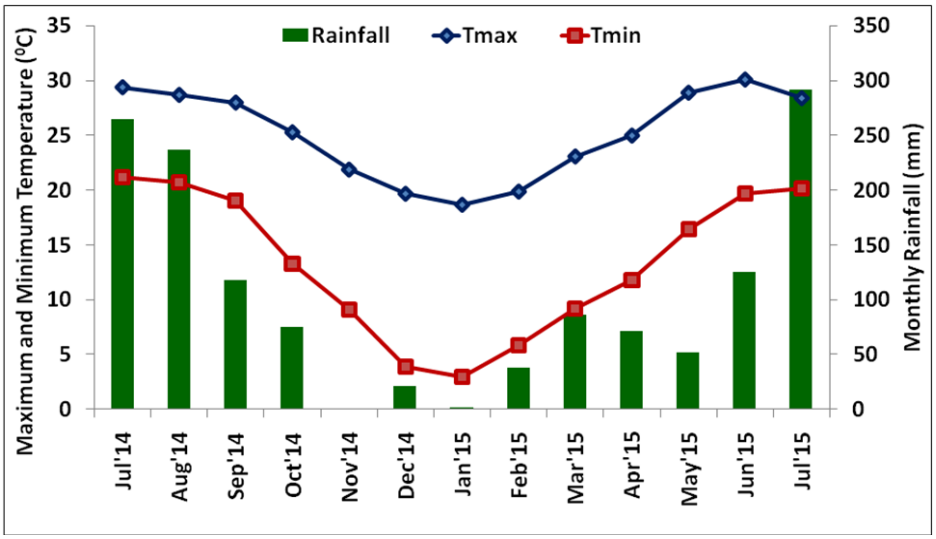
- Strengthen utilization and on-farm conservation
- Rescue collections from earthquake affected districts and repatriation of germplasm to these districts from MLS
- Coordination for regeneration, collection and multiplication
- *Coordination for in-situ conservation:* There are many wild species and wild relatives of cultivated species and wild edible plants distributed across the country. These are the reservoir for different important genes and evolution continuously takes places interacting with nature. These sites, where, important wild and wild relatives of crop species and wild edible plants exist, and are conserved or protected, are called in-situ conservation area. Economical means of in-situ conservation is coordination with National Parks, religiously and culturally protected sites, heritage sites and community. It is necessary to locate species that needs to be conserved on-site and develop strategies to protect their habitat collaborating with relevant stakeholders.

