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Good Practices for Agrobiodiversity Management

Editors: Bal Krishna Joshi, Devendra Gauchan, Bharat Bhandari and Devra Jarvis

Kathmandu, Nepal, 2020

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Good Practices for Agrobiodiversity Management

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Alliance

Kathmandu, Nepal
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NAGRC (Khumaltar, Lalitpur; http://narc.gov.np)
The National Agriculture Genetic Resources Center (NAGRC) was established in 2010 under NARC for the conservation and utilization of all agricultural genetic resources that includes six components of agrobiodiversity (crop, forage, livestock, aquatic, insect and microorganism) and four sub components (domesticated, semi domesticated, wild relatives and wild edible). Agricultural genetic resources are managed through four strategies (ex-situ, on-farm, in-situ and breeding) and deploying >50 good practices across the country.

LI-BIRD (Pokhara, Nepal; http://www.libird.org)
Local Initiatives for Biodiversity, Research and Development (LI-BIRD) is a non-profit, non-governmental organization established in 1995 to reduce poverty and promote social justice. LI-BIRD is committed to capitalizing on local initiatives, synergy, and partnerships for sustainable management of renewable natural resources. LI-BIRD contributes to several innovative methods and approaches aiming to achieve a positive impact on the livelihoods of rural poor and marginalized farmers through appropriate technological, social, and policy changes.

Alliance of Bioversity International and CIAT, Rome, Italy (https://www.bioversityinternational.org)
The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) delivers research-based solutions that harness agricultural biodiversity and sustainably transform food systems to improve people's lives in a climate crisis. The Alliance is part of CGIAR, a global research partnership for a food-secure future.

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Cover photo: Roplefaat homestay team, PVS Roplefaat, Seeds diversity, Chino kutak in Humla

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Acknowledgements

Native agricultural genetic resources have been generally under-valued, therefore, some initiatives have been taken through Global In-situ agrobiodiversity project joinly implemented by NARC, LI-BIRD and Bioversity International since 1997 in Nepal for conservation and sustainable use of agrobiodiversity on-farm. Global in-situ project (1997-2006) has developed many good practices for agrobiodiversity management which are published in On-farm Management of Agricultural Biodiversity in Nepal: Good Practices 2006 (B Sthapit, P Shrestha and M Upadyay, eds). A good practice is a process or methodology or action that is effective and successful; environmentally, economically and socially sustainable; technically feasible; inherently participatory; replicable and adaptable, that has been proven to work well and produce good results. It is a successful experience tested and validated in achieving its objective. For further widening the scope of good practices in the country, NAGRC, LI-BIRD and Bioversity International have generated, tested and adapted a number of good practices in four sites, Jungu, Dolakha; Ghapanpokhara, Lamjung; Hanku, Jumla; and Chippra, Humla through a project "Integrating Traditional Crop Genetic Diversity into Technology: Using a Biodiversity Portfolio Approach to Buffer against Unpredictable Environmental Change in the Nepal Himalayas", commonly called as Local Crop Project (LCP) from 2014 to 2019. Good practices listed here are well tested and adapted by the communtiies in the fields, shown their positive impact, shared and discussed among the relevant stakholders. Project team have tested and validated many good practices, however, we have included 22 good practices that are worth sharing for its dessimination and mainstreaming. These practices, though specially based on eight crops (rice, bean, barley, foxtail millet, proso millet, amaranth and buckwheat), can be widely applicable to other agricultural genetic ressources in different locations, national and globally.

Farmers and community leaders of these four sites who directly involved on generating and testing good practices are highly acknowledged. We are particulary greateful for the works offered by all authors and contributers, project team members inluding Aruna Parajuli, Epsa Palikhe, Subash Gautam, Achyut Adhikari, Anish Subedi, Brinda Linkha, Sundar Rahaut, Purna Paudel and Sriram Subedi. Our special thanks go to project steering committee meembers, site management team members and national project coordinators (Drs Madan R. Bhatta, Mina N. Paudel, Bal K. Joshi and Krishna K. Mishra) for technical support and guidance. We would like to specially thank to our support team, Surendra Shrestha, Safal Khatiwada, Lila Jirel, Richa Gurung, Hem GC, Laxmi Gurung, Mira Dhakal and Khem Pun. We appreciate the institutional heads (Dr Deepak Bhandari, NARC; Dr Balaram Thapa, LI-BIRD and Juan Lucas Restrepo, Alliance of Bioversity International and CIAT) for their wholehearted support and creating enabling environment for the successful implementation of the project. Financial support provided by Global Environment Facility (GEF) through United Nations Enviornment Program (UNEP) is greatly appreciated.

The Editors

Foreword

Achieving long-term food and nutrition security will always remain a challenge without conserving and utilizing rich agricultural biodiversity present in developing countries. Increased pressure to grow more foods for human population, market preferences, national polices and climate change are some of the triggering factors that shape agrobiodiversity worldwide. Nepal being agrobiodiversity rich mountainous country, many globally significant crops genetic resources are reported that are being maintained by farmers in their production systems. National and international experts have been involved for the conservation and promotion of sustainable utilization of agricultural genetic resources since 1990s. Many community-based agrobiodiversity management process, approaches and methods that were piloted in Nepal such as community seed banks, diversity fair, and four cell analysis are now widely used in many parts of the world. Exemplary action research has contributed significantly for long term availability of agricultural genetic resources. Farmers, researchers, policy makers and consumers are equally involved in conserving and promoting native genetic resources through ex-situ, on-farm, in-situ and breeding strategies. Participatory tools developed, tested and validated in a particular site can be of great use to replicate in other areas for effective conservation and utilization of available genetic diversity. To accelerate the agrobiodiversity related work, three organizations namely, NARC, LI-BIRD and Bioversity International in partnership with the Department of Agriculture (DoA) have jointly implemented project entitled "Integrating Traditional Crop Genetic Diversity into Technology: Using a Biodiversity Portfolio Approach to Buffer against Unpredictable Environmental Change in the Nepal Himalayas" with the financial support from GEF-UNEP since 2014. We are very pleased with the efforts put by the project team in bringing this excellent publication timely for wider dissemination. We thank the editors, authors, project team members, contributors, including farmers and other stakeholders for their hard work and strong team spirit they demonstrated in developing and bringing out this publication on time. The efforts of the editors and authors are noteworthy as they have been able to document the good practices as an outcome of the project. We believe that this document will be read widely and will serve as a valuable reference for researchers, development professionals, students, academicians and relevant stakeholders to accelerate the conservation and utilization of agricultural biodiversity in Nepal and globally.

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Uncommon Abbreviations

ABS	Access and Benefit Sharing
ACSBN	Association Of Community Seed Bank in Nepal
APGR	Agricultural Plant Genetic Resource
CBM	Community Biodiversity Management
CBR	Community Biodiversity Register
DG	Director General
CDABCC	Crop Development and Agricultural Biodiversity Conservation Centre
CSB	Community Seed Bank
DF	Diversity Fair
DFF	Diversity Field Flora
DFS	Diversity Field School
DFTQC	Department of Food Technology and Quality Control
DoA	Department of Agriculture
ED	Executive Director
FCA	Four Cell Analysis
FFS	Farmers Field School
FFT	Farmer Field Trial
FGD	Focus Group Discussion
FRD	Food Research Division
GEF	Global Environment Facility
GI	Geographic Indicator
HDI	Household Diversity Index
IRD	Informal Research and Development
KII	Key Informant Interview
KIS	Key Informant Survey
LCP	Local Crop Project
LI-BIRD	Local Initiatives For Biodiversity, Research and Development
MoICS	Ministry of Industry, Commerce and Supplies
NAGRC	National Agriculture Genetic Resources Center
NARC	Nepal Agricultural Research Council
NPC	National Project Coordinator
PA	Preference Analysis
PIC	Prior-Informed Consent
PMU	Project Management Unit
PPB	Participatory Plant Breeding
PRA	Participatory Rural Appraisal
PSE	Participatory Seed Exchange
PVS	Participatory Variety Selection
SEAN	Seed Entrepreneur Association of Nepal
SMT	Site Management Team
SQCC	Seed Quality Control Center
UNEP	United Nations Enviornment Program
VDC	Village Development Committee
WLE	Water, Land and Ecosystem
WTLCP	Western Terai Landscape Complex Project

Nepali-English Glossary

Nepali word	English translation
Aalu	Potato
Bhate Phaper	Rice tartary buckwheat
Chhapati	Flat bread of cereals or also called Roti
Chino	Proso millet
Chino Kutak	Proso millet thresher (dehusker)
Dhan	Rice
Dhindo	Thick porridge from millet flour
Dudhe Chino	Milky prosomillet
Gaon Palika	Rural Municipality
Ghee	Butter
Hariyo	Green
Jhand	Local fermented liquor from grain (beer) not distilled
Kaguno	Foxtail millet
Kalo	Black
Khairo ghiu simi	Brown butter bean
Khir	Pudding made from grains
Kodo	Finger millet
Laddoo	Sweet ball
Latte	Amaranth
Maas	Gram
Malpuwa	A type of sweet small fried bread used as snack
Nimkin	A type of fried chips from cereal flour
Okhal	Pestle
Palika	Municipality
Panhelo simi	Yellow bean
Raithane	Indigenous, native
Rato kodo	Red finger millet
Red	Rato
Roti	Flat bread of cereals
Selroti	Ring bread
Shayu	Apple
Simi	Bean

Good Practices: Project Outcome

A good practice is a process or methodology or action that is effective and successful in achieving its objectives. It is inherently participatory; replicable and adaptable, that has been proven to work well and produce good results. This book documents 22 good practices of agrobiodiversity management either developed or refined during the project period (2014-2019) in Nepal. All these practices were implemented in the project sites in partnership with communties, discussed and shared among farmers and other stakeholders. Project team has also reviewed various literatures and validated with relevant experts while documenting these good practices. Some of them were totally new and therefore, are an outcome of this project. Project details are given below.

Local Crop Project

Integrating Traditional Crop Genetic Diversity into Technology: Using a Biodiversity Portfolio Approach to Buffer against Unpredictable Environmental Change in the Nepal Himalayas

The Himalayan system, with its outlying subranges, stretches across six countries, with the longest division in Nepal. The region, with extreme variations in topography and micro-environments, harbours centres of unique crop diversity adapted to mountain environments. The diversity of local crop varieties, with globally important cold-tolerant genes, is one of the few natural resources available to mountain farmers to cope with marginal and heterogeneous environments that are likely to be starkly affected by climate change. These traditional crops are also important for sustainable development of their local economy. The key to the sustainability of the high mountain agroecosystems in Nepal is that farmers have continued to keep a large diversity of traits in their traditional varieties, despite the bottleneck of cold stress. In these vulnerable environments, diversity in the production system can support ecosystem provisioning, cultural and regulating services and buffer the risks of pest, disease and environmental stresses. Yet, little research and development has been done focussing on these important, nutritious and climate-resilient crops from the perspective of breeding, processing, promotion and policies. The project aims to mainstream the use of diversity-rich solutions in the mountain agroecosystems to improve ecosystem services provisioning and resilience. The project will develop and promote diverse sets of varieties, improve access to diverse sets of planting materials and drudgery-reducing processing technologies and promote an enabling environment for access to and benefit-sharing of planting materials.

Project Goal

To contribute to the conservation of globally important crop biodiversity, which form the basis for food security in areas of highagricultural systems throughout the world.

Project Objective

To mainstream the conservation and use of agricultural biodiversity in the mountain agricultural production landscapes of Nepal to improve ecosystem resilience, ecosystem services and access and benefit-sharing capacity in the mountain communities.

Crops and Sites

The project worked on eight neglected and underutilized mountain crops, namely, buckwheat (*Fagopyrum esculentum* and *F. tararicum*), cold tolerant rice (*Oryza sativa*), common bean (*Phaseolus vulgaris*), finger millet (*Eleusine coracana*), foxtail millet (Setaria italica), grain amaranth (*Amaranthus caudatus* and *A. hypochondriacus*), naked barley (*Hordeum vulgare* var. *nudum*), and proso millet (*Panicum miliaceum*). The research work was conducted in four districts (Dolakha, Humla, Jumla and Lamjung) of Nepal.

National Partners

The key executing national partners were the Nepal Agricultural Research Council, the Department of Agriculture (DoA), and Local Initiatives for Biodiversity, Research and Development (LI-BIRD).

Donors

The GEF Trust Fund provided USD 2.3 million for five years in grant, while the four implementing and executing partners (the Government of Nepal mainly NARC, LI-BIRD, Bioversity International and UNEP) provided additional USD 5.8 million in cash and in-kind cofinancing. The project was executed by Bioversity International and supported by the CGIAR Research Program on Water, Land and Ecosystems (WLE), a program to provide an integrated approach to natural resource management research lead by the International Water Management Institute (IWMI).

Project Management

The project was implemented by UNEP and executed by Bioversity International, NARC, DoA and LI-BIRD. The National Genebank, NARC hosted the Project Management Unit (PMU) and the Chief, acted as the National Project Coordinator (NPC). The PMU was consisted of the NPC, supported by a National Project Manager and a National Project Assistant. The PMU was supported at the site level by project leaders from executing agencies and the Site Management Teams supported by the District Coordination Committees. The project team was assisted by an interdisciplinary core team and thematic experts known as the National Technical Coordination Committee. At the national level, the project is governed by National Project Steering Committee, chaired by the Joint Secretary of the Ministry of Agricultural and Livestock Development (MoALD) involving representation of key stakeholders such as Minstry of Forestry and Environemnt, Ministry of Finance, NARC, LI-BIRD, ICIMOD, UNEP and Bioversity International including a woman farmers' representative from the project sites. The role of Project Steering Committee is to review the overall progress of the project and provide policy decisions about the implementation of the project and play a proactive role in mainstreaming good practices into national policies.

Working Approach

The project cultivated partnerships with public, private and NGO sector and leveraged resources for generating and mainstreaming lessons and good practices. Community-based biodiversity management approaches was employed to empower local institutions to effectively participate in local governance processes to set up and implement relevant research for- development agenda. Many activities were implemented under the three envisoned project components, which are

- Component 1: Mainstreaming mechanisms that integrate diversity-rich solutions into breeding and technology
- Component 2: Increasing access to local agrobiodiversity planting materials
- Component 3: Promoting an enabling environment for access and benefit sharing of local agrobiodiversity planting materials

Local, National and Global Benefits

Local communities have improved capacity of managing diverse sets of agricultural biodiversity for improved production and risk management, and have better access to planting materials and processing equipment. Nationally and globally important cold, drought and pest tolerant germplasm of eight target crops have been conserved and made accessible to farmers and other stakeholders in Nepal.Tools, methods and approaches for conservation and sustainable use of agrobiodiversity are developed and piloted during the project period for upscaling and mainstreaming at the local, national and international level. Project has developed and published several knowledge products in both English and local langauge and maintained them in the project website (www.himalayancrops.org) that are being widely shared and freely available to the global community.

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1. On-farm Agrobiodiversity Measurement and Conservation Approaches

Bal Krishna Joshi, Krishna Hari Ghimire, Rita Gurung, Niranjan Pudasaini, Saroj Pant, Pragati Paneru, Devendra Gauchan, Krishna Kumar Mishra and Devra Jarvis

A. Introduction

Total agrobiodiversity of any area is necessary to plan the implementation of agricultural and environmental projects and activities. Diversity is most for advancing agriculture development, however, modern agriculture has accelerated the replacement of old age crop diversity. Agrobiodiversity index and measures are commonly used and estimated for crop and animal species, landraces and sites. These are useful for locating sites, crops and custodians of agrobiodiversity. Agrobiodiversity includes crop and plant; livestock and fish, insect and microbial genetic resources that are cultivated, semi domesticated or wild. Diversity are necessary for a long-term basis to secure the food and nutrition in the world. Among the three conservation strategies (ex-situ, on-farm and in-situ), on-farm conservation strategy is farmer led and least cost strategy to manage total agricultural genetic resources. Within on-farm conservation, there are many approaches and methods being applied in Nepal. Agrobiodiversity in any area should be estimated properly that leads to choose the conservation approaches effectively.

B. Objectives

- To assess and measure diversity of agrobiodiversity on farm
- To examine the genetic variation and trend on genetic erosion
- To conserve and utilize native genetic diversity following different approaches on farm

C. Methods and Process

On-farm Agrobiodiversity Measurement

Different types of data are generated or collected for the measurement of agrobiodiversity on-farm (**Figure** 1). Primary and secondary data are used. Both quantitative and qualitative data are collected through different methods (**Table** 1). The information for measuring agrobiodiversity comes from different levels. The levels of information are the genes, traits, genetic markers, variety, the crop, the parcel or plot, the household (farmer), the village, the community, the ethnicity, the municipality, the landscape or region, district, province, country, region.

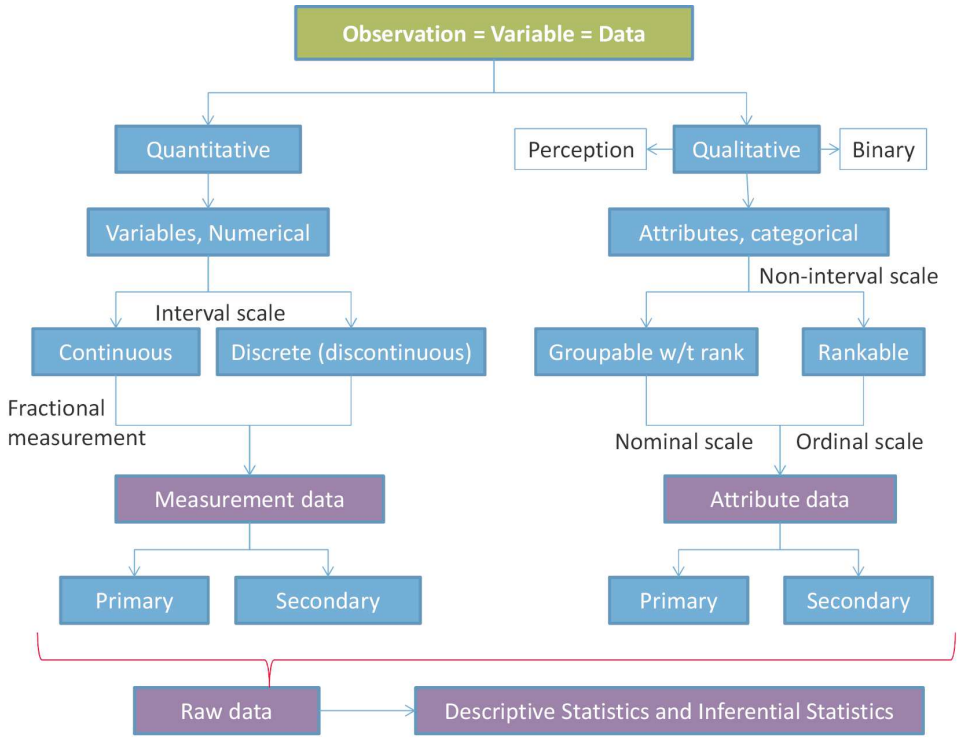

Figure 1. Data types for measuring on-farm agrobiodiversity at ecosystem, species and cultivar levels.

Table 1. Methods of collecting data from on-farm for measuring agrobiodiversity

SN	Data Collection Method	Description	Remarks
1.	Community biodiversity register review and community seed bank visit	Community Biodiversity Register (CBR) is maintained with detail of local agricultural genetic resources by community. Community seed bank (CSB) manage local crop diversity through germplasm flow among the farmers	Species, varieties, unique landraces and traits along with use value are collected
2.	Diversity block	Growing and evaluating locally available crop landraces in easily accessible sites in small plots in farmers fields	Observation are recorded (inter and intra landrace level diversity, including population structure)
3.	Diversity collection	Exploration and collection mission are launched for assessing diversity within landraces, sites. Seeds and information are collected.	Seed morphology and passport data are collected. Collection and diversity map are generated using GIS and analog sites using Climate

SN	Data Collection Method	Description	Remarks
4.	Diversity fair	Exhibition of local seeds by all farmers in single spot	Useful for survey and diversity assessment and measurement including traditional knowledge
5.	Field/ transect walk	Walk along the farming areas with custodian farmers and field staff	Team observe diversity and record data
6.	Focus group discussion	Collecting of specific required information from the group of relevant farmers and stakeholders for discussion on agrobiodiversity	Check lists-based discussions help to collect and verify data. Pattern of landrace occurrence (growing areas and household), resource mapping, etc are done
7.	Food fair	Exhibition and sale of local food made from local genetic resources	Assessment and survey of food diversity and traditional knowledge during food fair
8.	Household survey	Questionnaire based structured collection of information from different sampling strategies	Assess different level of diversity by collecting both qualitative and quantitative data
9.	Key informant survey	Knowledgeable person on agrobiodiversity are surveyed as per the checklists	Experiences are documented and data are validated along with resource mapping
10.	Lab experiments	Includes molecular lab, seed lab, nutrition lab	Molecular level diversity, nutrition diversity are assessed along with image analysis
11.	Literature review	Relevant literatures eg baseline survey report, annual report, project reports etc are reviewed	Secondary data are collected, verified and updated
12.	Local market visit	Market near the site is visited and information are collected. Interview to seller is carried out	Diversity of target sites along with food items are assessed
13.	On-farm trial	Diversity are further characterized and evaluated in farmers' fields following local practices	Data are recorded and verified based on descriptors and farmers' unit of descriptors

SN	Data Collection Method	Description	Remarks
14.	On-station trial	Controlled experiment is conducted for diversity characterization, evaluation and screening	Data are recorded and verified based on descriptors

The scientific community has developed a wide range of methods of measuring various dimensions of agrobiodiversity, which is often referred as agrobiodiversity index (Boversity International, 2017; Sthapit et al, 2017). Diversity is measured and explained at different levels eg ecosystem, species, landrace and gene levels. Within genotypic diversity, there are functional, molecular, use value and nutritional diversity (Figure 2). Based on the data types, objectives and objects, different measures are used to estimate and compare the diversity (Table 2). These are diversity indices and measures used to quantify the diversity in a particular site. Diversity indices can be used to allow comparisons within and between different populations at species, landraces and genetic levels. Some of these are further used to classify the landraces and species in different categories. For examples, areas and number of household are used in four cell analysis to group available landraces under four cells (patterns of landrace occurrence).

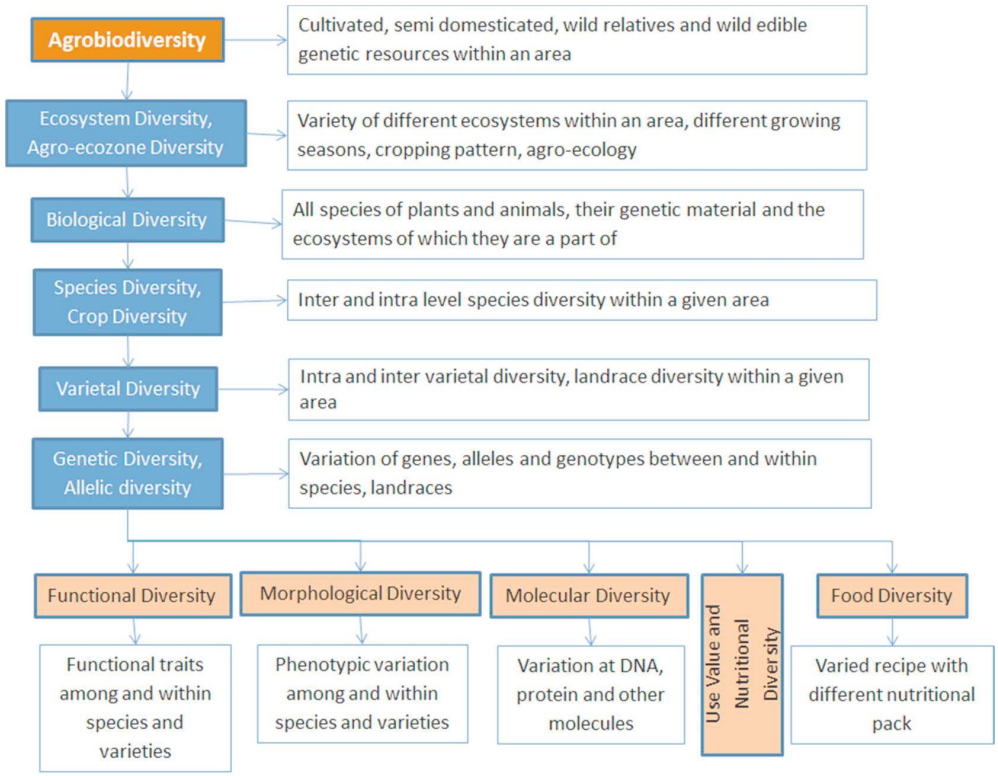

Figure 2. Levels and types of diversity within agricultural genetic resources.

Measuring patterns of landrace occurrence is the simplest basis for measuring the population structure of a particular species. Classification of landraces is common and easy based on growing areas and number of growing household. These two measures classify each landrace according to whether or not it is widespread (occurs in more than a few fields) versus localized (restricted to a few fields), and secondly whether it is common (here defined as grown at least on some farms, in large numbers, in above-average field sizes) versus rare (in small fields only).

Diversity changes over time and space are also estimated using different diversity measures. Both spatial and temporal changes are important for monitoring and applying appropriate methods of conservation.

Table 2. Different measures for on-farm agrobiodiversity measurement

SN	Diversity Measure	Description	Remarks
1.	Chi square ($?^2$)	Tests for comparing two sets of data, for example comparing two varieties or two populations for disease resistance classes, or comparing observed phenotypic classes in one population with the expected series	Comparison of a local population to a known established variety for a qualitative trait distributed according to classes such as flower color
2.	Cluster analysis	Group entities with similar characteristics into categories. Methods may be hierarchical, resulting in a dendrogram, or non-hierarchical, resulting simply in groups of similar samples	There are numerous different clustering algorithms, which often lead to quite different results with the same data set
3.	Crop groups	Number of crop groups based on different criteria eg use value base, economic importance base national list base, habitat base, red list base, growing season base, national priority base, etc. higher the number of such groups, indicate higher diversity,	Examples are cereals, vegetables fruits, released variety, registered variety, major, minor, primary, secondary, staple, commodity, high value, commercial, industrial, food crops, feed crops, manuring crops, pesticidal plants, cash crops, cover crops, trap crops, catch crop, , cultivated, semi domesticated, wild edible, field crops, garden crops, aquatic plants, common, rare, endangered, extinct, localized, vulnerable, winter crops, summer crops, off-season

SN	Diversity Measure	Description	Remarks
4.	Cropping patterns	Number of different cropping pattern	Indicates number of species, variation in growing seasons
2.	Cluster analysis	Group entities with similar characteristics into categories. Methods may be hierarchical, resulting in a dendrogram, or non-hierarchical, resulting simply in groups of similar samples	There are numerous different clustering algorithms, which often lead to quite different results with the same data set
5.	Coefficient of Variation (CV)	Quantifying diversity using quantitative agromorphological data. Expresses sample variability relative to the mean of the sample –it is also called a measure of relative variability or relative dispersion	For comparing diversity across groups
6.	Dissimilarity coefficients	Measure the degree to which two populations or individuals are different in composition	Examples are Euclidean distances, Mahalanobis' generalized distance
7.	Distinctness	Not identical	The range of variation found
8.	Evenness (species, cultivar)	The frequency of occurrence, observations distributed evenly among categories result in high diversity	Distribution of the different classes (eg % area covered by each variety of a crop in a given village)
9.	F-test and ANOVA	Quantifying diversity using quantitative data	Used to estimate genetic variance between entities (varieties, populations, regions, sites
10.	Growing season	Number of crop growing time and seasonal variation	Higher number of growing seasons indicates higher varietal and species diversity
11.	Household Diversity Index (HDI)	Estimate following Shannon-Weaver Index method	Total diversity maintained by each farmers, considering either species of different categories or varietal traits categories
12.	Land type and habitat	Different types of land and habitat in an area	As number of different number of land type increase, diversity at varietal and species level increased
13.	Mean	Average of all values of the a variable	Compare mean of different samples

SN	Diversity Measure	Description	Remarks
14.	Minimum, maximum value	Largest and smallest value	Compare among species and landraces
15.	Morpho type	Groping of species or landraces based on their outlook	Consider all traits at a time to define morpho type
16.	Percentage and frequency	A display of data that specifies the percentage of observations that exist for each data point or grouping of data points	Useful method of expressing the relative frequency of survey responses and other data
17.	Principal component analysis	Similarity or dissimilarity coefficients based ordination method, scatter plotting of observations based on their diversity values	Explain the variance-covariance structure of a set of variables through linear combinations. It is often used as a dimensionality-reduction technique
18.	Range	The difference between the lowest and highest values	Shows how much the numbers in a set vary
19.	Red list	Name list of genetic resources (at genotype, landrace, variety, strain and breed levels) under different groups based on the analysis of distribution and population size (also called five cell analysis), and trait distribution	Conservation status group eg common, vulnerable, rare, endangered, localized, unique
20.	Richness (species, cultivar)	Take into account the number of species, landraces, any functional unit or objects	Number of types (eg crops, varieties, traits, genes), species richness, varietal richness
21.	Shannon Diversity Index (H')	Take into account the number of species (the richness) and their relative contribution (the evenness)	Diversity index for qualitative data
22.	Similarity coefficients	Measure the degree to which the populations of samples are alike	Simple matching coefficients, Jaccard's coefficient
23.	Simpson's index (D)	Take into account the number of species (the richness) and their relative contribution (the evenness)	Quantifying diversity using qualitative data, diversity index
24.	Species density	Take into account the number of species in an area, landrace density may also be estimated	Number of species in a sample area
25.	Trend analysis	Temporal and spatial analysis on status and changes in agrobiodiversity	Regular estimate of different diversity measures over time and space, useful for monitoring diversity status

SN	Diversity Measure	Description	Remarks
26.	Center of diversity	Presence of crop wild relatives near to site	Indicates areas with wild relatives a higher diversity for this species
27.	Use value (food items	Types of different local food items and other cultural and social values made from locally available agricultural genetic resources	Higher agrobiodiversity means more number of different types of foods and use values
28.	Variation and standard deviation	The average of the squared differences from the mean. the average difference between the arithmetic mean and the value of each observation in a data set	Measures of spread

On-farm Conservation Approaches

Three strategies ie breeding, in-situ and on-farm are considered at local level for overall conservation and utilization of agrobiodiversity. Different methods and approaches for on-farm conservation are given in Figure 2. All or any of these are applied and among them community seed bank is very common for management of crop diversity. In all these approaches, local and native genetic resources are considered. Farmers, communities, farmer groups and local stakeholders need to actively participate.

D. Advantages and Disadvantages

Advantages

- Many options (simple to complex) to measure and monitor agrobiodiversity
- Any level (crop, plot, farmer, village, etc) can be considered for estimate
- Useful to compare diversity among crops, village and districts
- Farmers and agriculturist involve equally to estimate and assess the diversity
- Different farmers, group of farmers can choose any conservation approaches and these are simple and cost effective
- Easy access to diversity and accelerate the germplasm flow
- Conservation through use continue the evolutionary process

Disadvantages

- Need to consider multiple approaches and dimension to estimate and collect data
- Take more time and human resources
- Information collected on native genetic resources might further be needed to verify

- Difficult to demark the areas for analysis of diversity. Area coverage is based on administrative rather than adaptation of genetic resources
- In some cases, technical expertise are needed
- Strong collaborations are needed.

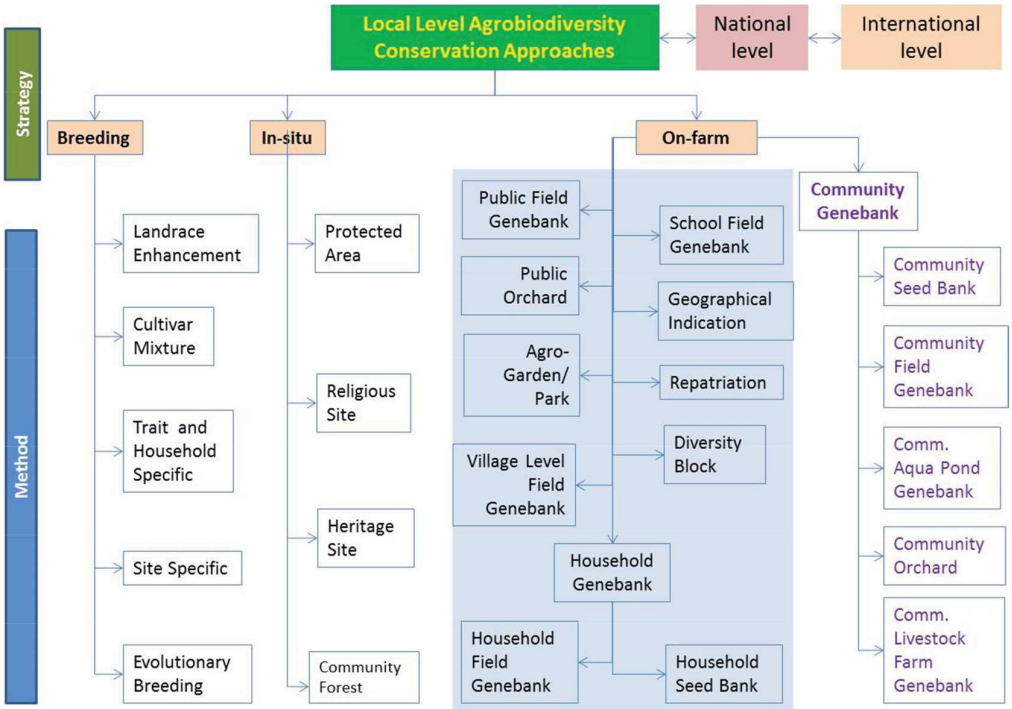

Figure 3. Agrobiodiversity conservation approaches and methods at local level adopted in Nepal.

Source: Joshi and Upadhyay 2019

E. Success Cases

Many diversity measures and indices are estimated for different sites and crop species and landraces. Most commonly used measures are analysis of variance, mean, SD, multivariate analysis, and Shannon-Weaver index. Information is available from species to landraces to genes levels of rice, bean, proso millet, finger millet, amaranth, buckwheat, naked barley, foxtail millet, etc. Native and local crop genetic resources are being conserved through community seed bank in Humla, Jumla, Lamjung and Dolakha. Linkage among stakeholders is established for in-situ conservation. Local landraces have been genetically enhanced through participatory approaches. Some such landraces are got registered. Custodian farmers are identified and household genebank are established along with community field genebank.

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Citation

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2. Red Zoning and Red Listing

Bal Krishna Joshi, Krishna Hari Ghimire, Bharat Bhandari, Devendra Gauchan, Rita Gurung and Niranjan Pudasaini

A. Introduction

Agricultural diversity is at risk of loss, even though all genetic resources could not be collected for long term conservation within a short period of time. Therefore, red zoning and red listing are very useful for prioritizing conservation and utilization efforts as well as for initiating in-situ, on-farm and ex-situ conservation appropriately. Red listing is more common in wild fauna and flora. The World Conservation Union (IUCN) and Convention on International Trade in Endangered Species of wild flora and fauna (CITES) have developed their own criteria for wild fauna and flora for red listing since 1965. Red list categories for agricultural plant genetic resources (APGRs) have been started since 1998 in Nepal (Joshi et al 2004, Sthapit et al 2005, Joshi and Gauchan 2017).

Red zone is any areas where agricultural land is going turned to other uses, and native genetic resources are at risk of loss because of modern varieties, development works, natural disasters, etc. Red zoning is the process of identifying red zone in agricultural land. Collection gap is the areas from where any genetic resources have not been collected before or if collected, in very few numbers. Red list (also termed conservation status) is the list of crop species, and cultivars (varieties or landraces), prepared from the conservation aspects and considered trend of genetic erosion. The process of listing under red list categories is called red listing. It also includes rare and unique cultivars which are based upon the geographic range, habitat specificity, trait specificity and local population size. For example decreasing population size over the time of any landrace indicates that this landrace is at endangered state and it may extinct soon. This is important to determine the red zone, collection gap and red list status of crop landraces for setting priority attention for conservation as well as planning different types of actions for groups of landraces (Joshi and Gauchan 2017).

B. Objectives

- To prioritize the conservation areas and agricultural genetic resources
- To identify the farming areas that are at the edge of changing use pattern and map the red zone in farming areas
- To group the genetic resources based on the distribution and population size for accelerating conservation of rare, endangered and unique resources (red list)

C. Methods and Process

Red Zoning Farming Areas

Red zone is the agricultural areas where the diversity in native agricultural genetic resources is decreasing over the seasons and years due to many natural and socioeconomic factors. There are major six factors that turn agricultural lands in to red zone (Figure 1). These factors include ad hoc distribution of modern varieties, heavy drought, disease and pests, natural disasters, migration of farmers after disasters, change in land use and commercialization. Red zone area is identified through the analysis on the degree of these factors in a particular site. Area coverage during analysis can be village, municipality, district, province or nation. Four approaches are used for red zoning. 1. Focus group discussion (FGD) and Key Informant Survey (KIS) are conducted to analyze the degree of these factors in the area coverage. 2. Report, news and social media are referred particularly for knowing natural calamities eg earthquake, drought, etc. 3. Interaction meeting with the developmental organizations (both governmental and non-governmental) particularly for locating mega project eg hydro electricity project, urbanization, new settlement, etc. 4. Collection gap analysis using Genebank passport data.

Geographical information system (eg DIVA-GIS) is applied to generate the existing collections map of any crop species based on the passport data of National Genebank. Based on the collection map, gaps are located (areas from where no collections have not been made). To validate the gaps, it is more effective to relate gaps with information generated from literature review, FGD and KIS. These gaps are the potential areas for extinction of crop diversity, therefore needs to rescue them. After identifying gaps, further discussion and information collection should be organized to know the red list status of landraces available in these gap areas.

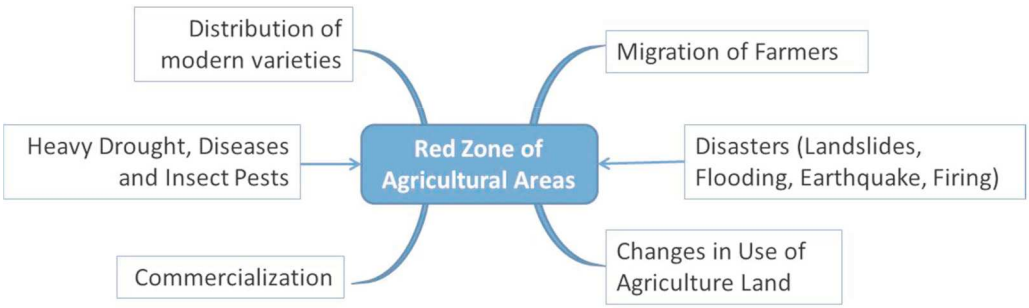

Figure 1. Factors that turn agricultural land to red zone (ie area where crop landraces become endangered).

Red Listing Agricultural Genetic Resources

Red list is the name list of genetic resources (at genotype, landrace, variety, strain and breed levels) under different groups based on the analysis of distribution and population size (also called five cell analysis), and trait distribution. Red listing is the process of preparing the red list.

Five Cell Analysis (Distribution and Population Size Analysis): Landraces are grouped under five classes based on the distribution pattern and population size as well as based on the area coverage and number of farmers growing these particular landraces in a village. Earlier it was commonly called Four Cell Analysis (Sthapit et al 2006, Joshi et al 2004), which considers areas and number of farmers growing this landrace to group into four classes (large area by many farmers, small area by many farmers, large areas by few farmers and small area by few farmers). To have a complete picture of any particular areas of total native genetic resources, five different classes which is called red list status, is prepared (**Figure** 2). The distribution and population size of any landrace can be analyzed either by directly measuring the variables or organizing the focus group discussion (FGD). FGD is the simplest method to list the genetic resources under these five cells based on the criteria presented in Figure 2 and area coverage for analysis at the village level. During listing, some genetic resources may not be listed under not evaluated cell if information is lacking.

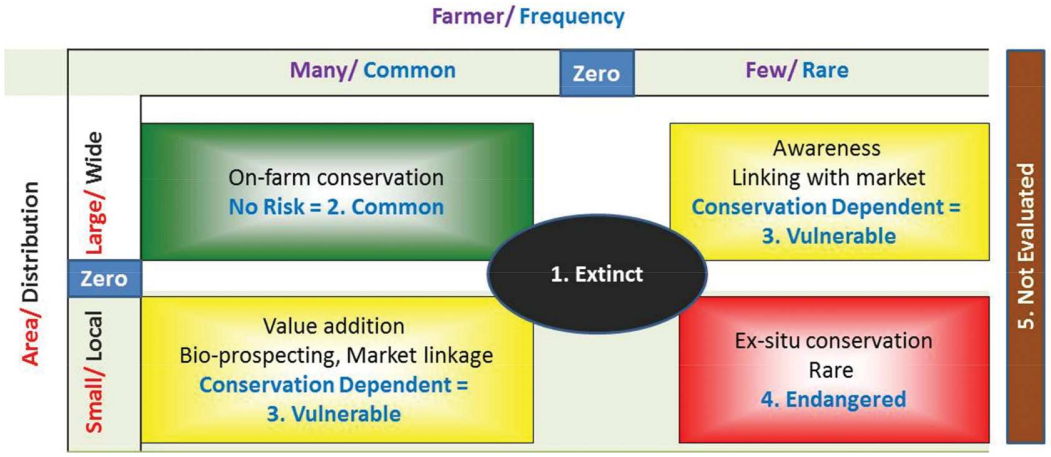

Figure 2. Categorization of crop landraces based on the distribution and population size.
Source: Joshi et al 2004 (modified)

Trait Distribution Analysis: Specific trait distribution is analyzed like areas and number of growers of any landraces. Four classes of trait distribution analysis are given in **Figure** 3. Landrace with specific trait which is not available in other landraces is called unique landrace. Potential danger in such case is possibility of loss of particular trait, therefore considered such landrace as endangered state and need immediate attention for conservation. Landraces falling in other three classes are not at risk of extinction for a time period. For example, Bhate Phaper (rice Tartary buckwheat) which has loose husk and available and cultivated for main staple in small area only in Dolpa district of western high mountains in Nepal. This

landrace is considered as unique and falls under endangered class. Field assessment for this analysis is costly and tedious, therefore, FGD and KIS are used.

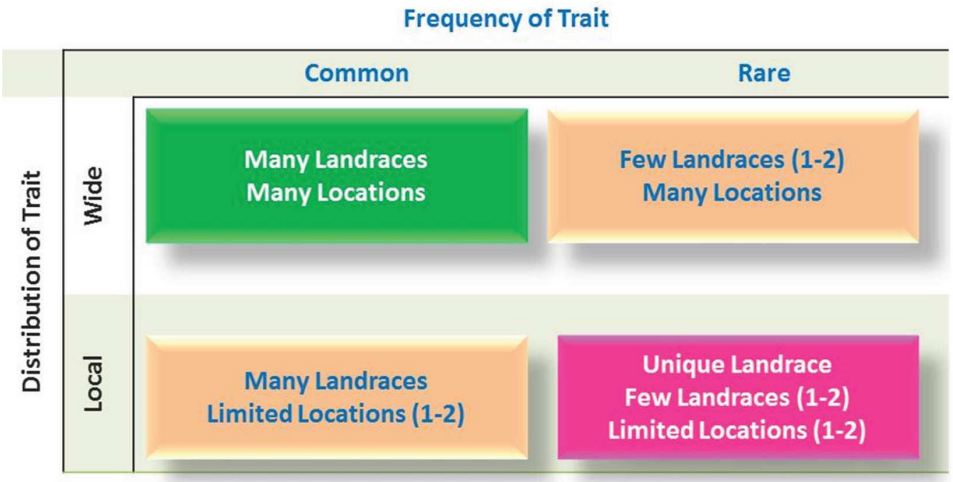

Figure 3. Categorization of crop landraces based on the distribution of traits.