Annex 1.1. Map of the command areas



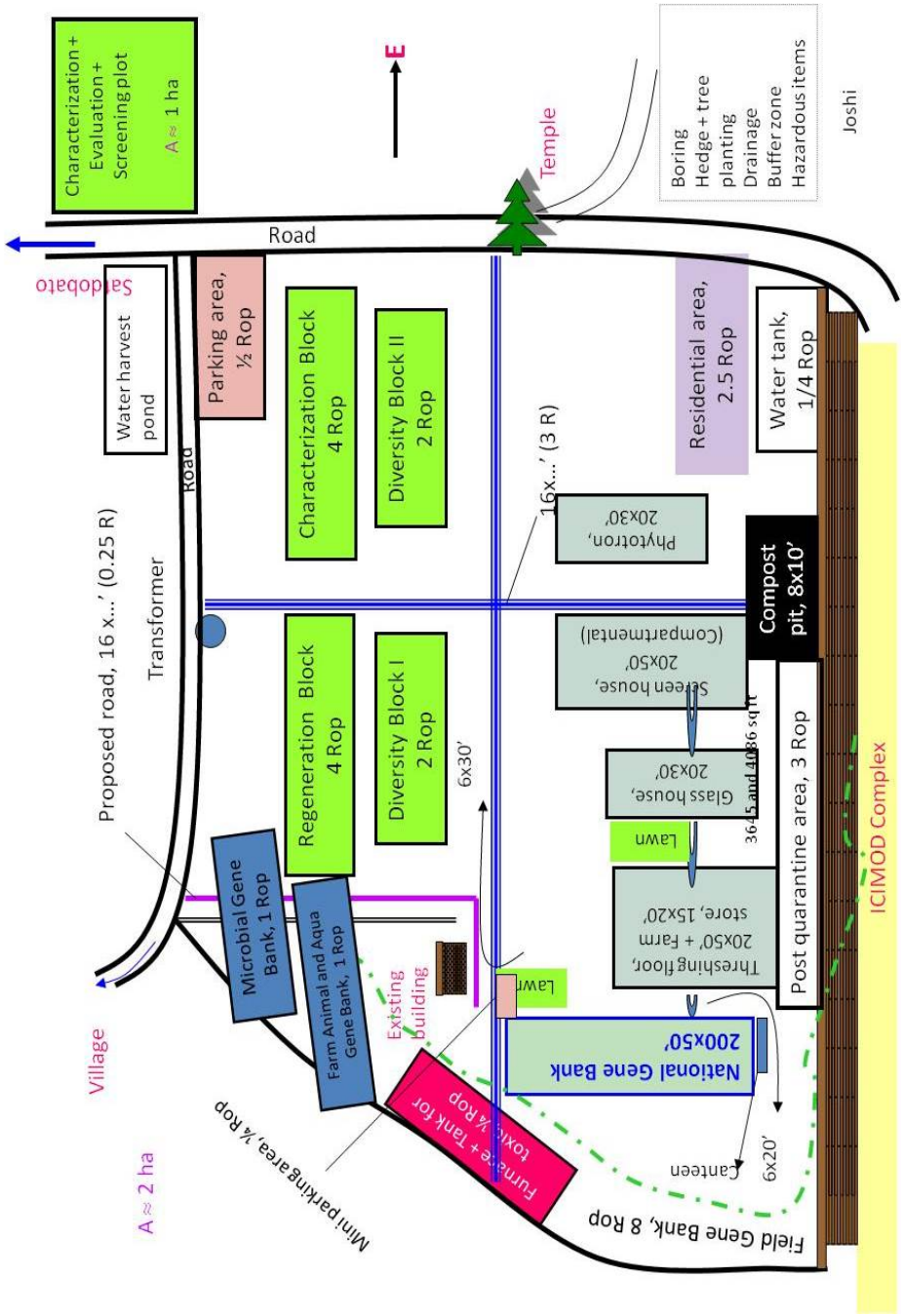
Command areas of NAGRC include all eco-zones (A) and NARC Stations (B).

Annex 1.2. Monthly agro-meteorological data of Khumaltar



NAGRC, Khumaltar received 1382 mm annual with annual average of maximum 25.2°C and minimum 13.4°C temperature.

Annex 2.1. Map of the Genebank Complex, Khumaltar



Annex 2.2. List of laboratory facilities

SN	Name of laboratory	Major instruments	Manpower in laboratory	Testing facilities
1.	In-vitro Culture Lab	Laminar Hood, In-vitro Culture Room, Autoclave, Shaker, pH meter, Distilled water plant	Dr Bal K Joshi	For tissue culture and in-vitro conservation
2.	Molecular Research Lab	PCR machine, Tissue lyzer, Centrifuge, Deep fridge, Gel doc, Electrophoresis unit, Water bath, autoclave, Pipettes, Vortex, Nano-based Spectrophotometer, ice-maker	Dr Bal K Joshi	For DNA works (diversity assessment, identification, screening and genes tagging and mapping)
3.	Seed Testing and Processing Lab	Seed germinator, pH meter, Aspirator, Seed grader, Conical divider, Soil divider, Seed counter, Magnifying glass, Gamet seed divider, Digital moisture meter, Oven, Grinding mill, Digital balance, Microscope, Purity board	Ms Deepa Singh and Santosh Sharma	For seed cleaning, testing and characterization
4.	Seed drying and packing Lab	Drying room. Digital weighing machine, Dehumidifier, Moisture meter, Seed dryer, Hygrometer	Mr Krishna H. Ghimire and Mr Shiva K. Budathoki	For drying and packaging for storage
5.	Medium and Long Term Storage	Cooler, dehumidifier, rack, Hygrometer,	Mr Krishna H. Ghimire and Mr Shiva K. Budathoki	For conserving orthodox seeds to active and base collection

Annex 2.3. Human resource in 2071/72 (2014/15)