D. Advantages and Disadvantages

Advantages

- Conservation of genetic resources before losing from the site due to adhoc promotion of modern varieties, natural calamities and changes in land use
- Create awareness and make familiar among stakeholders on existing diversity along with their status and urgency of conservation
- Involvement of many farmers and officials
- Simple and low cost techniques for assessing diversity along with status and importance of genetic resources
- Sensitize farmers and researchers to involve on conservation and utilization of native genetic resources

Disadvantages

- Information collected on native genetic resources might further be needed to verify
- Difficult to demark the areas for analysis of diversity. Area coverage is based on administrative rather than adaptation of genetic resources

E. Success Cases

Through red zoning, collection gap analysis and red listing, more than 1000 landraces of more than 20 crop species have been listed, collected, rescued and conserved. This good practice is exercised 250 times in 30 districts involving 1000 farmers and 100 officials.

Farming areas in earthquake affected districts (Lamjung, Gorkha, Dolakha) are red zones. Urban areas eg Simikot, Humla and Bijayanagar, Jumla are also red zones. We have noticed

loss of many landraces from these red zones. Collection maps of more than 10 crop species have been generated using GIS (DIVA), one example is given in Figure 4. There are many districts from where finger millet has not been collected and these areas are prime concern for further red listing and collection. Red list of some crop species from Jumla and Humla are given in Figure 5. Some unique trait landraces are Bhate phaper (local Tartary buckwheat), Jumli Marshi rice, Jumli bean, Dudhe chino (proso millet), Raato Kodo (finger millet), Jugu Simi (bean), etc.

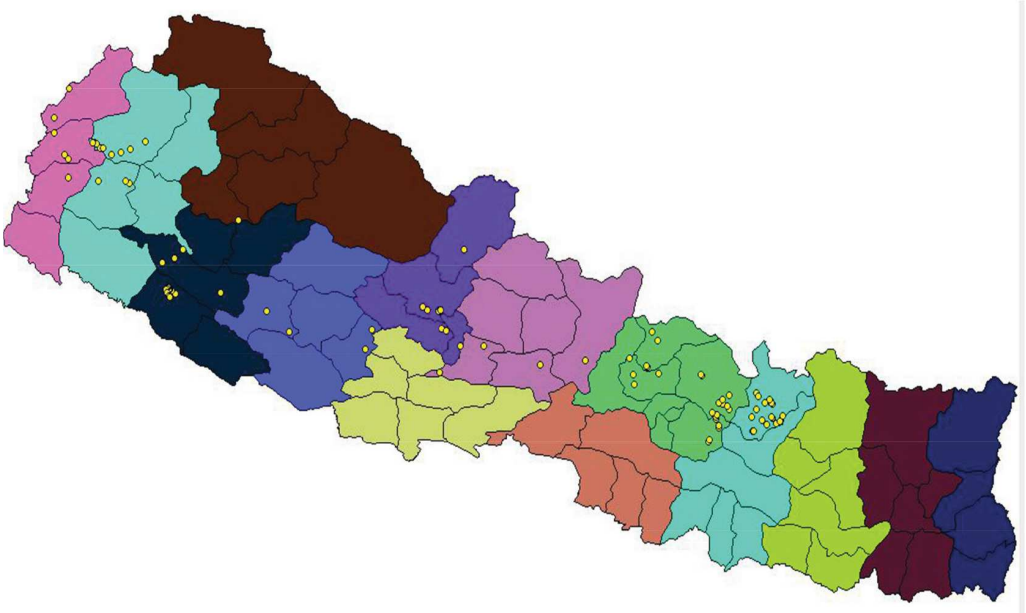

Figure 4. Collections map of finger millet using DIVA-GIS to analyze the gaps in collections

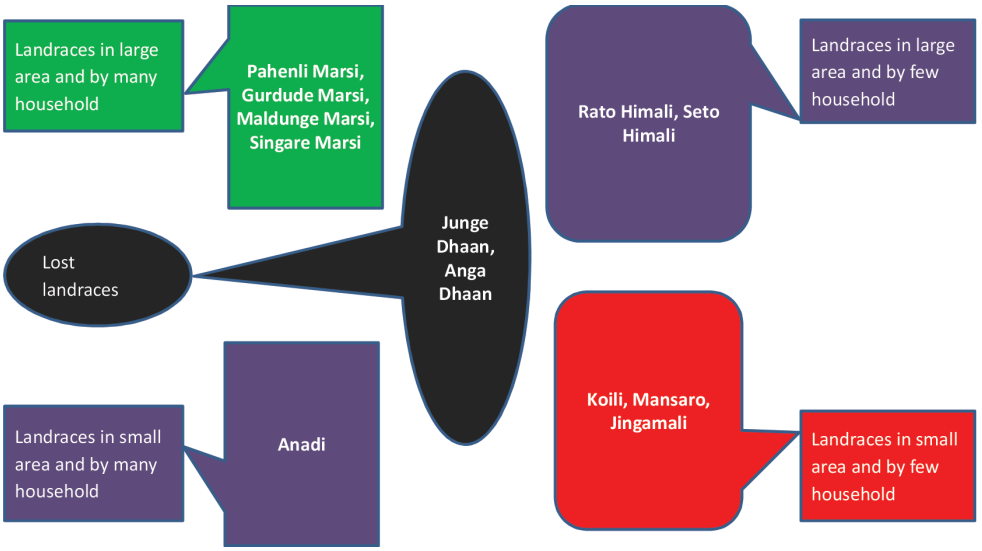

Figure 5. Some examples of five cell analysis.

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3. Diversity Rich Solutions

Bal Krishna Joshi, Devendra Gauchan, Bharat Bhandari and Devra Jarvis

A. Introduction

Every household is diverse and diversity can be observed within household in terms of crops, varieties and landraces, soil type, food preferences and preparation methods, knowledge and practices related with production management of agrobiodiversity and other genetic resources. Farmers are practicing agricultural practices that promotes the use of diversity such as growing mixture of landraces, composting, fertigation. Modern agriculture focuses on developing large scale uniform technology eg use of urea, mono-genotype variety. Such system puts pressure and disturbs the ecological balance causing high risk for crop failure and genetic erosion. Any technological option with greater diversity is less risky, more sustainable and higher adaptability in agriculture. Diversity rich solution is any technology or problem associated solution that considers diversity as an option and address problems with inter and intra level diversity as well as combinations of different components. it also includes multiple technology for a single problem. Some examples are broad genetic base variety, cultivar mixtures, compost (made from different species), biopesticide (made from different species), etc. Diversity rich solution is in practice since 2014 in Nepal with the objective of conserving agrobiodiversity, promoting ecologically oriented sustainable agriculture that also enhances ecosystem services.

B. Objectives

- To collect, test and screen different types of solutions, technologies for site, crop, problem, household;
- To develop diversity rich technology for biodiversity rich sustainable agriculture;
- To make farmers access to diversity rich solution;
- To make aware on importance of diversity at every steps of agriculture practices

C. Methods and Process

Diversity rich solutions are identified through participatory action research and detailed field surveys. Traditional knowledge on using diversity is documented through household survey, focus group discussion and literature review. After prioritizing the problem, various types of researches are conducted in research stations and farmers fields (**Figure** 1). Among the potential list of practices, technologies and methods, assessment was done to identify

diversity rich solutions. Technology, practices and methods with diversity are then selected, which are called diversity rich solutions. Different technologies and practices can also be identified for a single problem. These technologies and practices are disseminated to farmers from different approaches, eg diversity field schools, participatory varietal selection, diversity kits, agricultural exhibitions. Focus is given to have diversity within each solution eg for developing variety, we look on broad genetic base, heterogeneous populations, cultivar mixtures, multilines and composites.

Some examples of diversity rich agricultural technologies are given in **Figure** 2. Such diversity rich solutions are listed, developed and implemented for each household. Diversity may be at species level, varietal level, genotype level, gene/ trait level in case of crop variety. In case of compost, it may be at crop species, animal species, micro-organisms and different parts and component levels.

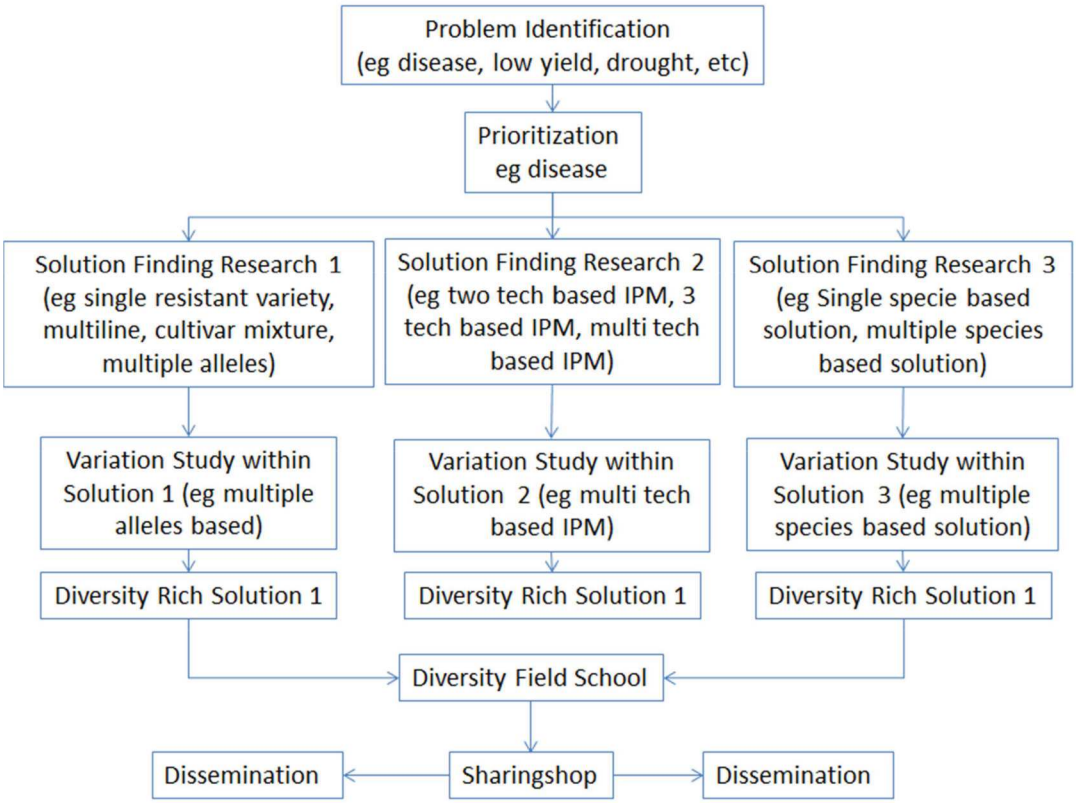

Figure 1. Steps of identifying diversity rich solution in agriculture.

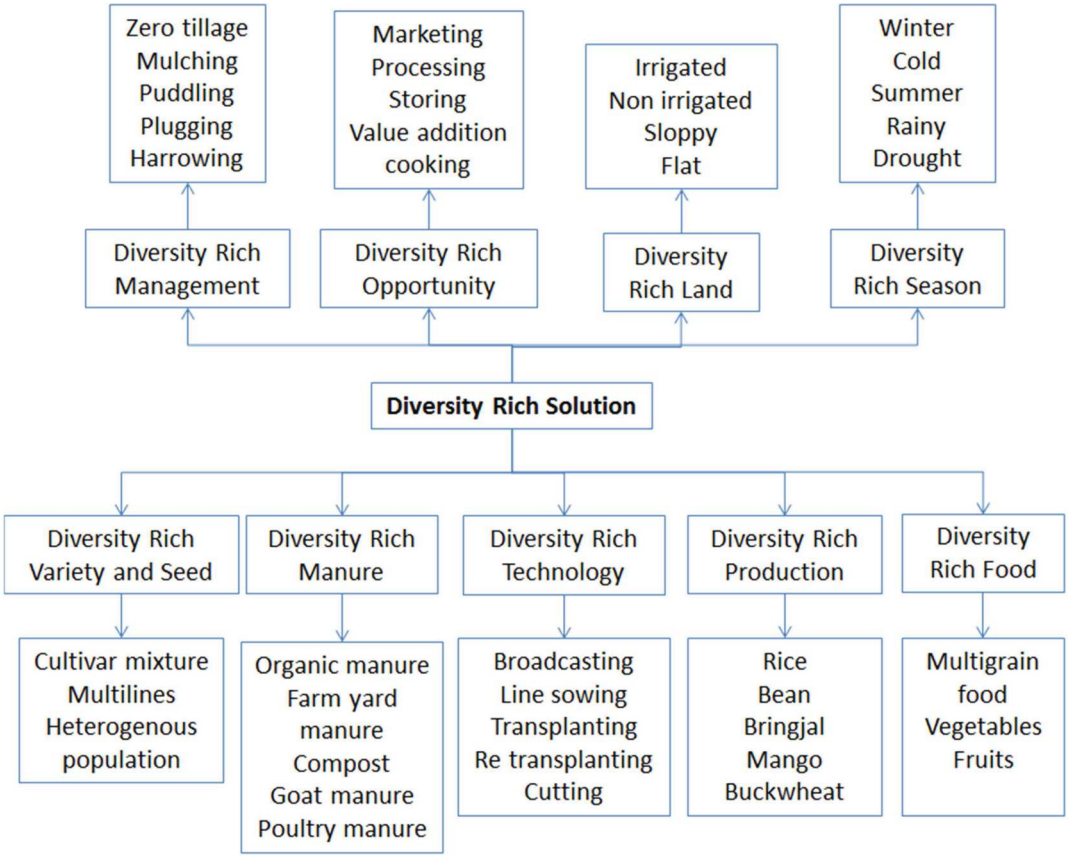

Figure 1. **Diversity rich agricultural solutions.**

D. Advantages and Disadvantages

Advantages

- Help to minimize the risk associated with agriculture production and practicing ecological and sustainable agriculture
- Support for maintaining and enhancing ecosystem functions and services
- This is sustainable method and simple in operation
- High adaptation in diverse conditions including changing climate and market needs
- Supports in the promotion and conservation of agrobiodiversity

Disadvantages

- May be difficulty on mechanization in diverse crop cultivation and using high-tech production and post-harvest technology
- Difficult for farmers and stakeholders to easily accept diversity rich solutions
- There is need of favorable policy to promote diversity rich solutions

- It is some time costly on developing diversity-based technologies for a single problem
- May be difficult to find out the diversity rich solution for all kinds of problem

E. Success Cases

Cultivar mixtures of rice, bean, naked barley, common buckwheat have been successful and in practice in many areas in Nepal. Twelve different food items have been prepared and recipe documented from traditional underutilized mountain crop such as proso millet. Diversity at intra varietal level have proved important for managing unpredictability factors, to increase seed set, to improve the ecological services, to produce better and nutritious production. Many technology for different crop species have been in practice for particular work eg broadcasting, line sowing, hand transplanting, machine transplanting, are available for rice seeding.

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4. Geographical Indication

Bal Krishna Joshi and Devendra Gauchan

A. Introduction

Agricultural products are generally associated with their place of production and are influenced by specific local, geographical factors such as climate and soil. A geographical indication (GI) is a sign (or name) used on products that have a specific geographical origin and possess unique qualities or a reputation associated with the product of the origin (WIPO 2004). The qualities, characteristics or reputation of the product should be essentially due to the place of origin. GI is an intellectual property that protects the product of the area and ultimately helps to promote conservation of agrobiodiversity on-farm and boost economy of local community. The well-known examples of GIs in South Asia include Darjeeling tea, Basmati rice, Himalayan water, Alphonso and Sindhri mangoes, Bhutanese red rice, Pakistani shu (wind proof woolen fabric) and Ajrak (designs from Sindh), jasmine (Hom Mali) rice. Until now, there is no any GI protected products in Nepal. Government of Nepal has approved the National Intellectual Property Right Policy (2017) which includes Copyrights, Patents, Industrial design, Trademarks, GI, Varietal protection, Trade secrets and Traditional knowledge policy (MoICS 2017). Among these policies, GI gives exclusive right to a region or a landscape (eg village, town, region or country) to use a name for a particular product with certain characteristics that corresponds to their specific location. There are more than 100 agricultural products (Joshi et al 2017) which have already established their reputation representing their GIs. Malla and Shakya (2004) have identified and listed 87 potential products for geographical indication (GI) protection in Nepal. Most of the products possess greater cultural and age-old traditional values. Important indigenous crop landraces and their products linked with particular geography, which should therefore, be protected with GI by developing suitable legislation for their market promotion, on-farm conservation and livelihood enhancement of local communities. For GI promotion, Geo-linked popular crop landraces and their traits need to be found out for their potential trade promotion and value addition.

B. Objectives

- To identify and verify the geo-linked genes and traits of native agricultural genetic resources and products associated with particular location
- To use geographical indicator for the promotion of landraces and products
- To register geo linked products and link GI for on-farm conservation of agrobiodiversity

- To help farmers get benefit through application of GI (considering products for purity, tasty, quality and nutritious) and respect their locations and traditions

C. Methods and Process

The first and most important part to obtain GI right to the particular agriculture products, research is necessary to identify particular crop landraces and agricultural products that possess particular geo-linked traits preferred by the consumers.. Such traits should be verified and identified growing crop landraces in geographical areas where GI is applicable so that expression of geo-linked traits can be assessed and ascertained in a particular landrace. Research should be designed after the extensive survey on potential GI related Agricultural Plant Genetic Resources (APGRs). Three methods are in use to identify the geographically associated agricultural genetic resources and their products.

Survey

Household survey, Focus Group Discussions (FGDs), Key Informant Interviews (KIS), market and literature survey are used combining second sources of information to list the existing practices, genetic resources and quality of products associated with geographical indication. Major question in such survey is what native products with unique quality are available in the specific localities that are not similar to any products originated from other localities.

Field and lab evaluation

After identifying potential genetic resources for GI from preliminary survey, such materials are tested in original location as well in other similar production domains. Materials from other localities are also included in field test preferably in scientifically designed experiments such as Replicated trials. To verify the GI for particular trait in specific genetic resource, both field and lab test are conducted. Agromorphological traits, organoleptic tests, quality and nutritional test as well post harvest processing and other appropriate tests based on the type of the products are carried out and analyzed for verification. Testing methods are documented and labeling of such product is based on the results.

Identification of geo linked genes and traits

If possible further study at genetic level in combination with experimental studies in specific soil and climate conditions of the geographic locations should be carried out to identify the genes and traits associated with geo location. Different kinds of markers (morphological, biochemical or DNA) based analysis as well as soil and climatic analysis need to consider for this work. Though this method is not generally carried out for this purpose, it is the best method to verify and claim GI on a right way.

Registration

GI can be protected in accordance with international treaties and national laws under a wide range of concepts eg Sui generis system (special regimes of local protection), using

collective or certification marks and methods focusing on business practices, including administrative product approval schemes. Department of Industry under Ministry of Industry, Commerce and Supplies (MoICS) is the responsible body for granting GI in Nepal. Concern authority with sufficient information need to apply for getting the GI on their products.

D. Advantages and Disadvantages

Advantages

- Legal protection of agricultural genetic resources and their products and preventing from unauthorized use
- Support for on-farm conservation and maintain identity continuously
- Benefits for local producers, improve farmer's income, boost the local economy and support rural development
- Reduces unfair practices of trade preserving local culture and resources
- Consumers understand and appreciate importance to the quality of foodstuffs in their diet
- Helps consumers differentiate between products coming from a particular region and similar products coming from a different region
- Good impact of GI on price, consumers willing to pay premium price
- Marketing tools in the local products that have a specific quality and is exclusive to or essentially due to the geographical environment in which the products are produced

Disadvantages

- Long process to get agricultural genetic resources and products registered
- Resource and time demanding to verify and identify geo linked genes and traits
- Extra work on labeling and branding and regular monitoring for any duplicates in the market

E. Success Cases

There are many practices of selling agricultural products by the name of locality of origin in the country. For instance, Jumli Simi and Jumli Marshi Dhan from Jumla are very famous among the consumers and they are willing to pay more because of their unique taste and qualities of the geographic origin. All the visitors to Jumla looks for these products to buy and bring to home with them. In the market, such products are sold by the name of crop and name of location such asJumla ko simi (bean from

Jumla), Jugu ko Simi (bean from Jugu, Dolakha) (Joshi et al 2017). Some potential such geo related agricultural genetic resources popular among consumers and developed in certain geography has been considered with geo-linked property. They are listed in **Table** 1.

Most of such landrace have very good taste and sold in the market with high price and consumers pay premium price mainly for taste, nutrition, purity and deliciousness. Such products are sold at higher price in certain places (**Table** 2) and visitors prefer to buy some of them mainly because of good taste and popularity of the product. Most of the local markets related to location specific are seasonal and can be found in certain pockets areas along the road and hat bazar. Most of such products are not well labeled, packed and cleaned.

Table 1. Geo-linked popular crops and their important traits

SN	Crop	Location	Important traits	Geo linked crop name
1.	Apple	Marpha, Dolpa and Jumla	Very delicious, juicy, high demand and market value	Marpha ko shayu
2.	Apricot (local)	Humla	Oil from seed has medicinal value	Humlako Chuli (local apricot)
3.	Bean	Jumla, Mustang, Humla, Rasuwa and Lukla	Very delicious, good cooking quality, nutritious, high demand	Jumla ko simi, Mustang simi, Lukla ko simi
4.	Potato	Mude, Dolakha; Langtang, Hemja	Soft, tasty, farrapareko after boiling	Mude ko aalu, aalu
5.	Rice	Jumla	Adapted to cold areas, tasty, nutritious,	Jumli Marshi (red rice)

Table 2. Geo-linked popular crop landraces and their important traits

SN	Crop	Landrace	Location/ address	Geo-linked trait	Value of this trait	Geo-information
6.	Banana	Ghiu Kera	Lamjung; Tanahun	Scented green, long storage life	Quality and market value	Sub tropical
7.	Bean	Jumli bean	Jumla	Good taste, high cooking quality	High market value	Cool temperate
8.	Black cumin	Himali Jira	Jumla	Good spice	Medicinal value	Cool temperate
9.	Black gram	Kalo Maas	Lamjung, Tanahun	Very tasty and good cooking quality	High demand	Sub tropical
10.	Colocasia	Hattipau	Lamjung and Tanahu	Large size, many eyes and good cooking quality (soft and tasty)	High value	Sub tropical
11.	Mountain dill	Mountain Sauf	Jumla	Good spice, good smell	High market value	Cool temperate
12.	Potato	Mude	Mude, Dolakha	Easy cooking, tasty	High market value and demand	Warm temperate
13.	Rice	Jumli Marshi	Jumla	Cold tolerance, taste, reddish	High market value	Cool temperate

Table 3. Some market places of geo-linked products for sales in Nepal

SN	Market	Address	GI products	Geo-location of GI products
1.	Chipledungha	Pokhara, Kaski	Jethodbudo rice, black gram, Manakamana ko Suntala, Banana, Apple	Kaski, Gorkha, Lamjung; Tanahun, Mustang
2.	Damauli bazar	Damauli, Tanahun	Banana, black gram, Makai Bodi	Lamjung, Tanahun
3.	Food Cooperation	Thapathali, Kathmandu	Jumli beans	Jumla, Humla
4.	Nepalgunj bazar	Nepalgunj, Banke	Apple, beans, Jumli Marshi, buckwheat	Jumla, Humla, Dolpa

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5. Diversifying the Sourcing and Deploying Methods to enhance the Crop Diversity

Krishna Hari Ghimire, Bal Krishna Joshi, Rita Gurung, Niranjan Pudasaini, Devendra Gauchan, Sajal Sthapit and Devra Jarvis

A. Introduction

ANepalese farmers of mountain and hill agro-ecosystem mostly grow landraces or traditional varieties of most of the crops. In some major crops like rice, wheat and maize, very old varieties are in cultivation. Insufficient research on minor crops and poor extension networks to disseminate new varieties of major crops are the major reasons to narrow down the varietal options available to the farmers. Crop genetic diversity can make farming systems more resilient, but a major constraint is that farmers lack access to crop genetic resources (Tripp 1997). Farmers have fewer options available to choose, especially at a time when more new diversity is needed to cope with climate and market change (Atlin et al 2017). A portfolio of varieties exists in National Agricultural Genetic Resources Centre (Genebank) and many research stations that includes different varieties which are better than those currently grown by small farmers in remote hills and mountains, who have had limited opportunity to test these different options. In this context, potentials landraces sourced and collected in national Genebank from different environments can be deployed to the farmers of similar production environments.

Since the beginning of agricultural research and development system in early 1950s, formal institutions in Nepal and other developing countries used to introduce new varieties to farmers either by researchers in the form of farmer field trials (FFT) to evaluate performance and measure farmer's acceptance of the varieties or by extension workers in the form of mini-kits to promote new varieties. These approaches involved farmers in the later stage of variety development and dissemination and were not able to provide varieties that met the needs of a large number of smallholder farmers in marginal lands (Witcombe et al 1998). The conventional process of deploying new crop varietal diversity is time consuming, offering limited choices and often targeting high production potential environments (Witcombe et al 1996). Participatory breeding approaches provide farmers access to varieties at a much earlier stage of development through new sourcing methods. Participatory and community-based approaches such as diversity fairs, diversity blocks, participatory variety selection (PVS), participatory seed exchange (PSE), informal research and development

(IRD) kits and diversity kits are practiced as simple methods for sourcing and deploying new crop diversity which can reach a greater number of farmers in risk prone mountain environments. Selecting the appropriate method to source new crop diversity will depend on four major aspects (Jarvis et al 2016): first, whether there is sufficient diversity of traditional crop varieties within the production system; second, whether farmers can access this available diversity; third, whether information on and the performance of varieties available in key aspects; and fourth, the ability of farmers and communities to realize the true value of the materials they manage and use.

B. Objectives

- To deploy diversity in the community and improve access to quality seeds
- To broaden the functional diversity and climate resilience of the agricultural system
- To increase varietal options to the farmer to cultivate in specific agro-environments
- To assess varietal diversity and generate valid agronomical data useful for release/register and promotion of the crop varieties
- To repatriate old landraces and/or lost landraces into the community and to disseminate elite crop varieties
- To ensure farmers' participation in testing, selecting and multiplying promising landraces/varieties

C. Methods and Process

Methods for sourcing new varieties are grouped under two broad categories, conventional and participatory approaches to highlight their differences (Sthapit et al 2020). The conventional system takes only fully developed and tested varieties made available to farmers. By contrast, in the participatory system, farmers or end users are involved as key actors in the technology development and testing process from the very beginning. Participatory methods incorporate the perspective of farmers, usually by inviting farmers to participate in varietal evaluation of activities and make decisions about varietal choice. Success of the method depends on the researchers' ability to incorporate the knowledge and preferences of the technology users (Burman et al 2018). Although participatory seed exchange (Shrestha et al 2013) is not used as part of the breeding process, it has been included here because it provides access to a great diversity of seeds and allows farmers to select the varieties they want to evaluate. Similarly, use of climate analogue tool (CAT) for sourcing new diversity has also been included here due to the applicability of tool for deciding right entry selection. Our focus is to highlight on participatory methods that are used for sourcing and deploying new crop diversity to the community. Key steps of the process are drawn in **Figure** 1, whereas the key methods are described below.

Climate Analogue Tool (CAT) for sourcing diversity

Genetic resources of target crops conserved in national and international genebanks are mapped using geo-reference information of the passport data. Released and promising varieties of mandate crops are also mapped according to their suitability in different agro-climatic regions. Climate Analogue Tools (CAT), an online analysis tool available at http://www.ccafs-analogues.org/tool/, is used to identify analogue sites ie sites with similar climate (maximum and minimum temperatures as well as rainfall) of the site where we want to deploy diversity (Joshi et al 2017). Collection map is overlaid with analogue sites map and climatic suitability is assessed for the varieties/landraces. Landraces and released varieties in the genebank collections from similar climates were deployed to project sites as diversity blocks, participatory variety selection (PVS), yield trials, informal research and development (IRD) kits and diversity kits.

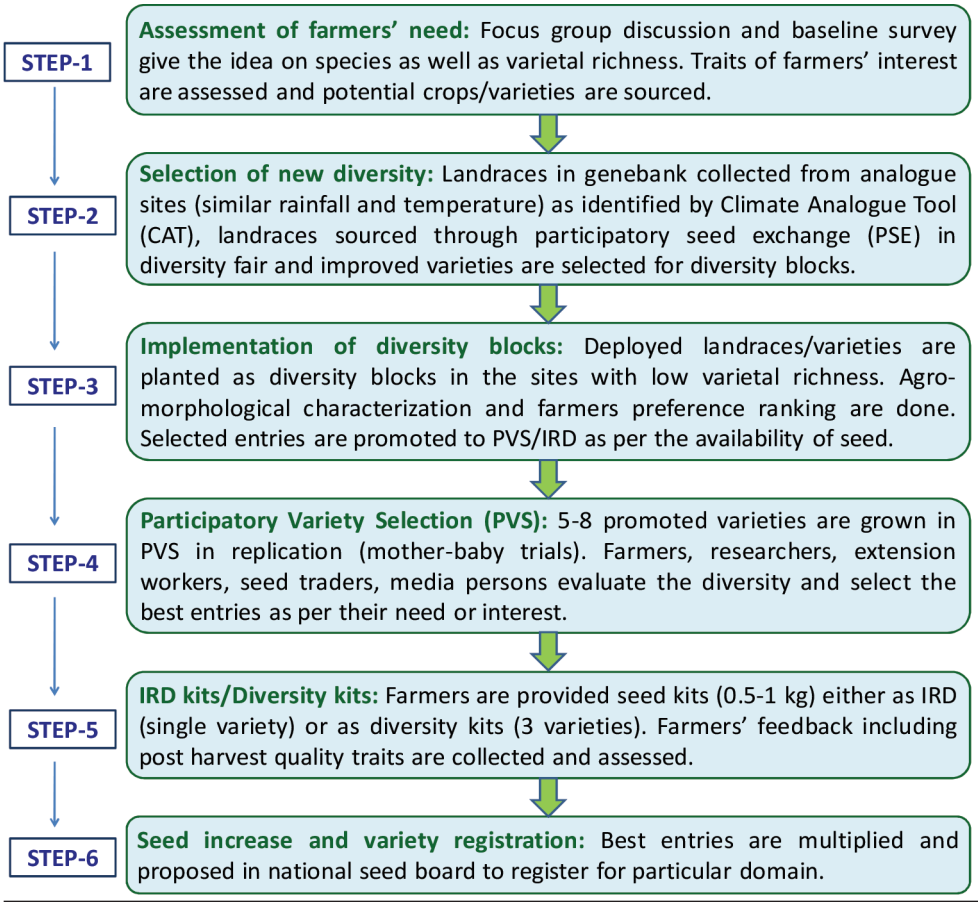

Figure 1. Steps for sourcing and deploying new crop diversity.

Participatory seed exchange (PSE)

The majority of smallholder farmers still rely on informal seed system for their needs. Self-saved seed is their primary source. They use their personal networks to obtain seeds in cases of seed loss or new varieties. Participatory seed exchange (PSE) consolidates such one-on-one exchanges by organizing a village wide, preferably seasonal, seed exchange for multiple farmers to share seeds among themselves (Shrestha et al 2013). On a given date and a location, diversity fair or traditional seed fair can be organized where participating farmers bring seeds and planting materials that they have and are willing to share. When the participants arrive, an inventory of the varieties and the amount of seed is prepared. Then, farmers examine the seeds on display, ask questions about the varieties to the farmers and register their name in the request sheet if they are interested in a variety. Hearing cultivation and usage experiences of fellow farmers seem to be effective in helping farmers decide whether a variety will fit their needs or not.

Diversity blocks

Diversity block is an experimental block of portfolio of varieties (landraces sourced from diversity fair and participatory seed exchange (PSE), and landraces sourced from national and international genebanks, breeding lines and new promising varieties developed by plant breeders. Comparatively larger number of entries is evaluated in smaller plots without replication in the community managed by local institutions (community seed banks or custodian farmers). These diversity blocks are not only used for assessing agro-morphological diversity but also used to validate farmers' descriptors by inviting farmers to visit the block (Tiwari et al 2006). Farmers and researchers jointly evaluate the block and select the number of entries based on their trait of interest (earliness, yield, height, shape, size, color, etc). Diversity block has additional advantage of raising public awareness acting as demonstration blocks. Seeds can be multiplied simultaneously for farmers to farmers' seed exchange as well as inclusion in further participatory trials.

Participatory varietal selection (PVS)

Participatory varietal selection (PVS) is also known as mother-baby trial where two sets of experiments done simultaneously. Mother trial includes 5-8 selected entries, may be from diversity block, and is planted in 2-3 replications (a farmer may be as a replicate) for yield and other agronomical traits. In baby trial, seed of each variety, included in mother trial, is provided to 5 farmers involving a total of 25 to 40 farmers in a village cluster. In a baby trial, quantity of seed depends upon the availability. Individual farmers getting baby trials are asked to compare with their own variety under their own management. Farmers, researchers, extension workers, seed traders and media persons jointly visit to the mother and baby trials and rank the varieties based on the functional trait (earliness, yield, height, shape, size, color, etc). Post-harvest quality traits are also evaluated during joint visit. PVS

provides access to seeds of portfolio of varieties to a larger number of farmers at the same time and farmer access to diversity is greatly improved. By simultaneously conducting the mother and baby trials, yield and agronomic data as well as farmer perception data for variety registration and release can be generated in the same year. However, if amount of seed is not sufficient to conduct baby trials, replicated yield trials can be conducted as mother trials.

Informal research and development (IRD)

Informal research and development (IRD) is an informal research approach of popularizing newly notified or pipeline varieties at a low cost. It is similar to baby trial in the mother baby trial set up described in PVS, but the number of farmers is increased while feedback collection requirements decreased. IRD kits comprise of a small packet of seeds (0.25 to 1 kg for cereals) in large number of farmers to introduce promising varieties to farmers in remote areas. IRD allows large number of farmers in inaccessible areas to obtain new genetic diversity resulting in greater farmer to farmer dissemination than baby trials.

Diversity kit

A diversity kit is a set of seeds of three or more unique, rare or culturally useful landraces in small quantities made available to farmers (Sthapit et al 2006, Sthapit et al 2017). Its objective is to deploy threatened diversity in farmers' fields to popularize them again. Similar to the IRD method, feedback about the acceptance of each new variety and the reasons for acceptance or rejection is not always collected as diversity kits are often not part of a variety release or registration process. However, sample surveys similar to IRD feedback can be used to assess the adoption of varieties. The method promotes farmer experimentation by deploying a portfolio of varieties and encourages farmers to select, exchange and disseminate the most preferred varieties for different situations. This informal research task is shared by many farmers (50-500 sets) who choose location-specific best varieties. For crops like vegetables, a diversity kits include many varieties or even multiple species to diversify home gardens for dietary diversity, but in the case of cereal and pseudo cereals, each household receives three varieties to compare with their local check.

D. Advantages and Disadvantages

Advantages

- Sourcing and deployment of diversity promotes conservation of genetic resources before losing from the site due to promotion of modern varieties, natural calamities and changes in land use.
- Diversity blocks are simple and low cost techniques for assessing diversity along with status and importance of genetic resources as well as source of new diversity
- The participatory methods of PVS, diversity kit and IRD accelerate the adoption of

new varieties and increase crop genetic diversity in a community
- PVS provides information on overall acceptability of new crop varieties/landraces and generates necessary data for variety registration/release, while giving farmers early access to best lines and fast-tracking adoption and associated benefits.
- The costs of IRD and diversity kits are far lower and can be employed if yield trial data is not needed.
- Participatory seed exchange promotes the access of seeds and planting materials and also helps to identify source farmers of particular crops and varieties

Disadvantages

- PVS requires relatively higher cost and more involvement of researchers and farmers.
- PVS need high level of advanced planning and coordination, timely monitoring stakeholders.
- Challenging to obtain sufficient quantity of quality seed for baby trials, IRD and diversity kits.
- Requires high labor cost for packaging for baby trials, IRD and diversity kits.
- Feedback collection from large number of farmers is challenging.
- PSE Requires good preparation with good rapport building with local communities

E. Success Cases

Various participatory methods for deploying and sourcing new crops diversity have been practiced during UNEP/GEF funded project: Integrating traditional crop genetic diversity into technology: using a biodiversity portfolio approach to buffer against unpredictable environmental change in the Nepal Himalayas. More than 300 landraces and new varieties of eight local crops: amaranth, naked barley, common bean, buckwheat, finger millet, foxtail millet, proso millet and cold tolerant rice were deployed in four districts: Humla, Jumla, Lamjung and Dolakha that are sourced from national Genebank, research centers and farmers fields across the mountain agro-ecosystems of Nepal. A cold tolerant landrace from Rasuwa called Borang dhan (NGRC03234) and unique black lentil from Rasuwa called Kalo musuro (NGRC05973) have been popularized in Ghanpokhara, Lamjung through participatory deployment and evaluation. Similarly, unique and high yielding naked barley landrace from Humla called Jhuse uwa (NGRC04894) that has been deployed from national Genebank is being preferred by the farmers in Jumla, Lamjung and Dolakha. A cold tolerant pipeline variety of rice called NR10695-2-2 developed by Agriculture Botany Division under NARC was deployed in four mountain project sites (Humla, Jumla, Lamjung and Dolakha) which is found high yielding in Hanku, Jumla and preferred by farmers. Number of landraces of amaranth, bean, buckwheat, finger millet, foxtail millet and naked barley were identified promising in farmers' fields that are deployed through UNEP/GEF project. Participatory variety selection had identified elite landraces of some crops. They are Rato marse of

amaranth, Rato kodo of finger millet, Dudhe chino of proso millet, Bariyo kaguno of foxtail millet, Pahenlo simi and Khairo simi of bean. Proposals for registration of these landraces have been developed and are ready to submit to national seed board for their large scale deployment and promoting enhanced access to small holder farmers in the mountains. Research outputs have been published for national breeders as well as global scientific community after the participatory assessment of agro-morphological diversity and on-farm evaluation in cold tolerant rice (Yadav et al 2019), foxtail millet (Yadav et al 2018a), finger millet (Yadav et al 2018b) and naked barley (Ghimire et al 2019, Yadav et al 2018c), which are expected for the wide scale deployment of traditional varieties of mountain crops in Nepal Himalayas.

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6. Germplasm Rescue and Repatriation

Bal Krishna Joshi, Krishna Hari Ghimire, Rita Gurung and Devendra Gauchan

A. Introduction

Many agricultural areas are at risk of converting them to use for non-agriculture purposes. Due to many factors such as increase access and availability of modern varieties, change in market preferences, low productivity of native landraces and climate change, crop landraces are threatened and are at the risk of losing from the fields. Still there are many rare and unique landraces conserved by farmers in different parts of the country. Native agricultural genetic resources that are being grown in red zone areas are all endangered. Unique and rare landraces as well as landraces grown in small areas by few farmers are also endangered. Different natural calamities also make native landraces endangered. Such landraces are lost if further conservation action did not take place. Exploration and collection of such endangered landraces is called germplasm rescue. National gene bank started rescue since 2014 for buckwheat diversity in Dolpa district.

Collection of native germplasm was started in 1940 in Nepal and almost 50,000 accessions have been collected so far. After collections, these landraces are never reintroduced or repatriated to the sites from where these were collected. Repatriation is the process of returning collected landraces to their collection site after a few to many years as well to the analog sites identified using geo-references of the collection point. Repatriation of germplasm has been formally initiated since 2016 in Nepal. National Genebank regularly repatriate crop landraces through distribution of diversity kit during field visit for collection. Rescue supports for long term conservation of endangered landraces and repatriation supports maintain diversity on-farm.

B. Objectives

- To conserve and make availability of endangered, rare and unique crop landraces in future
- To repatriate the germplasm in lost or original place and their analog site
- To increase the population of endangered landraces and providing farmers additional crop diversity

C. Methods and Process

Germplasm Rescue

Red zoning and red listing are the initial step for germplasm rescue (**Figure** 1). Different methods, tools and approaches eg interaction meeting, field and literature survey, news, field visit, focus group discussion, key informant survey, GIS and CAT can be used to identify the endangered, rare and unique landraces. Rescue mission is then organized following the exploration and collection standards of the Genebank. Among the different rescue techniques (**Figure** 1, Joshi and Gauchan 2017), direct rescue is more effective and should be carried out the earliest the possible. Seeds and other planting materials should be collected properly along with passport data.

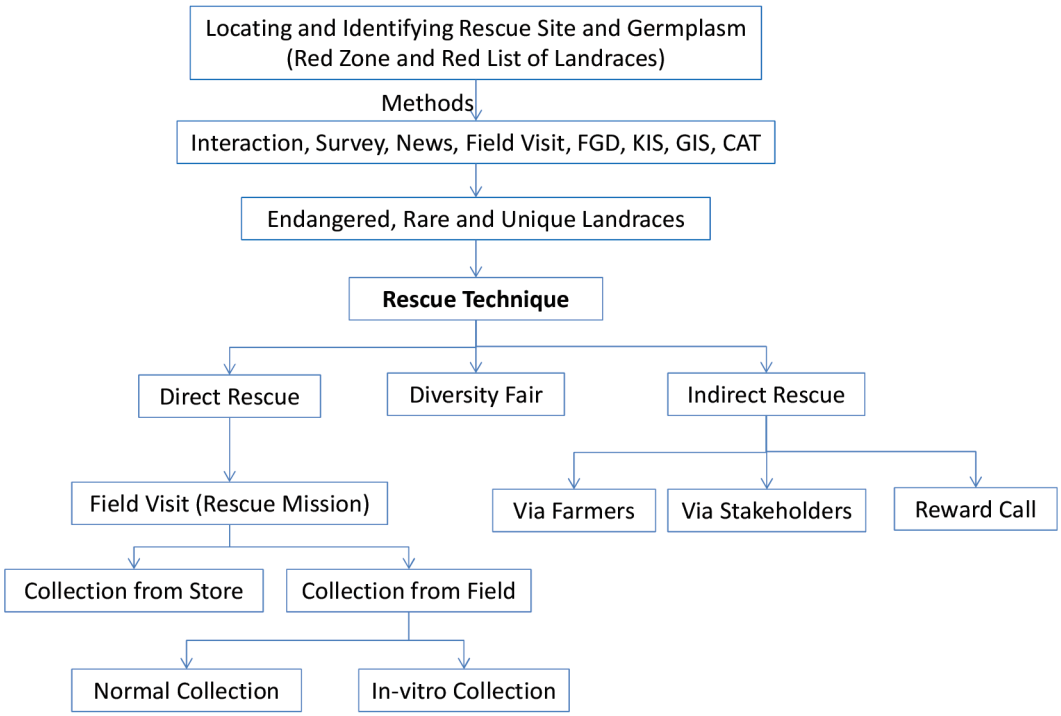

Figure 1. Different techniques and methods of rescuing the germplasm.