SN	Name	Position	Qualification	Specialization/working area
1.	Mr. Madan R. Bhatta	Chief, Senior Scientist (S-4)	MSc Ag	Plant Breeding
2.	Dr. Bal K. Joshi	Senior Scientist (S-3)	PhD	Genetics and Plant Breeding
3.	Mr. Krishna H. Ghimire	Senior Scientist (S-3)	MSc	Plant Breeding and PGR
4.	Ms. Deepa Singh Shrestha	Senior Scientist (S-3)	MSc	Plant Breeding
5.	Mr. Shiva K. Budhathoki	Tech. Officer (T-6)	ISc Ag	Plant Breeding
6.	Mr. Mukunda Bhattarai	Tech. Officer (T-6)	BSc Ag	Plant Breeding
7.	Mr. Baudhha K Neupane	Account Officer (A-6)	I Com	Financial Admin
8.	Mr. Puny P. Dunghana	Account Officer (A-6)	BCom	Financial Admin
9.	Mr. Ashok K. Basnet	Admin. Officer (A-6)	MEd	Administration
10.	Mr. Bishnu K Rana	Admin. Officer (A-6)	MA	Administration
11.	Mr. Santosh Sharma	Junior Technician (T-5)	JT Training	
12.	Mr. Kabir Alam Ansari	Electrician (T-5)	Engineering Diploma	
13.	Mr. Dipak Manandhar	Light Driver		
14.	Mr. Raghu NP Paudel	Admin. Assistant	Literate	
15.	Mr. Sunil K Mandal	Tech. Assistant	SLC	
16.	Ms. Indra M. Maharjan	Admin. Assistant	Literate	
17.	Mr. Surendra K. Shrestha*	Database Officer	MBA	Business admin
18.	Dr Devendra Gauchan*	Project Manager	PhD	Economics
19.	Mr Safal Kathiwada*	Project Assistant	MBA	

** Project staff*

Annex 3.1. Summary progress of NARC research projects and activities in 2071/72

Project code number	Name of project/activity	Activity leader	End year	Budget allocated	Major progress achievements
33267001	Management of Agricultural Plant Genetic Resources (MAPGR) in Nepal	MR Bhatta	-		
Activity 1	Exploration, collection and distribution of multi-crop germplasm	MR Bhatta	2072		• Distributed 189 accessions of barley, naked barley, soybean, rapeseed and 32 okra • In-vitro potato plantlets of two accessions to NPRP • Collected 1627 accessions of different crops from 15 districts
Activity 2	Seed cleaning and testing	D Singh	2072		• 1802 accessions of different crop seeds cleaned and germination tested
Activity 3	Seed processing and conservation of germplasm in medium and long term storages	KH Ghimire	2072		• 1237 accessions of 27 different crops dried, packed and conserved under long term and medium term storages • 261 wheat and 250 barley safety duplicated at CIMMYT and ICARDA
Activity 4	Regeneration, multiplication and characterization of agronomical crops	KH Ghimire	2072		• 1271 accessions of 12 different crops (200 maize, 113 amaranths, 43 blackgram, 12 horsegram, 62 ricebean, 152 rice, 15 soybean, 47 fingermillet, 35 barley, 42 naked barley, 390 wheat and 130 buckwheat) characterized and harvested
Activity 5	Regeneration, multiplication and characterization	D Singh	2072		• 227 accessions of different crops (35 chilli, 15 brinjal, 11 cucumber, 13 tomato,

Project code number	Name of project/activity	Activity leader	End year	Budget allocated	Major progress achievements
	of horticultural crops				3 spinach, 19 BL mustard, 30 okra, 35 chilli and 40 beans) characterized and harvested
Activity 6	Development and management of Field Genebank for vegetatively propagated and recalcitrant seed crops	BK Joshi/M Bhattarai	2072		• Ginger, garlic, turmeric, taro and sugarcane, chayote accessions and 33 different fruit trees maintained in Field Genebank • More than 15 crops maintained in display blocks
Activity 7	Promotion of on-farm conservation of agricultural biodiversity	MR Bhatta/B K Joshi	2072		• Seeds from 17 Community Seed Banks of 14 districts in Genebank • Farmers involved in different meetings, training and workshops
Activity 8	In-vitro conservation of vegetatively propagated and recalcitrant seed crops	BK Joshi	2072		• Potato, sugarcane, sweet potato, cardamom maintained in-vitro (Tissue Bank) • Rooting methods (sand and cocopeat) tested
Activity 9	Use of molecular markers for management of agricultural biodiversity	BK Joshi	2072		• Strategic and progress paper: Use of biotech for APGR management prepared and presented • 96 accessions of maize profiled by 3 SSR primers
Activity 10	Evaluation and pre-breeding of agronomical crops	KH Ghimire	2072		• Drought, cold and blast screening nursery of rice harvested • Organoleptic test of elite rice landraces-Hansaraj and Sali Dhan conducted
Activity 11	Evaluation of horticultural crops	D Singh	2072		• Two bean and 2 brinjal accessions found promising • Elite lines of brinjal, chilli provided to

Project code number	Name of project/activity	Activity leader	End year	Budget allocated	Major progress achievements
					ARS, Malepatan
Activity 12	Documentation and database management	BK Joshi	2072		• Passport data template prepared • Training workshop organized • Descriptors for buckwheat drafted
Activity 13	Maintenance of display blocks	M Bhattarai	2072		• Display block 18 crop species maintained
Activity 14	Capacity enhancement on agro-biodiversity management (training workshop)	MR Bhatta/B K Joshi	2071		• APGR in the Eastern region documented • Stakeholders got aware on conservation of agrobiodiversity

Annex 3.2. Summary progress of special research projects and activities in 2071/72 (2014/15)

Name of project	Project leader	Begin year	End year	Budget allocated for this year	Major progress/ achievements
1. Strengthening National Capacity to implement ITPGRFA and MLS: (GRPI-2, Bioversity Int'l)	BK Joshi	2012	2015	Rs. 1509212.21	• Empirical evidence on interdependency on PGR and Policy developed
2. Morphological and Molecular Characterization of Selected Rice and Buckwheat Collections to Promote Use (IMPGR/AFACI)	BK Joshi	2015	2017	Rs. 2638947.21	• DNA extracted and phenotype
3. Integrating Traditional Crop Genetic Diversity into Technology using a Biodiversity Portfolio Approach to Buffer against Unpredictable Environmental Change in the Nepal Himalayas (UNEP/GEF)	BK Joshi	2014	2018	Rs. 2926613.40	• Germplasm collected and diversity blocks maintained

Annex 4.1. Training/workshop/seminar organized in FY 2071/72 (2014/15)

SN	Name of Training/ Workshop/ Seminar	Duration	Target group	Location	No. of participants
1.	Crop genetic diversity and disease assessment workshop	10-14 Sept 2014	Officer and scientist	Dolakha	25
2.	Participatory crop improvement and seed system	16-18 Sept 2014,	Officer and scientist	Khumaltar	16
3.	Diversity Kits and Crowdsourcing Training	29-30 June, 2015	Officer and scientist	Pokhara	20
4.	Regional Training Workshop on Management of Agricultural Plant Genetic Resources	11-12 May 2015	Officer and scientist, farmer	Tarahara	36
5.	Training on Field Genebank Establishment and Management (FGEM)	2-4 Feb 2015	Officer and scientist, farmer	Khumaltar	18
6.	Quality seed production	2 days	Farmer	Jumla	25
7.	Quality seed production, storage and marketing	2 days	Farmer	Bara	44

Annex 4.2. Publications in FY 2071/72 (2014/15)

SN	Name of publications	Type	Language	Authors	No. of copies
1.	AFACI Pan Asia Project (IMPGR): Exploration, regeneration and conservation of endangered cereals, grain legumes from Central Mid and High Hills of Nepal. Project Completion Report and Outcomes	Book	English	Joshi BK, KH Ghimire and SK Shrestha, eds	100
2.	Annual Report 207071 (2013/14)	Book	English	Joshi BK, KH Ghimire and D Singh, eds	150
3.	National agro-biodiversity policy 2007, Revised 2014	Booklet	English	NAGRC, MoAD	100
4.	खाद्य तथा कृषिका लागि वानस्पतिक आनुवंशिक स्रोत सम्बन्धि अन्तराष्ट्रिय सन्धिमा	Book	Nepali	NAGRC, MoAD	15
5.	फापर बालीमा बिबिधता, बिउ छनौट र उत्पादन	Leaflet	Nepali	बालकृष्ण जोशी र कृष्ण हरि घिमिरे	200
6.	Passport format	Leaf	Nepali and English	NAGRC	4000

Annex 4.3. Information disseminated through media

SN	Information disseminated/ Media coverage	Type	Name/ type of media	Date/ time
1.	Genebank and Community Seed Bank	Interview	FM Radio/ Pokhara	2071/10/12
2.	Role of genebank in earthquake affected districts	Interview	FM Radio/ Pokhara	2072/02/22