Repatriation

First of all, it is important to identify the landraces for repatriation either in original site of that landrace or in analog sites of their original place. Alternatively, sites identification can be first step in repatriation process (**Figure** 2). If landrace is important and main target of repatriation, then landraces identification comes first in the repatriation steps. Methods used for site and landrace identification are field and literature survey, genebank database observation, collection map, focus group discussion, key informant survey, GIS and CAT.

Enough seeds should be prepared based on the number of farmers interested to grow in original as well as analog sites. Such landraces can also be included in diversity kit for distribution to farmers. Information related to selected landrace should be compiled. Seeds along with cultivation techniques are provided to farmers free of cost. Regular monitoring and discussion with growers helps the program success. After few years, impact study is assessed and findings are shared among the relevant stakeholders.

GIS and Climate Analog Tool (CAT) are used for germplasm rescue and repatriation. DIVA-GIS (https://www.diva-gis.org/) is simple GIS software that can be used for generating collection map, analysis of collections, and identifying climate smart germplasm. CAT (http://analogues.ciat.cgiar.org/index.html?showresults=1) is used for identifying analog sites based on different scenarios. Details of these software are explained in Joshi et al (2017b) and Chaudhary et al (2016).

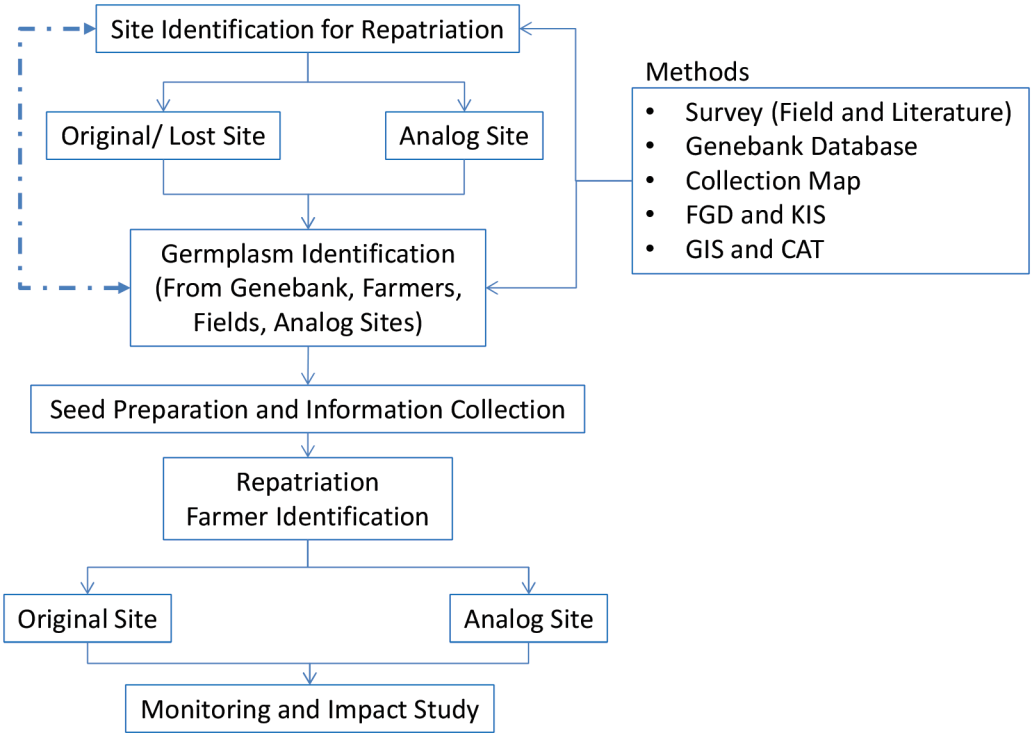

Figure 2. Steps for germplasm repatriation (any one either site or germplasm can be considered as first step depending on the target).

D. Advantages and Disadvantages

Advantages

- No risk of losing landraces from the field and communities

- Create awareness among farmers and researchers on importance of local genetic resources
- Very effective technique for collections of germplasm and passport data for gene bank preservation and future use
- Simple method for increasing population size of endangered landraces
- Increase diversity and help to maintain diversity on-farm
- Farmers feel happy to get either lost landraces or new landraces
- Local organizations eg community seed banks and farmer groups can be engaged and mobilized

Disadvantages

- Often risky and costly to visit to red zone areas
- Collection team should always be ready with necessary field collection items
- Seeds may be very few and need to multiply before providing to farmers
- Performance of repatriated landraces may not be good (Dongol et al 2017) may be due to quality of seeds
- Very few farmers may be interested on growing such landraces as many are interested on modern varieties

E. Success Cases

Based on the farmer's information, National Genebank had rescued some accessions of buckwheat from Dolpa, foxtail millet and proso millet from Humla and Lamjung. Rescue project of the Crop Trust in collaboration with GEF UNEP project rescued a total of 284 crop landraces from 2015 earthquake affected 10 districts (red zone) namely Lamjung, Dolakha, Kavre, Sindhupalchok, Gorkha, Dhading, Makawanpur, Rasuwa, Nuwakot and Ramechhap (Joshi et al 2017a). Local bean from Jugu, Dolakha has been rescued and multiplied. Eight crop landraces of rice, buckwheat, finger millet, proso millet, bean, amaranth, naked barley and foxtail millet were repatriated to Dolakha, Lamjung, Humla and Jumla. Endangered landraces of rice, lentil, naked barley, and foxtail millet were repatriated to Lamjung, Kavreplanchok and Dolakha districts (Dongol et al 2017). This strategy was useful to promote both ex-situ and on-farm agrobiodiversity conservation, validate methodology to conservation and rebuild local seed system affected by disaster and help to safeguard native crop biodiversity for future generation to adapt to more extreme and changing climatic conditions (Gauchan et al 2018).

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7. Participatory Seed Exchange (PSE): A Community based Mechanism for Promoting Access to Seeds

Niranjan Pudasaini Bharat Bhandari, Rita Gurung, Pitambar Shrestha and Devendra Gauchan

A. Introduction

Participatory Seed Exchange (PSE) is a low cost, simple and effective community-based mechanism for improving farmers' access to locally adapted seeds and planting materials which promotes farmer led on-farm conservation and utilization of the agrobiodiversity by exchanging available Agricultural Plant Genetic Resource (APGR) within the community (Shrestha et al 2013, Gautam et al 2017, Sthapit et al 2019). In Nepal, PSE was first piloted by the Western Terai Landscape Complex Project (WTLCP) in 2008 (Shrestha et al 2013). PSE is being utilized as a multi-propose tool to identify, exchange and document available APGR along with associated traditional knowledge by mobilizing local community and their networks. Though PSE is a one-day event, it takes an approximately a month-long time period to plan, prepare and practice.

Traditionally, informal seed exchange between farmers, neighbor and relatives is a common practice at local level. Whereas, PSE is just a well-organized collective action which widens the exchange boundaries at local level and manage the process in a systematic manner. There is no specific criteria to identify the need of PSE to be practiced but in general; community which are rich in local agro biodiversity and those that greatly rely on local planting materials, geographically diverse and fragmented, have limited opportunities to access and exchange planting material and are willing to conserve and utilize local varieties are some of the ideal conditions to organize an effective PSE. Organizing small scale PSE events targeting different planting season is more effective to achieve its goal. It is found to be more effective on exchanging vegetable seeds and identified rare and unique local crops and varieties. Besides, demonstrating, exchanging and documenting local APGR, it can contribute other cross cutting issues as well. Organizing PSE can motivate farmers to practice similar type of collective actions. Participation and involvement of women farmers, valuing local custodian farmers and their knowledge motivate them to conserve and utilize local crops and landrace. Sensitization of local people and concerned agencies is another crosscutting benefit of PSE which helps to enable a favorable working environment towards valuing local APGR and farmer’s contribution to conserve them. PSE generated data and information can be further used to plan community-based conservation and promotional activities

B. Objectives

- To increase access and exchange of locally available seed and planting materials
- To identify and document rare and unique crop landraces with associated knowledge
- To make farmers aware to share, value and utilize available plant genetic resources and associated knowledge
- To develop culture of collective actions and expand farmer's network

C. Methodology

Community based organizations, research and development agencies, local government and others. can organize PSE but technical facilitation and guidance from professional and experienced people are vital. Before organizing PSE, organizers should have clear idea why they are going to organize PSE in order to justify its relevancy which can helps to gather common understanding and ownership towards the event. Community participation is very crucial on each step which helps to utilize maximum level of local resources in order to make it more cost effective as well as impactful. There are three major steps consisting of preparation, implementation and post event that are followed sequentially to organize an effective PSE as shown in **Figure** 1.

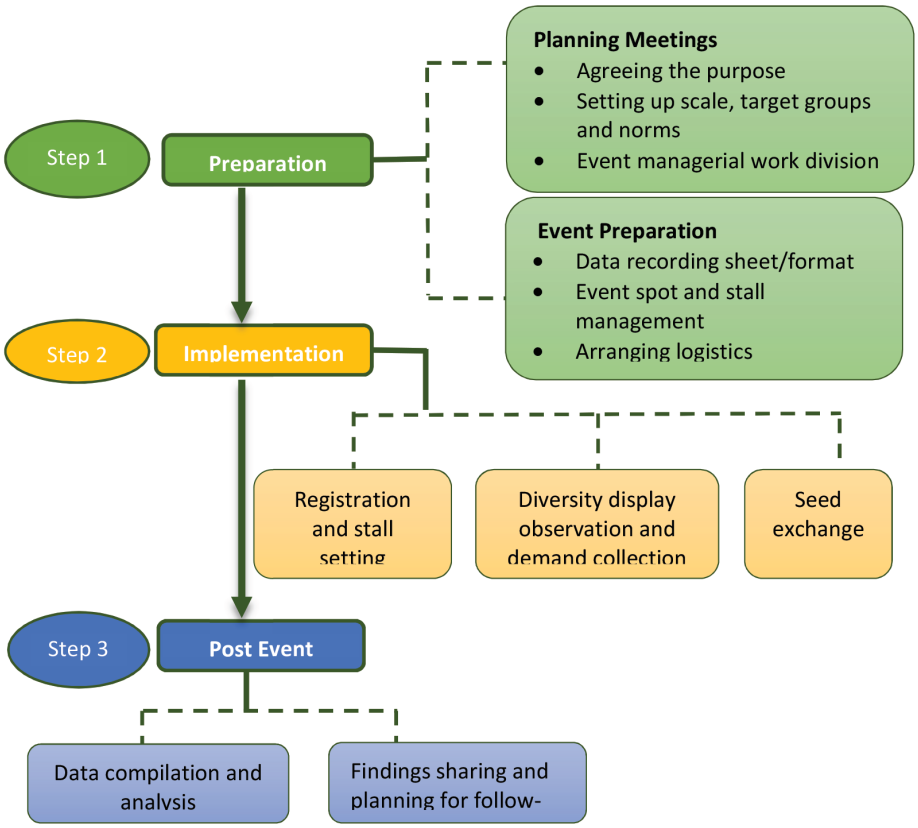

Figure 1. Diagrammatic presentation of Participatory Seed Exchange (PSE) process.

PSE can be complemented with local cultural dance, folk songs and dramas to flow positive massages as well as to make the event more entertaining. Awarding most diversity bringing and highest seed donor team etc. can motivate participants to engage in similar future events.

3.1 Preparation

Planning Meeting: Since it's a participatory activity, community's agreement and need realization on organizing PSE is crucial. Preparatory meetings should be organized for community need realization and to develop a common agreement on work plans to practice PSE. The scale of the PSE (individual household level/farmers group level/ community level/seed bank level) needs to be defined which guides further preparation of required logistics. Organizing big scale event with large number of participants might be inconvenient to handle and manage particularly to track down exchange and sharing as well as documentation. PSE should be medium level event so that organizer can monitor and document each and every core step, 10-12 distinct participating groups is ideal. PSE participants should be inclusive i.e. gender wise, ethnicity wise, geography wise etc. Each participants/groups/ethnicity can have their own unique way of utilization and management practice for similar variety so diversity on participation is crucial.

Event Preparation: Event date, venue and management team should be identified beforehand, and participating farmers/groups should be oriented about the process and importance of the PSE. Since it is a participatory community-based activity, no legal or prior consent from legal authorities has to be taken but informing concerned agencies at local level and their participation will definitely add value in the process.

PSE is primarily an event to display and share available APGR among the community member/participants in a systematic way. Stationeries for meeting minute, crop inventory, participant's registration, seed labels, demand and supply record book are primary resources to track and document the PSE. Besides that; display stalls, tables, chair, seed vessels/bags as well as other minor resources to conduct an exhibition like event is needed. Considering economic aspect, PSE is not much expensive activity as it mostly utilizes locally made materials. Volunteers for facilitation and logistic arrangement from farmer's side are key strength of PSE but financial resource is needed to fulfill some mandatory necessities like refreshment, award cost, stationaries and transportation. For the event, PSE should be organized in such a place where locals can easily attend and accommodate.

3.2 Implementation

Registration and Display: Participating groups/farmers need to register their seed/propagative materials they brought into an inventory, labeled and put it on to display stall. Identification

of source farmer is crucial from which interested farmers can get seeds event after the PSE event.

Diversity Observation and knowledge sharing: Farmers along with the other participants need to walk from stall to stall to observe seeds from display stall and take note what they would like to share. Participants from each stall/group/individual has to describe the varieties they have and share information on cropping practice, unique traits, use value and other properties of the varieties and crops.

Demand Collection: Depending up on farmers/visitor's interest, seed demand can vary. Demand collection format should be developed to track number of seed demand and its quantity. Each group should maintain these data by discussing with farmers while visiting stalls.

Seed Exchange: Based on the demand collected, the available seed materials have to be portioned and shared among interested in free of cost. If seed might not meet the demands, source farmer should be identified and referred with contact detail.

Evaluation: Each stall has to be evaluated by considering the criteria of seed diversity, seed quality and quantity and quality of knowledge sharing has to be used to declare the best stall of the event and should be awarded.

3.3 Post Event Activities

Data and information collected from PSE has to be maintained in excel sheet for future use. Perception of participating people needs to be documented to understand the effectiveness, use and success of the event.

D. Advantages and Disadvantages

Advantages

- Increase the access of seeds and planting materials and also helps to identify source farmers of particular crops
- Unique and rare varieties can be explored and shared among participants that help conserve such crop varieties
- Traditional knowledge associated with local crops and varieties will be shared and documented
- Helps in revival of lost diversity if conducted after disasters (e.g. earthquake event)
- Highest diversity conserving nodal and custodian type of farmers particularly women can be identified
- Creates opportunity to discuss and exchange PGR and knowledge at local level,

helps to sensitize local people to realize the importance and use value of available agro diversity.

Disadvantages

- PSE is more efficient on exchanging small sized vegetable and other crop seeds comparing to bigger sized cereals and other crops
- Sharing large amount free of cost can lead economic loss to poor farmers.
- Requires good preparation with good rapport building with local communities

E. Success Case

PSE events were organized in three severely earthquake hit districts of Dolakha, Ramechhap and Sindhuplanchowk covering six Village Development Committees (VDCs) with two VDC in each district under GEF-LCP and Bioversity funded Seed Rescue Project immediately after mega earthquake in 2015. PSEs were organized in those earthquake hit VDCs, where most of the farmers lost their seed storage due to earthquake. In each VDC, 9 participating groups representing their respective ward participated in the event. In total, 485 farmers brought 2,058 samples of seeds to share and 503 farmers took 1,249 samples of seeds from the exchanges where legumes, vegetables and cereals were most prominent in the exchange (**Table** 1 and **Figure** 2).

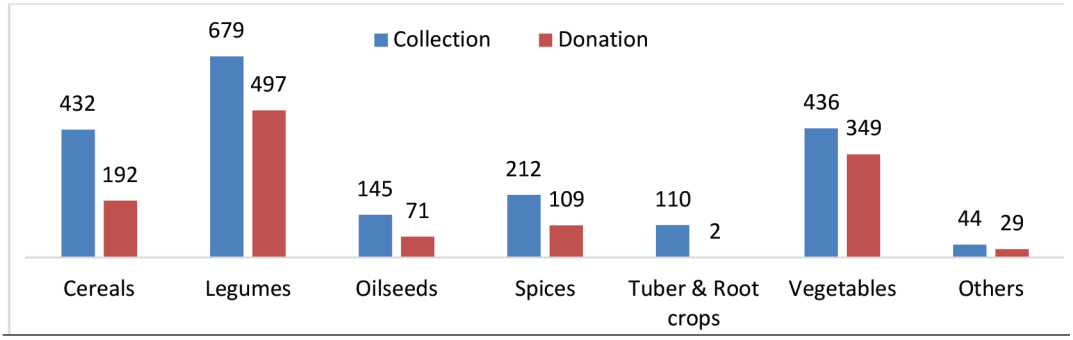

Figure 2. Crop type wise exchange detail in all six PSE event (Gautam et al 2017).

Over 98.95% of the seed exchange transactions were for varieties not in the official national notified list of varieties, which demonstrates the valuable complementary role PSE that can play to strengthen informal seed sector (Gautam et al 2017). Smallholder farmers and women were the key beneficiaries of the PSE (Gauchan et al 2018)

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8. Diversity Kits for Enhancing Access and Deploying Diversity

Rita Gurung, Krishna Hari Ghimire and Niranjan Pudasaini

A. Introduction

In Nepal, more than 80% of seed requirement is met by the informal seed system, i.e., using own farm-saved seeds and exchanges between farmers. Landraces forms major part of the informal seed systems. In the case of traditional mountain crops such as proso millet and foxtail millet, the share of landraces is 100% (Parajuli et al 2017, Palikhey et al 2017). Timely availability of quality and desired seeds plays a vital role in making the agricultural production system resilient. Studies show that the poor access to genetic resources, seeds and knowledge are major constraints faced by the rural farmers in Nepal. In this context, diversity kits are the simple but impactful tools to increase access to seeds and planting materials. The diversity kit is simply a set of a small quantity of seeds of different varieties of a crop, generally local landraces, sometimes improved varieties of farmer's choices, but no hybrid, which is made available to farmers in the beginning of the planting season (Sthapit et al 2017). It is distributed with an objective of deploying diversity in the community and improving access to quality seeds and eventually broadening the functional diversity and climate resilience of the agricultural system. Tracing back history of diversity deployment tools, an innovative approach 'Informal Research and Development (IRD)', was first introduced by the Agriculture Research Station (ARS) Lumle and Pakhribas in 1990 (Sthapit et al 2006) with an objective to spread and test the adaptability of pipeline varieties for registration (Joshi and Sthapit 1990). Later, LI-BIRD widely adopted this method with some modification in its home garden, Community Biodiversity Management (CBM) and many other program and projects. The home garden project distributed diversity kits or a composite pack of different types of vegetables or crop species (4-6) thus adding diversity to home gardens. Diversity Kit is a good practice nowadays adopted by a number of non-government organizations working in Nepal and its further scaling up is necessary to create impact at scale. The Nepal UNEP GEF Local Crop Project (LCP) also integrated this approach as one of the interventions linking with community seed banks activities and found effective to increase local access to seeds of local crop varieties

B. Objectives

- To increase access to diversity and deploy diversity
- To repatriate landraces

C. Methods and Process

Diversity kits distribution can either be implemented as an independent activity by just distributing the diverse seed materials to households or it can be combined as one of activity under an agro-biodiversity management or any kind of livelihood improvement program and projects. There arefew basic steps that have to be followed as outlined in **Figure** 1 and the text below:

Local Diversity Assessment and Need Identification

The first step of Diversity Kit is the assessment of locally available diversity followed by need identification. This identifies what community has in terms of diversity and what germplasm is needed for strengthening the functional diversity at household and community level. For example, if the community doesn't have enough number of varieties which can resist pest and disease or tolerate drought, then we can identify such varieties and make them available suitable new varieties to the farming community in the form of diversity kits. For diversity assessment and documentation several tools like diversity fair, four cell analysis, focus group discussion on local crop genetic diversity, functional trait analysis can be applied.

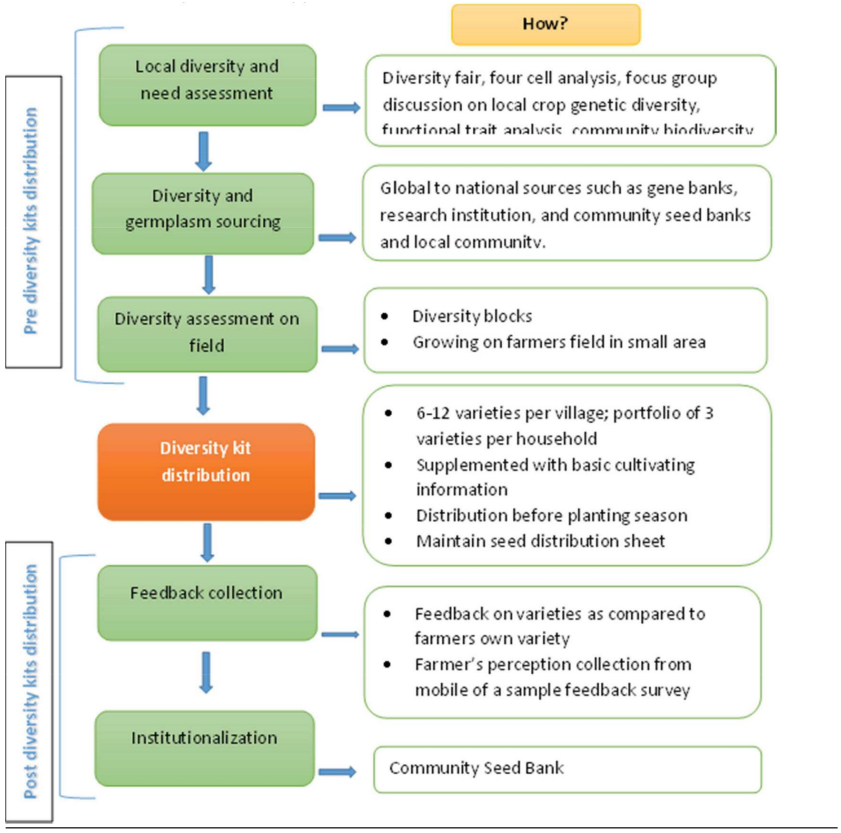

Figure 1. Steps and process of implementing diversity kits.