Annex 4.4. Visitors to NAGRC in FY 2071/72 (2014/15)

SN	Category	Number	Districts	Area of major interest
1.	Farmers	34	Different districts	Landraces and genebank
2.	Teachers and Students	200	Kathmandu, Bhaktapur, Lalitpur, Chitwan	Agrobiodiversity, genebank, biotechnology
3.	Entrepreneurs	8	Kathmandu, Lalitpur, Chitwan	Landraces
4.	Extension officials	8	Kathmandu, Lalitpur	Agrobiodiversity, genebank
5.	NGO officials	14	Chitwan, Hetauda, Pokhara	Genebank
6.	International delegates	20	China, Japan, America, Taiwan, Italy, India, Swiss	Agrobiodiversity and genebank

Annex 5.1. Training/workshop/seminar attended by staff in FY 2071/72

SN	Name of Staff	Position	Name of Training / seminar/ workshop	Duration	Place/ country	Organizer
1.	BK Joshi, KH Ghimire, M Bhattarai, MR Bhatta, S Shrestha	S3, S4	Crop genetic diversity and disease assessment workshop	10-14 Sept 2014	Dolakha.	NAGRC, LIBIRD, BI
2.	MR Bhatta	S4	Final regional meeting of project, Enhancing, understanding and implementation of ITPGRFA in Asia	3 days	Thailand	FAO
3.	BK Joshi		National conference on biotechnology	22-23 Nov 2014	Khumaltar	NBA
4.	D Singh, KH Ghimire, K Bhattarai, MR Bhatta	S3, S4	Participatory crop improvement and seed system	3 days	Khumaltar	NAGRC, LIBIRD, BI

SN	Name of Staff	Position	Name of Training / seminar/ workshop	Duration	Place/ country	Organizer
5.	BK Joshi, KH Ghimire, D Singh, M Bhattarai, S Shrestha	S3, T6	Diversity kits and crowdsourcing training	29-30 June 2015	Pokhara	NAGRC, LIBRID, BI
6.	BK Joshi		30th anniversary of NIAS genebank project and PGRAsia initiation meeting	1-6 May 2015	Japan	NIAS
7.	BK Joshi		PGRAsia kick off meeting	14-20 June 2015	Japan	NIAS
8.	BK Joshi	S3	Interactive workshop on the implementation of ITPGFRA-MLS	1 day	Kathmandu	MoAD
9.	BK Joshi, D Singh, MR Bhatta, KH Ghimire, SK Shrestha, M Bhattarai		GEF On-farm Project half yearly review and planning meeting	20-24 May 2015	Pokhara	NAGRC, LIBIRD, BI
10.	D Singh	S3	Post plant breeding training	3 days	Lalitpur	ABD
11.	D Singh	S3	Training on seed quality control	7 days	Nepalgunj	SQCC
12.	D Singh	S3	Experimental design and Data Analysis	7 days	Kaski	CIMMYT
13.	MR Bhatta	S4	IMPGR Experts Workshop	6 days	Srilanka	AFACI
14.	M Bhattarai	T6	Experimental Design and Data Analysis	7 days	Chitwan	CIMMYT
15.	Santosh Sharma, N Shrestha	T5	Training on Field Genebank Establishment and Management	3 days	Khumaltar	NAGRC
16.	KH Ghimire	S3	3rd AFACI international training workshop on germplasm management system	10 days	Korea	AFACI

Annex 5.2. Paper published in FY 2071/72 (2014/15)

SN	Title of Paper	Authors	Name of Proceedings, Journal, Year
Published papers			
1.	Farmers' knowledge on and on-station characterization of Bhate Phaper (rice Tartary buckwheat)	Joshi BK	Nepal Agric. Res. J. 14:44-52, 2014
2.	Biotechnology for effectively managing agricultural biodiversity in Nepal	Joshi BK, MR Bhatta, KH Ghimire and D Singh	Abstract. National Conference on Biotechnology, 2014
3.	Nepal, one of the centers of diversity for buckwheat	Joshi BK	NARC Newsletter 21(1):4-5, 2014
4.	Genetic parameters of common wheat in Nepal	Joshi BK, DB Thapa and MR Bhatta	Journal of Nepal Agric. Research Council 1:9-13, 2014
5.	गहुँको स्थानीय जातहरु: विविधता, प्रयोग तथा संरक्षण	बालकृष्ण जोशी	उन्नत गहु उत्पादन प्रबिधि संग्रह, राष्ट्रिय गहुबाली आनुसन्धान कार्यक्रम, भैरहवा, १७-२०, २०७२
6.	Wheat genetic resources: Diversity, conservation and utilization	Joshi BK	Wheat Working Group Meeting (WWGM), NWRP, p.7-10, 2015
7.	Plant Genetic Resources Conservation and Utilization Initiatives for Implementation of ITPGFRA in Nepal. Research outputs from GRPI-2 project	Joshi BK, ed	Technical report, GRPI-2. NAGRC, MoAD and LIBIRD, 2015
8.	Crop (Plant Genetic Resources) Biodiversity in Nepal	Joshi BK, MR Bhatta, D Gauchan, KH Ghimire, D Singh and S Sanjya	Country Reports for The State of the World's Biodiversity for Food and Agriculture, 2015
9.	Exploration, regeneration and conservation of endangered cereals, grain legumes from Central Mid and High Hills of Nepal	Bhatta MR, KH Ghimire, BK Joshi, D Singh, M Bhattarai and SK Shrestha	AFACI Expert Workshop and Planning Meeting for IMPGR, 2014, Sri Lanka, p.183-210.
10.	Characterization of finger millet (*Eleusine coracana* Gaertn.) germplasm with agro-morphological markers	Bhattarai M, KH Ghimire, BK Joshi and MR Bhatta	Proceedings of the 27th National Summer Crops Workshop, NARC, Rampur, 18-20 April 2013. Vol II: 184-189, Dec 2014
11.	Varietal research on fine grain and aromatic rice for terai and river basin areas of Nepal	Thakur GC, SN Sah, T Akhtar, RK Mahato, KH Ghimire, G Hamal, R B Chaudhary and G Yadav	Proceedings of the 27th National Summer Crops Workshop, NARC, Rampur, 18-20 April 2013. Vol II: 92-101, Dec 2014

SN	Title of Paper	Authors	Name of Proceedings, Journal, Year
Presented papers			
1.	Empirical evidence of country interdependence on PGRFA.	Joshi BK	A. Consultation meeting 2014, Khumaltar; B. Interactive workshop 2014, MoAD, Kathmandu and C. Regional consultation meeting 2014, Rampur, NARC, MoAD and LIBIRD
2.	Proposed list of Nepalese PGRFA for the inclusion in the MLS	Joshi BK	A. Consultation meeting 2014, Khumaltar; B. Interactive workshop 2014, MoAD, Kathmandu and C. Regional consultation meeting 2014, Rampur, NARC, MoAD and LIBIRD
3.	Understanding hybrid and GMO	Joshi BK	Talk program. White House College, 2015
4.	Biotechnology for effectively managing agricultural biodiversity in Nepal	Joshi BK, MR Bhatta, KH Ghimire and D Singh	National Conference on Biotechnology, 22-23 Nov 2014, Khumaltar
5.	Existing and proposed mechanisms for the germplasm exchange under the ITPGRFA-MLS	Joshi BK	Interactive workshop on the implementation of ITPGFRA-MLS, 2014, MoAD, Kathmandu
6.	Conservation perspective	Joshi BK	Orientation workshop on the GEF-UNEP project, 2014, Pokhara
7.	Application of GIS and CAT for agricultural plant genetic resources management in National Genebank	Joshi BK	Idea Sharingshop, 12 Oct 2014, NAGRC, Khumaltar.
8.	National Genebank: An Introduction	Joshi BK.	30th anniversary of NIAS Genebank project and PGRAsia Initiation Meeting. 1-6 May 2015, Japan
9.	Research institutes on PGRFA in Nepal	Joshi BK and YR Pandey	PGRAsia kick off meeting. 14-20 June 2015, Japan
10.	Agricultural plant genetic resources management and agriculture in Nepal	Ghimire KH, HB KC, BK Joshi and MR Bhatta	The 3rd AFACI International Training Workshop on Germplasm Management System (GMS) 11-20 May 2015, Jeonju, Korea. 2015

Annex 6.1. Regular annual budget and expenditure record of FY 2071/72 (2014/15)