Diversity/Germplasm Sourcing

After identifying the need, the next step is germplasm sourcing. Germplasms can be accessed from global to national sources such as national and international gene banks, research institutions, community seed banks and community of other areas. For traditional varieties, National Genebank is an important source of germplasm. For the project sites, National Genebank provided about 250 different landraces of eight target crops in the first 3 years of the project period (2014-2017).

Performance Assessment on Field

Before distributing seeds to the community, it is necessary to test germplasms on the field for examining its adaptability and performance either by growing it in diversity blocks or farmer fields, preferably managed by custodian or nodal farmers. If we decide to establish a diversity block, it helps to multiply seeds from where farmers can make a visit for the selection of varieties of their interest. The following year, thus selected varieties can be produced in bulk for wider distribution. The basic criteria of seed selection and seed cleaning have to be followed to ensure the quality of the seeds produced for distribution.

Diversity Kits Preparation and Distribution

The whole process of diversity kit preparation and distribution is briefly explained in Table 1 and 2. It is important to consider the amount of seeds to be included in the diversity seed kit packets which generally depends on the type of seeds and its 100-grain weight. Make sure appropriate information related to crop variety and the distribution (is recorded for monitoring and feedback collection. Diversity kit distribution is generally led or managed by a local community organization such as community seed banks and it taken as one of the key steps of agricultural biodiversity management initiative or activity.

Table 1. Criteria and key characteristics of diversity kits program

Criteria	Description
Number of varieties/portfolio of varieties	One or more than one (up to 3 varieties) per household; or multiple species per household in case of vegetables can be made available. Farmers can choose one or more variety/landraces from the set that is made available to them
Information to be provided along with kits	Planting season and time, harvesting time, cultivation practice (if it is new for the community) farming altitude, photos are tagged
When to distribute	Before planting season (at least 15 days ahead of planting season)
How to distribute	Identify a local active community-based institution such as Community Seed Bank; use local famer network, nodal or custodian farmers, and local government mechanism can also be mobilized.
Information to be maintained	Distribution sheet of diversity kits recipient (Name, age, address and contact number compulsory) (Note: for seed diffusion tracking)
Feedback collection	Feedback collection on performance is optional; feedback on varieties as compared to farmers' own variety; Farmer's perception collection using a mobile-based sample feedback survey technique

Table 2. Optimum seed quantity to provide in Diversity Kits

Crop	Optimum seed quantity (g)
Rice	500
Maize	500
Minor or small millets (finger millet, foxtail millet, proso millet)	200-250
Amaranth	5-10
Bean (Phaseolus *vulgaris*)	300-400
Buckwheat	300-400
Barley, Naked Barley, Wheat	500
Chilly	10
Sponge Gourd	25-30
Cucumber	25-30
Pumpkin	25-30
Fresh leafy vegetable (Rayo, Spinach, Swisschard)	10-15
Radish, Carrot	20-25
Brinjal	15
Okra	50

D. Advantages and Disadvantages

Advantages

- Improves famer's access to new seeds and planting materials
- User-friendly, flexible practical and low-cost technology; it can easily be practiced by local community institution i.e., Community seed bank
- Helps in increasing area of rare and unique landraces
- Seed availability is a kind of incentive to farmers
- Spread the varieties that are well adapted to the local environment which can be used for seed production linking with community seed bank
- Identification and adaptation of variety that performs well

Disadvantages

- Though it is an easy tool to use, significant background work on diversity assessment, farmers need and linkage with research organization is needed for sustainability and better impact.
- Ensuring fair access to quality seeds is a challenge in case of rare landrace
- It has to be fully supported by cultivation practices and basic knowledge to avoid any undesirable results such as untimely planting of the variety in an unsuitable domain that may lead to low or no production

E. Success Case

Use of diversity kit as tool for diversity deployment has provided positive results in the project sites for promoting rare and endangered landraces and crops. The project has been

able to deploy and reach 15000 households through diversity kits alone in the last 5 years (**Table** 3).

In Jungu, Dolakha and Ghanpokhara, Lamjung, use of diversity kits have helped to revive naked barley crops which were at the verge of extinction. Now, it has become one of thecommon winter crops in both sites. In 2016, a set of germplasm collected from gene bank and different project sites were tested in diversity blocks (19 entries) and a yield trial was conducted in the following year in both sites. Farmer visits were conducted for varietal performance evaluation, ranking and selection. Among these 19, two landraces (NGRC 6327 accession from Mustang and NGRC02327 accession from Myagdi) are being widely adopted in Jungu, Dolakha. The accessions are cultivated by 64 households and Jungu CSB is producing more than 50 kg seed of each variety and target to distribute it to 200 households as diversity kits through community seed bank next year. Similarly, in Ghanpokhara, Lamjung two landraces (NGRC 02327 from Myagdi and NGRC 04903 (CO 1971 from Mugu) introduced through diversity kits are being widely adopted by farmers. Currently, more than 20 households including custodian farmers are cultivating and producing seeds of these varieties. Before the LCP project, there was only one landrace of naked barley in both sites, now they have the access to additional 19 landraces, and have the option to select while of which four are already popular. This has contributed to broaden portfolio of naked barley in Jungu and Ghanpokhara.

Table 3. Table 3. Total number of households reached through diversity kits

Sites	No of crops	No of landraces	No of household reached
Humla	10	26	4746
Jumla	6	10	5665
Lamjung	8	20	1539
Dolakha	19	39	3141
Total	20	95	15,091

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9. Cultivar Mixture

Bal Krishna Joshi, Suk Bahadur Gurung, Shree Prasad Vista, Pragati Babu Paneru, Rita Gurung and Saroj Pant

A. Introduction

Interspecific and intraspecific mixtures are very common practices in agriculture. Farmers grow several cultivars in a field or adjacent field as a strategy to cope with heterogeneous and uncertain ecological and socioeconomic conditions. Due to development of uniform high fertilizer responsive varieties, mixing practices have been undermined and replaced by cultivation of monogenotype crop varieties. This leads to high risk of crop failure mainly because of abiotic and biotic stresses. Monogenotyping the farming land is also major factor of genetic erosion. Cultivars (that consists of landraces as well as varieties) mixture is a simple and sustainable genetic resources management system to increase yield, provide yield stability, to conserve genes, to manage diseases (buffer against disease loss) and to restrict the spread of disease considerably (Joshi et al 2018). Cultivars mixture is old age technology; however, formal research was started in yellow rust and yield in 1995 in Nepal (Pradhang et al 1995). Mixture prolong the useful life of resistance genes and increase the crop productivity by taking into account the functional differences in disease resistance and other agronomic traits of cultivars. Biblends of 9 different rice genotypes (landraces, cultivars and ancestors) were tested for blast management in 2005. Competition among wild rice, F1, variety and landrace were assessed in 1999. Since 2015, mixture trials were conducted in beans, rice, finger millet, buckwheat and naked barley for blast, anthracnose management and higher yield.

2. Objectives

- To identify the best mixing ability landraces and varieties
- To develop cultivar mixture technology for minimizing the abiotic and biotic stresses with low inputs
- To conserve native landraces through use and enhance the evolutionary rate
- To enhance the ecological services

3. Methods and Process

Based on the objectives, different types of landraces and varieties are collected. The steps of cultivar mixture along with collection of different genotypes are given in Figure 1. Mixture may be biblend, triblend, tetrablend, pentablend or more based on the availability and

mixing ability among cultivars. Preliminary information on cultivars are studied and collected from farmers. Mixing different landraces and cultivars of same species are called intraspecific mixture or multivar or varietal blend. Selection of cultivars for mixing/blending is the major task and important for success of this technology. Traits that need to consider for components selection in mixture are given below. Number of components in the mixture may vary and conventional experimental trials are conducted (Figure 2). Mixture of 3-5 landraces and varieties are better. Increasing diversity reduces losses from pests and diseases and genetic uniformity of monocultures leads to genetic vulnerability (**Figure** 3).

Important Traits for Mixing Cultivars

For space use (all dimensions)

- Different root length and texture
- Different plant height
- Different plant structure, shape
- Different size and canopy

For disease and insect pests

- Different reaction capacity with insect pests and diseases
- Different leaf and stem texture
- Different color and size
- Different scent, secondary metabolites

For drought

- Deep root
- Erect plant/leaf
- Different plant height and canopy
- Large leaf but few in number

Similarity in traits

- Maturity
- Cooking method and time
- Milling

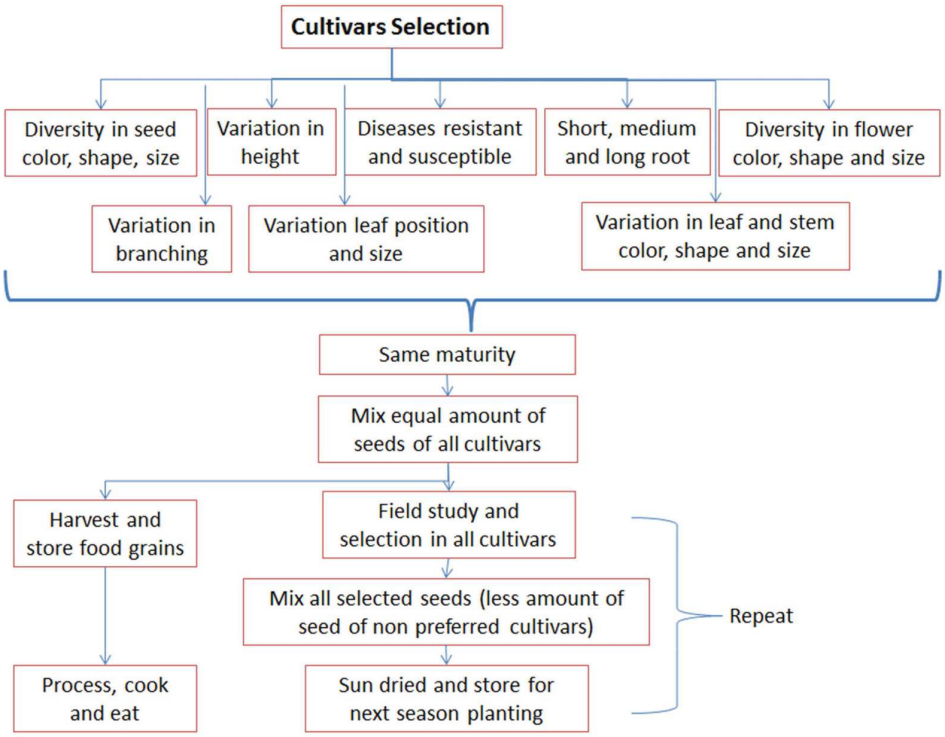

Figure 1. Steps in cultivars (landraces and varieties) mixture and improvement of mix population.

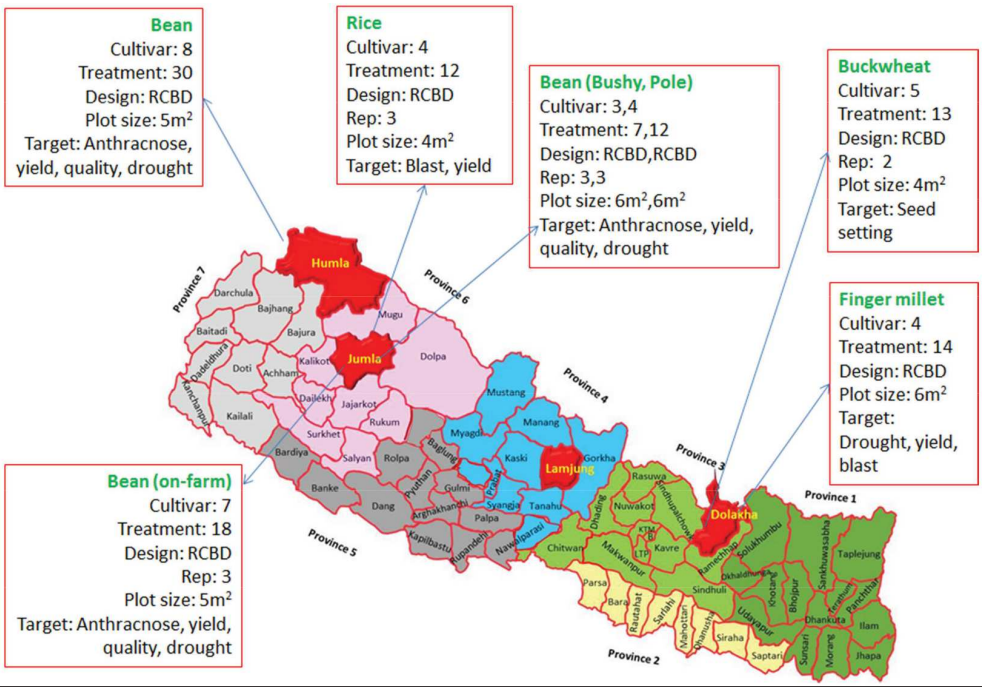

Figure 2. Experimental details for conducting mixture trials in rice, bean, finger millet and buckwheat.

4. Advantages and Disadvantages

Advantages

- Simple and low cost technology for controlling insects, diseases, drought, weeds and other stresses
- Higher yield and higher adaptation to adverse and diverse conditions
- Easily can maintain seeds by growers for next season planting
- High market value, more nutrition and tastier products
- Less storage pests attack
- Low risk of crop failure
- Chance to get new and better genotypes
- Conservation of landraces
- Applicable to all crop species

Disadvantages

- Prior knowledge of mixing ability of landraces and varieties is desirable
- Difficult to maintain seeds (need seeds from all landraces and varieties) and to identify ratios of mixing different cultivars
- Difficulty to harvest mixed population and may need better processing technology
- Policy does not favor mixed type of population
- Selection is necessary for seed maintenance

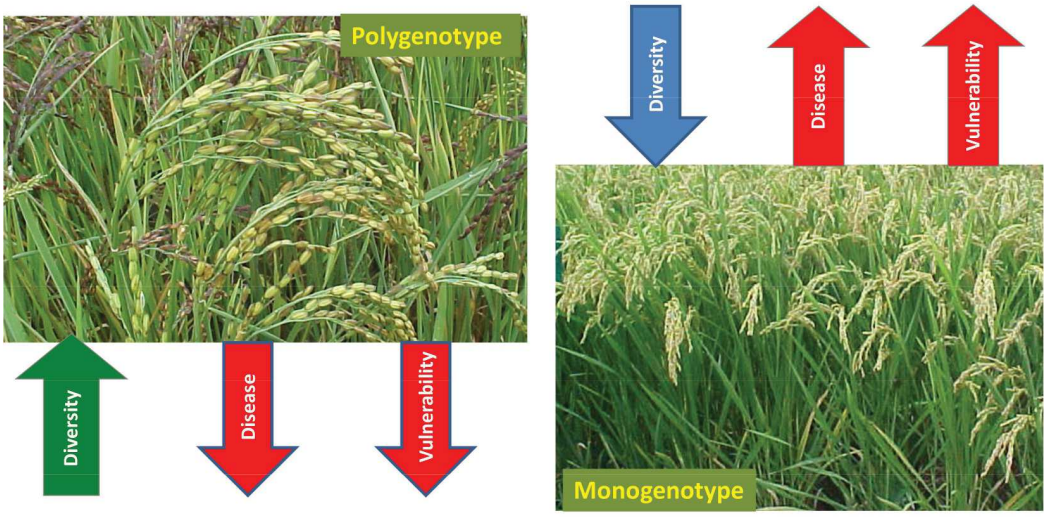

Figure 3. Effects of monogenotype and polygenotype on disease and vulnerability.

5. Success Cases

Farmers in Jumla mix beans of almost more than 10 different genotypes and getting benefit in terms of disease management and getting higher price (Palikhey et al 2016, Joshi et al 2018). Higher yield and low disease infestation have been observed in mixture of beans and rice in Jumla, beans in Humla, and buckwheat and finger millet in Dolakha (**Figure** 4). Mixing existing cultivars with more diverse genetic backgrounds enhances the functional diversity and improve yield by providing more chances for positive interactions among cultivars.

Landraces mixture in finger millet

Bushy bean

Rice mixture

Bean landraces

Figure 4. Mixture of finger millet, bean and rice in fields.

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10. Participatory Varietal Preference Ranking

Dipendra Kumar Ayer, Bal Krishna Joshi and Krishna Hari Ghimire

A. Introduction

The method of preference ranking was originally applied mainly in agriculture and forestry research programs (Pretty et al 1995). Subsequently, the technique has been employed in almost all fields like market survey of consumer preferences, government services priorities, environmental problems, etc. In agricultural research programs, preference ranking is a fast and efficient way of collecting information about which varieties are preferred by farmers and which are not, as compared to pairwise ranking (which is used to compare between two items and decide which the bigger problem/preference is). Farmers' opinions through visual rating are systematically collected and used in selection decisions through a simple technique called preference ranking or preference analysis (PA) (Paris 2011). Preference ranking is one of the basic tools used in participatory varietal selection (PVS) which involves the farmers' participation during evaluation of trials on-farm. PVS is a more rapid and cost-effective way of identifying farmer-preferred cultivars if a suitable choice of cultivars exists (Witcombe et al 1996). The method described here can also be equally applied to the post harvest preference ranking wherever applicable. In addition, preference ranking is also used to list out the most preferred traits or characters of the variety by farmers based on their local adaptation, community needs and market value. Preference ranking provides quantitative score for each variety as well as qualitative set of information (reasons or opinions for preference) which can be analysed statistically by plant breeders and decision can be made for wider dissemination of preferred variety. This method of preference ranking was applied in selecting best proso millet accessions in Humla under Local Crop Project (LCP) in partnership with Bioversity International and Nepal Agricultural Research Council (NARC). The practice was also applied for selecting best potato clones in Jumla under 'The Biodiverse and Nutritious Potato Project'.

B. Objectives

- For identifying best selection criteria as well as best varieties on-farm with participation of researchers and farmers during field evaluation.
- To rank varieties based on preferred traits during flowering stage, before harvest and post harvest stages of crop growth either on-farm or on-station trials.

- To get quantitative (scores or ranks) and qualitative (reasons for the preference made by farmers) data for further analysis.
- To help in decision making about acceptability and dissemination of experimental varieties for cultivation by farmers.

C. Steps

i. Selection of farmers and communities

Farmers are selected based on their experience on the crop, interest in the trial, area for conducting trials, easy access to market, communication skills and willingness to express their thoughts, and production systems for target crop for which preference ranking is done. These criteria are important to get the reliable snapshot of farmer's preference. A group of farmers are invited from the locality where the trial is taking place. Preferably a mixed group of 20 or more including men and women farmers of different ages are invited for voting process (ranking) during different stages of crop growth before harvest.

ii. Selection of the criteria and ranking through voting process

The group (minimum of 20 participants) is gathered and the objectives of the trial and the evaluation are briefly explained before starting voting process. Farmers are asked about their preference of a new variety and important traits or characters or criteria are listed out along with reasons for their preference. Each of the mentioned criteria is written on a paper bag or on a cardboard tray for easy voting process. Six (6) grains of corn are given to each male farmer and six grains of beans are given to each female farmer. Alternatively, any two different crop grains which can be easily differentiated are given to each participant (evaluating farmer) for voting. Each farmer can carry out a ranking of the previously identified criteria and votes can be differentiated for male and female groups separately. Farmers are requested to select the three most important criteria through voting process similar to election process. Each individual farmer is requested to cast vote one by one without discussing and coming to an agreement with the others. While casting votes, three grains are given for the most important criteria, two votes for the second most important criteria and one vote for the third most important criteria. Finally, votes are counted for male and female farmers separately based on the type of grain provided for voting and recorded in the tabular form as given in Table 1. Similarly, preference ranks can also be provided by researchers following same methodology by taking another type of kernels for voting. General preference ranking methodology is given in Figure 1.

iii. Selection of the preferred variety and ranking through voting process

With the group of farmers involved during selection of criteria, all of the trial fields or plots are visited in order to select the best variety, taking into account the previously identified criteria. In case of replicated trial, the evaluation is performed for each replicate. Varieties

in the trial are clearly identified with a number or a letter (written on a piece of cardboard) but variety's real name is not revealed to participants to prevent biasness (pre-conceived opinion) during ranking. Container (paper bag or small cardboard or plastic box) is placed at the foot of each plot for dropping votes. Farmers are requested to select the three most important varieties through voting process similar to election process. Each individual farmer is requested to cast vote one by one without discussing and coming to an agreement with the others. Each one casts their votes or ranks by using the grains provided individually. They deposit three grains in the best variety's container, two grains in the second best variety's container, and one grain in the third best variety's container. Finally, votes are counted for male and female farmers separately based on the type of grain provided for voting and recorded in the tabular form as given in Table 1. Similarly, preference ranks can also be provided by researchers following same methodology by taking another type of kernels for voting. General preference ranking methodology is given in Figure 1.

iv. Comparison of results and groups

After voting or ranking process, voting containers are collected individually from each plots and number of grains of different crops are counted separately in each container. The results of vote counts or ranks are recorded in tabular form for each plot or variety, separately for criteria selection and variety selection and ranks are provided based on the highest score with the first rank and so on in descending order. Results can be obtained for male and female farmer's preference scores separately as well as in total for final decision making based on the ranking process.

v. Sharing the results with evaluating farmers

The results obtained from preference ranking are shared with the farmers and further discussion is also done to know the reason of their preference. Once the ranking and reasons are identified, decision can be made for acceptability and dissemination of particular variety to the farmers.

Table 1. Ranking of preferred criteria and variety by plot

Selection Criteria or Variety	Male Farmers (n1=…)		Female Farmers (n2=…)		Total (N=…)	
	Score	Order of ranks	Score	Order of ranks	Score	Order of ranks
Total						

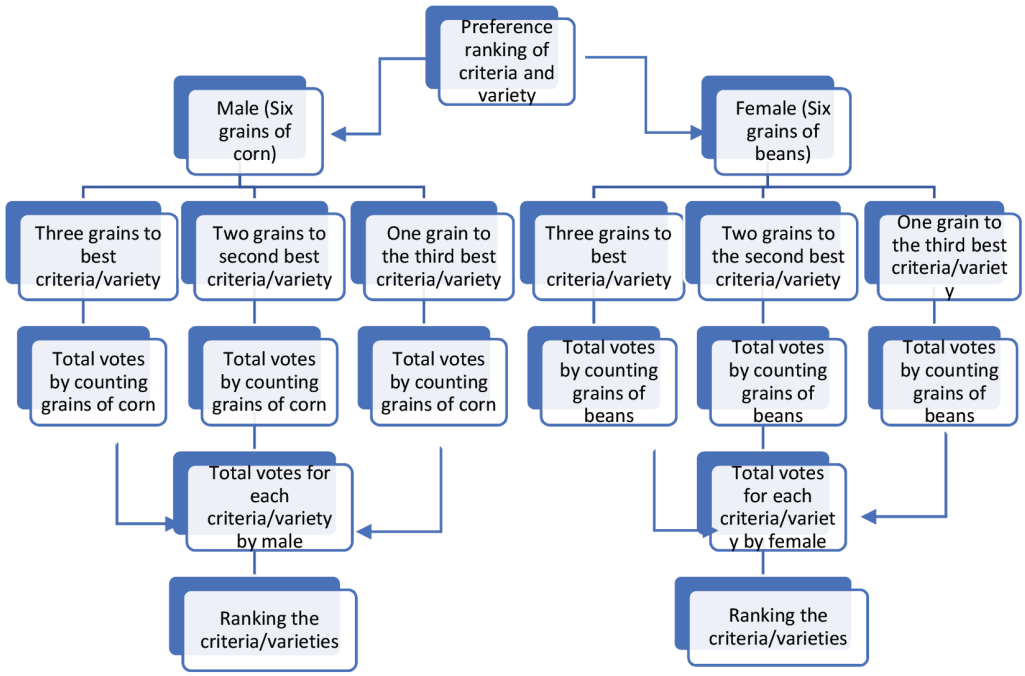

Figure 1. General methodology for preference ranking.

D. Advantages and Disadvantages

Advantages

- This method works well with illiterate farmers, since they do not have to be able to read or write to take part in the voting process.
- Based on the communication skills, preference and choice of farmers, different kinds of symbols or pictures can be used as ranks while voting.

Disadvantages

- It is done before harvest and farmers do not have any post-harvest data on which to base their choices and comments during preference ranking.
- It is only a tool for preliminary identification of varieties from on-farm evaluation.
- Preference ranking is also affected by the willingness of farmers to take part in the voting process and willingness to express their thought.

E. Success Cases and Way Forward

Preference ranking procedure was successfully applied in grassroots plant breeding and promotion of proso millet in Humla under 'Local Crop Project'. Proso millet is one of the major crop in Humla for food security. Proso millet is tolerant to biotic and abiotic stresses

but some of the varieties were less popular than others because of their difficult to thresh grains even if they had good yield. For identifying farmer preferred traits and selecting most promising variety, different accessions of proso millet were collected and preference ranks for selection criteria and variety were collected through preference ranking by farmers and research scientists. Three most promising easily threshing and higher yielding proso millet accessions were identified in Humla which are maintained by community seed bank and cultivated by farmers on-farm based on their preferred traits. Practice of preference ranking was also performed in evaluating CIP clones introduced in Jumla, Nepal under. Three most promising late blight resistant and higher yielding, red and white skinned potato tuber clones were identified and were promoted for multi environment trials in Sindhupalchowk, Lamjung and Achham.

Preference ranking or preference analysis is a simple and efficient way of identifying best selection criteria as well as best varieties on-farm with participation of farmers in the evaluation process. It can be applied during flowering stage, before harvest and post harvest stages of crop in on-farm as well as on-station trials. The data obtained from preference ranking procedure are quantitative (scores or ranks) and qualitative that can be used for statistical analysis.

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11. Participatory Plant Disease Identification and Management

Ajaya Karkee, Bal Krishna Joshi, Krishna H Ghimire, Niranjan Pudasaini and Devendra Gauchan

A. Introduction

Disease is one of the main causal factors to crop loss (Raaijmakers et al 2008). Plant disease, an impairment of the normal state of a plant interrupts or modifies its vital function of plants (Pelczar et al 2019), and caused by both infectious (fungi, bacteria, viruses and nematodes) and non-infectious agents such as mineral deficiency, sun burns (Agrios 2005).Diseases symptoms are the visible effects of disease on plants due to the interference in the development and/or function of the plant as it responds to the pathogen ie a result of invasion and infection by the pathogen whereas sign is the physical evidence of pathogen causing diseases (Isleib 2012). Infectious plant diseases are caused by living organisms that attack and obtain their nutrition from the plant they infect whereas noninfectious plant disease is caused by non-living organisms such as poor light, adverse weather, water-logging, phytotoxic compounds or lack of nutrients that affect the functioning of the plant system (Agrios 2005). Plant diseases identification is very important for effective diseases management. For identification of the plant disease, sign and symptoms of the plant diseases are important. This requires participatory plant disease identification in the fields in combination with laboratory analysis and field validation.

Participatory plant diseases identification and management is a disease diagnostic approach that brings plant pathologist, farmers and extension personnel together in the field in order to identify plant diseases correctly at farmers field and provide best suitable options for management of the plant diseases and also evaluate the efficiency of management practices after certain time of interval with the participation of the farmers. Participatory diagnosis aims to take the 'view from below', by exploring how user groups understand and act on problematic situations (Jarvis and Campilan 2006).

B. Objectives

- To identify plant diseases with the participation of related stakeholder at initial stage of infection at the farmer's field
- To identify diseases tolerant germplasm
- To reduce crop loss by timely implementation of plant protection measures
- To transfer knowledge to the farmers about plant diseases diagnosis techniques

and management practices
- To evaluate the plant protection measure applied for the effective management of the plant diseases
- To document farmer's perceptions and observations on disease diagnosis and disease management practice

C. Process

Step 1: Knowing about the crop

Interact and brainstorm with the participants mainly farmers and local key informants about the crop types, variety and its characteristics, crop family and stage, etc and discuss with other farmers too. Collect information and opinion from all the participants and record in note book.

Step 2: Collect information about the more common plant disease problems and local management practices

The participatory disease management involves collection of background Information about the common disease problems, its sign and symptoms, dispersal mechanisms, management options from secondary sources and farmers' local knowledge before going to the field. Generally, plant diseases are caused by four types of pathogens i.e. fungi, bacteria, virus and nematodes. Farmers might have traditional management/control practice for specific disease. Discussion should be carried out to know if there is any such practice.

Step 3: Inspect the field

Carefully compare those plants with symptoms or signs to others growing nearby with the farmers and extensionists. Pick a starting point for each plot and walk in a zigzag path (if possible) from one end of the plot to the other covering the whole planting areas of that variety as described by Manandhar et al (2016). The objective of the walking is to observe maximum crop plants of the plot and note the different sign of the pathogen, symptoms showed by the crop and diseases damage. Discuss within the group and take opinion from the other participants about the observation.

If any problem is first noticed in a plant during this step and possibly diseases may be the cause but it is not always right to draw a conclusion based on first observation. Careful observations of the affected plants, surrounding plants and general environmental conditions are needed. If the problems appear to all plants or nearly all the plants in the field, then the causes of the problems may be abiotic and considered carefully. Diseases or biotic problems rarely infect all the plants in an area at the same times, diseases infections takes time and spread over a time(Riley et al 2002). If symptoms appear very quickly, be careful to explore other cause i.e. soil nutrient, frost, hail or chemical damage.

Step 4: Review the cropping history of the affected area

Collect information about the previous cropping history of the locality with local farmers and stakeholders. Information such as types of crop grown (same crop or different) in previous year and season, same problems observed in the previous year or not, what types of agrochemicals applied in the previous seasons etc, should be collected. After collecting this information, think about the problem by some quarries on mind and discuss within the team i.e. could disease have carried over because the same crop was grown here previously, has the problem occurred in this area before, or maybe an herbicide carry-over problem. Another step could be "reviewing climatic pattern" remembering weather of last season and disease incidence so that farmers can understand specific disease can appear in specific climatic conditions. It helps them to predict and be prepare by analyzing climatic condition. Like long duration rain can lead fungal disease, dry climate can increase insect problem etc.

Step 5: Look at underground parts of the plants

Many above ground symptoms such as dwarf plant, yellowing leaves, poor terminal growth and flower or fruit production can be associated with root diseases or other problems. Affected plants should be dug up carefully and their roots need to be examined. Healthy roots will have white or cream-colored whereas diseased roots appear darker.

Step 6: The entire plant must also be inspected carefully and score the symptoms

Note and discuss with entire team about whether the entire plant or only parts like stems, flowers, leaves or roots have symptoms. The purpose of on-farm disease scoring is to obtain objective observations of the severity and incidence of diseases for each landraces (Jarvis et al 2011, Manandhar et al 2016). Disease incidence and disease severity should be recorded in each observation separately at each spot as described by Manandhar et al (2016).

Steps 7: Draw a conclusion

Based on the sign and symptoms of the collected sample from the field, discuss and compare with the different sign developed by biotic agents and symptoms developed by fungus, bacteria, virus, nematodes as well as non-infectious diseases.

Fungal pathogen: Most plant diseases, around 85% are caused by fungal or fungal-like organisms (Isleib 2012). Fungal pathogens are the most common crop disease problems (Agrios 2005). Both signs and symptoms may be present but the most distinctive and easily identifiable characteristics of fungal infections are the physical presence of signs of the pathogen (Jibril et al 2016). Signs ie hyphae, mycelia, fruiting bodies and spores of the fungal pathogen are significant clues for proper identification and diagnosis of a disease. Fungal diseases signs may be rusts, smuts, sclerotinia and mildews whereas fungal diseases symptoms may be anthracnose, canker, damping off, scab, soft and dry root rots, blight, dieback, galls, leaf curls, wilt and club root etc.

Bacterial pathogen: Bacterial plant diseases are most frequent and severe in tropical and subtropical places, where warm and humid conditions exit (Kannan et al 2015).Bacteria show both sign and symptoms on plants. Bacterial disease sign (difficult to observe, but can include) are bacterial ooze, water-soaked lesions and bacterial streaming in water from a cut stem, etc whereas bacterial diseases symptoms are leaf spots and blights, soft rots of fruits, roots and storage organs, wilts, overgrowths, scabs and cankers, etc (Agrios 2005) .

Viral pathogen: Viruses are usually transmitted by insect or nematode vectors (Jibril et al 2016) and are seed borne or transferred by sap when plants are physically damaged. This disease results in poor performance of crop, but usually don't kill plants outright. Virus doesn't develop sign and it produces symptoms on plants parts (Singh 2018).Viral disease symptoms are dwarfing, resetting, chlorosis and mosaic, etc (Agrios 2005).

Nematode pathogen: Nematodes are microscopic roundworms. The vast majority of nematodes do not cause plant disease and are either non-harmful or beneficial to the plants and soil. However, there are a small number of serious plant pathogenic nematodes including stem, root and foliar nematodes. Nematode disease sign may be nematodes attached to the root whereas nematode disease symptoms are root knots or galls, root lesions, excessive root branching, injured root tips, stunted root systems, slow decline of the entire plants, wilting even with ample soil moisture and foliage yellowing and fewer and smaller leaves, etc.

Nutrient deficiency: Poor plant growth and disorders in plant parts are caused by shortage or excess of one or more nutrients to the plants. Shortage may be caused due to poor uptake of nutrients from the soil which is due to deficiency of nutrients on soil, incorrect pH, shortage of water; poor root growth whereas excess of nutrients to the plants is due to excess amount of nutrients present in the soil and incorrect pH (Singh 2018).

Step 8: Laboratory analysis

If diseases could not be identified on the step 8, we need to send disease sample to the nearby plant pathology lab for identification of the pathogen. Disease sample consists of whole plants (if possible) with disease parts including root and rhizospheric soil. Pack it in paper bag and leveled it properly containing sample taken date, crop and variety name, address and farmers name and send it to the plant pathology lab as soon as possible.

Step 9: Decision on diseases management options

After identification, discuss with the team about the possible management options available at present. The goal of plant disease management is to reduce the economic damage caused by plant diseases (Maloy 2005). Generally two principles are applied for diseases management.

The first principle (prevention) includes disease management tactics applied before infection, the second principle (therapy or curative action) functions with any measure applied after the plant is infected.

Step10: Evaluation of diseases management practice applied

Evaluate the plant protection measure applied by the farmers after one week with the whole team. Take a feedback opinion from the farmers about the efficiency of the plant protection measure applied by individual farmers and review the whole process. If possible, visit the problematic field with team and observe the field and record the diseases progress. If it is not effective, then look for other available options.

D. Advantages and Disadvantages

Advantages

- Reduce the crop loss and farmers income by timely management of diseases
- Farmers, extension workers and plant pathologist involved in each steps and helps to transfer technology to the end users
- Diseases diagnosis and management skill of the farmers increased and helps to capture farmers' local knowledge in disease diagnosis and management.
- It helps regular monitoring of the farmers field which helps to solve other technical problems of the farmers
- If one management options is not effective, there is a chance of applying other options
- Platform helps to disseminate latest technologies and control measures in faster way

Disadvantages

- Need more time as many stakeholders have been involved
- Study plot might suffer standing crop damage because of participants movement and may increase risk of disease spreading by contamination
- Because of involvement of farmers and experts, cost may be high

E. Success Cases

GEF UNEP Local crop project carried out participatory disease diagnostic survey in 2016-17 relating crop diversity with disease damage index for three traditional mountain crops, namely beans in Jumla (anthracnose), finger millet (neck &finger Blast) in Humla and Dolakha and Rice (neck and panicle blast) in Lamjung sites. Participatory study was accomplished in 60 farm households with field disease scoring in each farms/plots in 10 spots in 3 directions (front, left and right side) per varieties. Findings showed that a significant relationship between Diversity Indices and Disease incidence was obtained indicating on- farm maintenance

of crop diversity reduces disease incidence. The study also concludes that farmers growing finger millet, rice and beans in larger farm areas maintain both richness and evenness of varietal diversity suffers low crop lose. Participatory study was helpful to identify specific disease with severity and incidence of disease and their damage to specific crop cultivars in mono cropping and mixture cropping practice.

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12. Simplifying the Traditional Processing System of Minor Millets

Ganga Ram Bhandari, Bal Krishna Joshi, Devendra Gauchan, Bharat Bhandari and Saroj Panta

A. Introduction

The proso millet (*Panicum miliaceum* L.) commonly known as chino and finger millet (*Eleusine coracana* G.) commonly known as *Kodo* are important minor millet crops grown in the hills and the mountain regions of Nepal. In Nepal, they are mainly grown in marginal slopes and terraces in mountains where other crops are not cultivated at higher altitude. They are potential crops for food security of high mountain region and have importance in conservation of local crop for bio diversity. Traditional processing methods of minor millets are tedious, time consuming and especially increases drudgery of rural women. Since, use of modern processing machines for minor millets are not available, promotion of new technology on processing may have the positive impact on the rural livelihood and reduction of women drudgery in rural mountainous areas.

Proso millet is consumed as proso millet rice, pudding, porridge and can be eaten after beaten and milling as floor. Proso millet contains a comparatively high percentage of indigestible fiber because the seeds are enclosed in the hulls, and difficult to remove by conventional milling processes (Matz 1969 quoted by Hulse et al 1980). The de-husking of proso millet therefore has been considered as a tedious and time-consuming work for people. Traditionally in the rural areas of Nepal proso millet is dehusked (removal of outer coat of seed) in Mortar and Pestle (*Okhal*) by using muscular power mainly by women. The traditional method of processing takes 1 hour to dehusk 2 – 3 kg of proso millet by two women and cause lots of physical exertion to them. Considering the strong need of the processing machine for the proso millet, the GEF UNEP Local Crop Project in Nepal has designed and piloted electric processing machine (dehusker) in the project site Humla (Chhipra, Kharpunath Rural Municipality) in 2018.

Millet is consumed as finger millet porridge (*Dhindo*), roti (*Chhapati /* pancake) and used in the preparation of liquor. However, manual threshing and dehulling ?nger millet is a tedious and time-consuming. In addition, manual threshing has low output, higher grain damage and involves more drudgery to the farmers mainly women. To address these problems, the Agricultural Engineering Division of Nepal Agricultural Research Council (NARC) has designed and developed a millet threshing machine but that has to be piloted

and up scaled widely for the benefit of hills and mountain farmers. In this context, Local Crop Project started piloted of the machines from 2017 which has shown positive results in terms of improving efficiency in threshing of finger millet and reducing women drudgery.

B. Objectives

- To design and pilot appropriate processing machinery for dehusking the proso millet
- To make farmers access to modern processing machinery to reduce the drudgery caused by traditional method of processing
- To evaluate the impact of Finger Millet thresher to the farmers

C. Methods and Process

Considering the critical problems of processing of minor millet especially proso millet as traditional methods of processing is labor intensive and involves high women drudgery, project designed programs for designing and developing appropriate machine for processing, field testing and feedback collections (**Figure** 1). To simplify the processing of proso millet some bio-physical properties are studied at Agricultural Engineering Division, Khumaltar (NARC). After conceptualization of dehusking principle by Agricultural Engineer a suitable prototype was fabricated at JB workshop. Several tests were carried out and field performance evaluation and demonstration were carried out in Kharpunath Rural Municipality–4 at Chhipra-Nalla, Humla. Demonstration sites were selected purposively in the project area of Humla with focus on processing of proso millet as it is an important crop to ensure food security and reduce drudgery of marginalized communities in Humla district.

In addition, for finger millet, electrical finger millet threshing and pearling machine which was developed by Agricultural Engineering Division, Khumaltar, was piloted in Lamjung and Dolakha project sites in addition to other districts of Nepal. The impact of finger millet thresher in the project site is evaluated through FGD, field observations and interaction with farmers. Data on machine distribution are taken from LI-BIRD official record and field performance records are taken by field staffs. Machine was tested in the field and performance is evaluated taking threshed grain and time taken to complete the job. Economic analysis and feasibility of promotion of this machine in the project sites have been made on the basis of information from the cost involvement in the technology adaptation and farmers feedbacks taken (**Figure** 1).

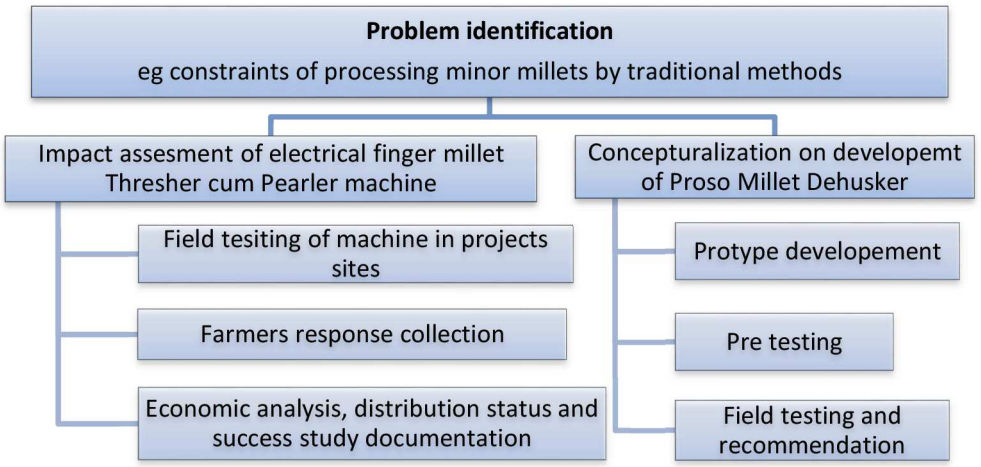

Figure 1. Process of research conduction to simplify the processing of minor millet.

The **Figure** 2 below provides newly designed electric proso millet thresher tested in Khumaltar and then in the farmers' fields in Humla.

Figure 2. Electric proso millet dehusker testing at Khumaltar and field testing in Humla.

D. Advantages and Disadvantages

Advantages of Proso Millet Dehusker

- Machine can be operated in the places where only single phase electricity supply is available.
- Not so heavy, simple, women friendly and can reduce the work load and drudgery.
- It can process/dehusk30 kilogram chino per hour and able to process up to 200 kg per day.
- Same machine could be used to pearl the foxtail and finger millet also.
- Machine is strong enough, cheap and made in Nepal.
- Useful to process the chino which is locally grown in mountain areas.

- Beneficial to small as well as food processing entrepreneurs.