Code	Budget Head	Annual Budget	Budget Released	Expenses	Balance
21111	Staff Basic Salary	48,23,000	48,14940	40,42,473	8,060
21113	Dearness Allowance	1,80,000	1,80,000	1,68,000	12,000
21121	Uniform Expenses	1,05,000	1,05,000	1,05,000	0
22112	Communication Expenses	1,00,000	1,00,000	97,073	2,927
22212	Repair & Maintenance	8,15,000	8,15,000	8,14,086	914
22311	Office Expenses	30,75,000	30,75,000	27,26,158	3,48,842
22522	Operational Expenses	67,95,000	67,95,000	67,33,290	61,710
22711	Miscellaneous Expenses	30,000	30,000	29,815	185
29221	New Construction of Building and Others	1,00,000	1,00,000	98,250	1,750
29231	Renovation Works	25,00,000	25,00,000	22,41,227	2,58,773
29232	Capital Renovation	2,00,000	2,00,000	1,98,362	1,638
29311	Furniture and Fixture	2,00,000	2,00,000	2,00,000	0
29511	Machinery and Equipment	8,75,000	8,75,000	74,919	8,00,081
	Total	**1,97,98,000**	**1,97,98,000**	**1,83,01,120**	**14,96,880**

Annex 6.2 Special Project budget and expenditure record of FY 2071/72 (2014/15)

Name of the Project	Funded by	Project Period	Budget Received	Expenses	Balance
IMPGR	RDA-Korea	3	22,05,000	8,27,709	13,77,291
GEF-On-Farm Project	GEF/UNEP	5	33,23,450	23,75,940	9,47,510
GRPI-II	Bioversity International	2	15,09,212	12,57,947	2,51,265
Total			**70,37,662**	**44,61,596**	**25,76,066**

Annex 6.3. Revenue status of FY 2071/72 (2014/15)

Source	Total	Remarks
Administrative Miscellaneous (Tender form)	29,600.00	
Inceme from crop production	14,050.00	
Interest from bank	1,59,611.33	
Other Income	13,31,224.88	
Total	**15,34,486.21**	

Annex 6.4. Beruju status of FY 2071/72 (2014/15)

Beruju	Amount	Remarks
Beruju till last year	0.00	
Beruju cleared this year	0.00	

Annex 7.1. Passport format in English

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):

Annex 7.2. Passport format in Nepali

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 नः
बाली (Crop):
बाली (स्थानिय नाम):
जाति (Genus):
प्रजाति (Species):
उपप्रजाति (Subspecies):
पूर्ख्यौलि (Parentage):
जातको नाम (नेपाली तथा स्थानिय भाषामा) र अर्थः

ख. सङ्कलन स्थान
कृषक वा दाताको नामः

I. साधारण
जिल्लाः गा.वि.स.:
वार्ड नः गाउँः
गा.वि.स. देखिको दुरीः
नजिकको बजार वा प्रसिद्ध ठाउँः
सङ्कलन स्थानको अक्षास (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. संस्था
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 महिनाः
संकलित बाली भित्र्याएको साल र महिनाः
प्रयोगः

महत्वपूर्ण गुणहरुः

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 ल्याइएकोः

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 संख्याः

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

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

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

XI. फोटो लिएकोः १. छ २. छैन

XII. खेती गरिने तरिकाः
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 संस्थाः

सङ्कलन मिति (YYYY/MM/DD):

Major contribution of organization in agricultural research

Agricultural plant genetic resources (APGR) activities were started back in 1984 in the Agriculture Botany Division focusing on exploration, collection, characterization, utilization, regeneration and documentation. After the establishment of National Agriculture Genetic Resources Center (Genebank) in 2010 at Khumaltar, the major contributions of the centre are:

- Made access of diverse genetic resources to plant breeders, students, researchers and farmers.
- Functionalized seed bank, tissue bank, DNA bank, field genebank and community genebank (seed and field genebank).
- Systematized the management of accessions through Excel database.
- Characterized and identified elites lines of different crops.
- Developed good practices of on-farm conservation.
- Contributed to development of Agrobiodiversity Policy 2007 (revised 2014) and NBSAP.
- Collaborated with national and international organizations for conserving and enhancing agricultural plant genetic resources.
- Conserved potato plantlets in-vitro.
- Genotyped accessions of different crop species and provided molecular lab facilities for genetic diversity study to other organizations
- Explored and collected > 9000 accessions of about 100 crop species from all 75 districts of the country.
- Conserved 9000 accessions of different crop species in medium-term and long-term storages.
- 1500 accessions of 7 crops safety duplicated in different CGIAR genebanks.