Disadvantages of Proso Millet Dehusker

- Costly for smallholder poor farmers
- Transportation and repairing rural remote area is difficult
- Need regular electricity with high voltage
- Applicable for single variety (Chino Kutak)

Advantages of Finger Millet Thresher

- Machine can be operated in the places where only single phase electricity supply is available.
- Not so heavy, simple, women friendly and can reduce the work load and drudgery.
- It can process (threshing as well as dehusking) 80 kilogram finger per hour
- Same machine could be used to pearl the foxtail and finger millet also.
- Machine is strong enough, cheap and made in Nepal.
- Useful to process the Finger Millet which is locally grown in mountain areas.

Disadvantages of Finger Millet Thresher

- Costly for smallholder poor farmers
- Transportation and repairing is a problem in remote and rural areas
- Need regular electricity with high voltage

E. Success Cases

Finger millet thresher

Electrical Finger Millet Thresher is one of the most successful machines developed by Agricultural Engineering Division. According to J.B workshop (commercial Manufacturer) more than 1000 machines have been in use in more than 30 districts (**Figure** 3).

Figure 3. Finger millet thresher in operation in rural mountains.

In Dolakha, Gurishankar Rural Municipality at ward2, Jungu, finger millet threshers are in use while additional 4 machines has been supported under 50% subsidy program to 4 different mother's groups. More than 50 HHs are getting service from 2 machines. Additional 4 machines are expected to provide service additional 150 HHs at minimum. Field testing of finger millet threshers indicated that it is 3-4 times more efficient in processing finger millet, saves significant time of family members and reduce women's drudgery significantly. In Lamjung, it has provided opportunity to run as a business for a local dalit woman who operates thresher as a small business in the season and shares profit with women's group. It has also becoming a source of revenue and local employment: Collected revenue from threshing in Lamjung is utilized by farmers groups to raise fund. The thresher also can be used other crops like barley, naked barley and wheat, thus showing great potential for rural poverty reduction.

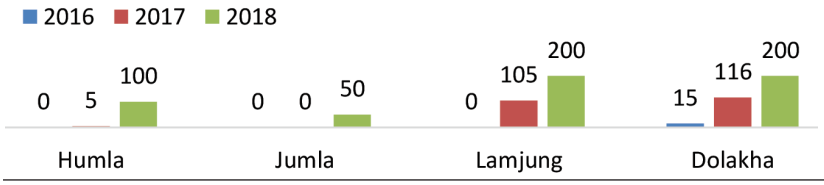

Figure 4. Actual and projected beneficiaries of using finger millet thresher (2016-2018).

Proso Millet Dehusker (Chino Kutak)

Piloting of proso millet dehusker has shown good result for processing of Dudhe chino variety that is most dominant and popular in Chhipra, Kharpunath, Humla. It has been identified as a potential technology in conservation and promotion of local crop and support the food security of high mountain areas. The results of the field testing indicated that it can reduce the cost of processing of proso millet by 80% as compared to traditional manual processing method.

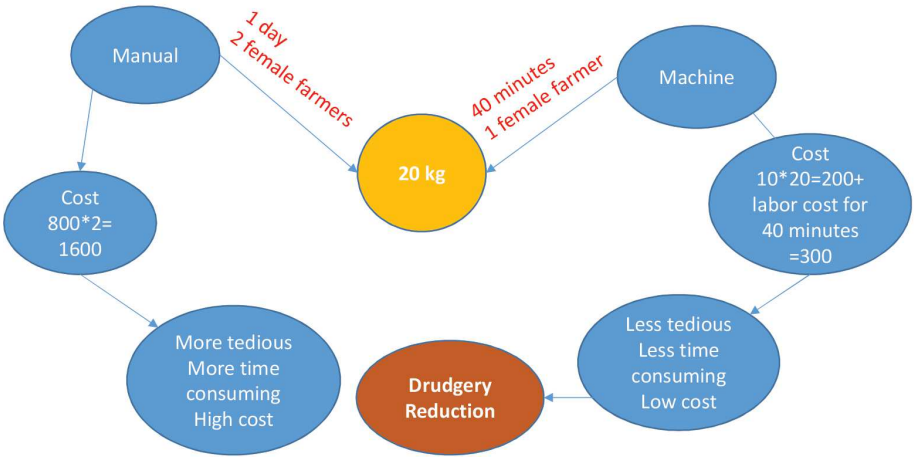

Figure 5. Comparison of manual processing with mechanical processing.

Conclusion

The design and piloting of proso millet thresher showed good results for simplification of processing of Dudhe chino variety of pros millet which is predominant in Chhipra area of Kharpunath rural municipality. The machine has provided a potential opportunity to save time, reduce drudgery of women and cost of processing and thereby promoting conservation, production and improving the value chain of proso millet. Future efforts should be further made in modification of machine suited to other varieties of proso millet for the benefit of smallholder farmers in high mountain region of Karnali and other provinces.

Finger Millet Thresher machine has been operated by local farmer after simple orientation about machine. This machine not complicated and can be repaired local if necessary. Farmers have given the positive feedbacks to this machine and going to be purchased more machines in the districts. Information from other projects and programs of the Department of Agriculture and other agencies also have showed that this machine has saved the human labor, time, processing cost and workload of female farmers in many hilly and mountain areas. Labor shortage in the rural areas could be addressed by this machine in some extent. This machine has been proved as women friendly successful example of farm mechanization in the project sites and beyond in the many hilly and mountain districts of Nepal.

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13. Diversity Fair

Niranjan Pudasaini, Rita Gurung, Bharat Bhandari, Pitambar Shrestha and Bal Krishna Joshi

A. Introduction

Farmers are maintaining large number of local agro-biodiversity on their farm lands since primitive time period and they are the masters of knowledge associated with local agro-biodiversity. But in recent years, rapid loss of local agro-biodiversity have been observed due to introduction of modern varieties, major-crop focused farming system, changes in food habit or preference and shift in social dimensions like migration and off-farm employment options. Farming communities with increased access to transport and market are increasingly neglecting or underutilizing traditionally grown crops knowingly or unknowingly leading to a threatening of local crop diversity loss. There are many local and unique crops/varieties that are maintained by small number of households which can be extinct from local production system at any time. Hence it is important to reveal such local, rare and unique varieties in wider mass, sharing knowledge associated with them which can contribute to excel their utilization and on-farm conservation.

Diversity Fair (DF) is a well-established multi-purpose participatory tool designed for sensitizing community and diverse stakeholders on the importance and value of local genetic resources. Sometimes DF is known as seed fair if community only focuses to exhibit crop seeds and planting materials. DF is recognized as an effective tool for promoting on-farm and in-situ conservation of local crops (Sthapit et al 2006). This is also an excellent tool DF has multiple functionalities as it support to explore and assess richness of diversity, locate diversity rich area or hotspot, identify custodians of biodiversity who maintains unique crops and varieties and promote exchange of seeds and traditional knowledge. Additional cross cutting benefit of DF is to motivate and capacitate local farmers specially women and their institutions for collective actions towards local crop diversity conservation and utilization. This kind of collective event also helps enhance social interactions and unifies communities and local organizations. Besides that, for researcher and development professional it can be a good opportunity to learn and document local traditional knowledge and special characteristics associated with local crop genetic resources.

B. Objectives

- To explore, exhibit and document existing inter and intra specific crop diversity
- To explore and locate rare and unique local crops and varieties

- To identify custodian farmers, specific communities and hot spot areas
- To promote exchange of germplasm and knowledge
- To mobilize farmers groups or local organizations for collective action
- To disseminate awareness rising and sensitizing messages or publications
- To sensitize and educate young generations and policy makers regarding value of agricultural biodiversity

C. Methods and Material

Any community based organizations, development agencies, local government, etc can organize DF but technical facilitation or guidance from professional is an essential. Before decision making, organizers should have clear idea why they are going to organize DF in order to justify its relevancy which can help for making common understanding and ownership of entire event. Community participation is very crucial on each steps of DF which helps to utilize maximum level of local resources in order to make it more cost effective as well as impactful. DF can be complemented with local cultural dance, folk songs and dramas to flow positive massages as well as to make the event more entertaining. Local food and product stalls in DF add significant value on local food promotion and utilization. Three major steps composed of many other sub steps should be followed sequentially to organize an effective DF as shown in **Figure** 1.

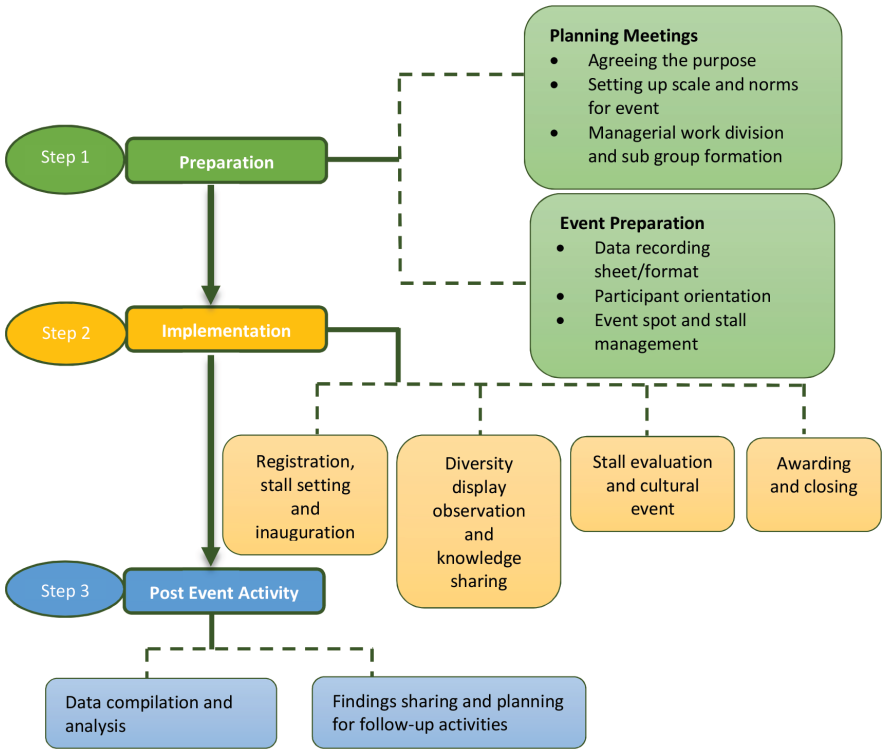

Figure 1. Sequential chart showing key steps with sub activities of DF implementation procedure.

3.1 Preparation

Planning Meeting: Series of planning and preparatory meetings are needed for developing common understanding among organizers, defining the coverage of the DF like, ward or village level/farmers group level or certain geographical areas focused, institution level, etc. Various norms should be agreed in prior which is supposed to be followed during DF implementation like setting criteria of stall evaluation, awarding scheme, number of participants, stall size/space size, etc. DF event management main and sub-committees should be formalized to share and complete specific tasks. Generally, separate teams for logistic and refreshment, stall and stage arrangement, inviting guest and communication, cultural event management, stall evaluation and award are required. Organizer can formalized more teams depending on requirement and available work force for specific task. Appropriate venue for the event should be finalized during planning meeting. Possible venues could be public or school ground where many people can be accommodated. Organizing DF linking with special days or festival can help to increase participation but busy planting and harvesting season should be avoided.

Event Preparation: Formats for data recording, registration and evaluation sheets should be developed at the beginning so that organizer can orient participating farmer groups earlier. Participating group wise information recording sheet is the most important document to be maintained during diversity collection and packaging for display (Table 1). Seed/diversity packing materials should be provided by the organizers to each participating groups. Each diversity display package/container should have small tag explaining crop name and variety name, its use value during its display. An orientation meeting should be organized regarding collection of diversity, diversity packaging for display and recording information. Even after the orientation, participating groups might need technical support during data recording and packaging so that technical persons are suggested to visit each group to monitor preparation.

Table 1. Example of information compilation format for participating groups

Participation Group Name: **Date:**

Address:

SN	Crop Name	Variety Name	Farmer's Descriptor/Distinguishing traits	Special Traits	Cultivation Status (Increasing/Same /Decreasing)	Contact of Source Farmers
	Naked Barley	Mudule Uwa	Short awns in panicles, light brown grain color	Easy threshing, drought and cold tolerant	Decreasing	Makhana Khadka, Jungu-1, Dolakha

Stall management team should manage stalls for diversity display and siting areas for participants and invitees. Space of stalls should be minimum 3X3 meter square or more and should have enough walking space in front of it for easy observation. Drinking water and sanitary management should be in top priority. Locally produced food items are highly encouraged to be included in refreshments menu which will convey positive massage to the guests and visitors. Public notice for invitation can be broadcasted via local FM radios along with sticky notice in key junctions of the local areas.

3.2 Implementation

Registration, stall setting and inauguration: Each participant should arrive at venue about 2-3 hours earlier than opening time so that they can register and set their stalls for display. Field record data and registered materials should be verified for fair competition. Formal inauguration should be done by chief guest and objectives should be explained briefly during opening session.

Diversity display observation and knowledge sharing: After opening session, local farmers and invitees should be guided to visit the stalls and facilitate in sharing the information and knowledge associated with the exhibited materials. Participants should be encouraged to share rare and unique local crop diversity and associated knowledge. This is core component of the DF and therefore, enough time and priority should be given to this session. In the background, organizer should formalize an evaluation committee along with scoring sheet.

Stall evaluation and cultural event: Massage giving folk songs, cultural dance, poems and dramas can be performed simultaneously while evaluation teams visits each stall and score as per the scoring sheet. As far as possible, guest and invitees related to agrobiodiversity should be in evaluation committee which helps to make evaluation more realistic and unbiased. Cultural show and events should not be performed during stall visit session because it can distract visitors.

Table 1. Example of stall evaluation format for awarding

Stall No./ Group No.	Diversity richness displayed (Mark: 40)	Quality of information and sharing skill (Mark: 30)	Presentation and stall decoration (Mark: 15)	Rarity of displayed crops/ varieties (Mark: 10)	Degree of women's participation (Marks 5)	Total (Full Mark: 100)
Stall 1	26	23	8	5	3	
Stall 2	34	21	12	7	4	

Awarding and closing: High scoring stalls/groups should be awarded with a prizes and certificate of appreciation for their generous contribution. Cultural show performing groups can be acknowledged by offering gifts and prize as well. To ensure fair evaluation and result

sharing, rigorous interaction and reflection should be done among evaluation team. DF program should be ended with closing remarks from guests. Motivating words from distinguished guests can motivate farmers to be organized and work further on conservation and promotion of local agrobiodiversity.

3.3 Post Event Activity

Data compilation and analysis: Data compilation and analysis is very crucial to make DF more meaningful. Collected data should be entered in computer and analyzed to explore most common and rare varieties in the community. Trend of increasing and decreasing crop varieties should be identified so that appropriate conservation and promotion related activities can be designed and implemented. Simply, diversity richness in terms of species and varietal level can give broader picture. Rare and unique crop's source farmers, farmers managing large number of crop diversity should be identified so that conservation related activities could work with them. This information helps to identify custodian farmers. A news blog article or technical report for online publication or radio news can be produced by compiling DF event and diversity assessment finding.

Finding sharing and planning: Key findings should be shared with local farmers and stakeholders which helps to realize them the status of local agrobiodiversity. Conservation and promotion related interventions can be designed to promote rare and unique crops or varieties. Similarly, most dominating or common varieties can be selected for crop improvement, release and registration. Introducing the concept of community seed bank linking with local diversity status can be more useful. Diversity can be conserved in different genebanks.

D. Advantages and Disadvantages

Advantages	Disadvantages
• Low cost multipurpose tool for awareness raising, diversity exploration and documentation focusing local agro-biodiversity • Facilitate germplasm/seed exchange promoting on-farm conservation • Provides a local level platform for interaction and sharing among diverse stakeholders like farmers, students, agriculture technicians and researchers, governmental officials, media and policy makers • Capacitate community based organizations/groups for collective actions • Supports to design and start agro-biodiversity research and development programs (collection of local germplasm and information for research) • Supports community rapport building and coordination with concern agencies	• Needs long and rigorous preparation, planning and follow-up • Managing large number of participants and visitors is challenging

E. A Case of Jungu Diversity Fair

Local Crop Project (LCP) organized a Local Crop Diversity Fair at Jungu, Dolakha in 2 April 2016. Project implementing local partner Himchuli Multi-purpose Co-operative managed the event by mobilizing local mother's groups, local schools, ward citizen forums and government line agencies. Involving mother's groups is a step towards empowering women farmers by recognizing their role in farming system and conserving traditional knowledge. The fair was visited by more than 450 local individuals.

Total 20 mother's groups contributed to represent their respective wards during the fair. More than 70 different crop species (8-cereals, 11-legumes, 16-vegetables, 14-spices, 10-fruits, and 11-medicinal herbs specie) were displayed. In total, 270 different varieties of 70 different crops with medicinal wild herbs were displayed reflecting high agrobiological richness of Jungu village. The event also explored and listed 176 varieties of various local crops that are in decreasing trend in terms of cultivation, indicating immediate need of conservation. The fair was complemented with massage giving folk song competition covering the issues of local farming system. Mother group's enthusiasm and motivation was admirable. Informative posters and flyers regarding agrobiodiversity conservation and promotion were displayed and distributed during the event which had caught the eyes of every age grouped people. Makhana Khadka, a woman farmer from Jungu, shared, *"I'm very happy that I got an opportunity to represent my ward and display our local crops among many distinctive people. Many local people are still unknown about crop varieties that we already have within our village. Occasions like this seem to be very useful to share seeds and knowledge between us."* The best demonstrating stalls were awarded

DF was effective to LCP to explore local diversity highlighting project mandate crops, their status (**Figures** 1 and 2). Consultation and sharing meeting with local community and stakeholders was organized to share DF findings and facts in order to make them realized the scenario of degrading local diversity. Partner cooperative and local government representative were highly impressed with the event ensuring the need of conservation and promotional related activities. As a result, community discussed and agreed to establish a community seed bank to address decreasing trend of crops and varieties. LCP utilized the collected germplasm of project mandate crops during DF in characterization trials and paved the way of research and development. Remaining collections were displayed in community bank and sent to National Genebank.

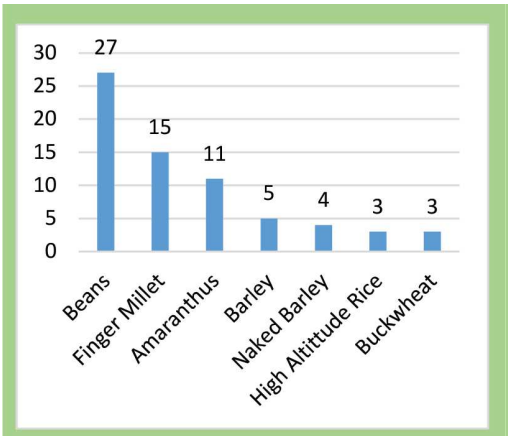

Figure 1. Varietal richness on LCP mandated traditional crops

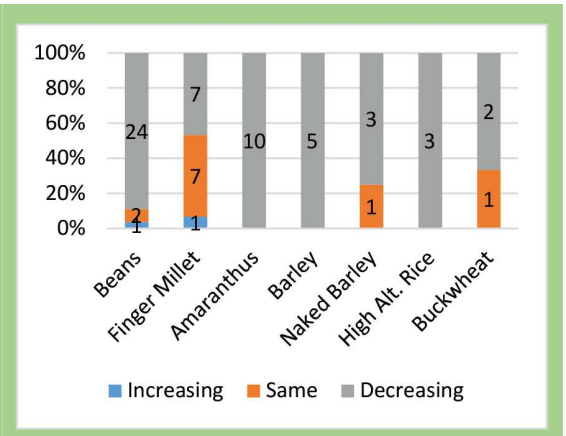

Figure 2. Cultivation trend of LCP mandated traditional crops

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जोशी, बालकृष्ण र कृष्ण घिमिरे । २०७५ । कृषि जैविक विविधता सम्बन्धी मेलाहरु र तिनका प्रकार । राष्ट्रीय कृषि आनुवंशिक स्रोत केन्द्र, खुमलटार, ललितपुर । नेपाल जीन बैंक पत्र, अंक १६ बर्ष २०७५, ललीतपुर

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14. Food Fair: A Mechanism for Promoting Traditional Crops

Rita Gurung, Niranjan Pudasaini, Krishna Hari Ghimire and Devendra Gauchan

A. Introduction

Local crop diversity is depleting in an alarming rate and one of the many reasons is its decreasing usage in food culture due to the changing food consumption pattern and habits. The long experience of Nepal in field of crop diversity conservation on-farm have shown its direct linkage with crop diversity usage in food culture and economic benefits generated from it. It is well accepted that the traditional mountain crops are highly nutrient dense and climate resilient crops which play critical role in achieving food and nutrition security. Though there are several reasons why these crops are being neglected and underutilized and some reasons being lack of awareness, less efforts and research in food diversification and promoting food culture forattracting new generation.Thus, along with technology generation and advancement for drudgery reduction in post harvesting phase of traditional mountain crops, the GEF UNEP Local Crop Project (LCP) has implemented and utilizedvarious promotional and educational platforms for promotion of the local and traditional mountain crops and their products sometimes linking with diversity fairs (seed fairs). Food fairs and organic fairs are the key activities and events among such platformspromoted by different sectors and actors including Local Crop Project recently in Nepal (Gurung and Dhewaju 2016, Pudasaini and Gauchan 2018, Paneru et al 2019).

Food fair is a promotional event aimed at raising awareness on food culture, introduce and market new food recipes, demonstrate traditional food and crop diversity and culture. It is indeed a food festival used as marketing tool for promoting local foods (Chang and Yuan 2011). It provides platform to different sectors such as local entrepreneur, homestay groups, extensionistsand researchers, for showcasing their initiativeson local crop promotion, food diversification and recipe generation. It can be organized at different level, local, regional to national.The event is generallycomplemented by cultural shows, food health related activities and discussion and sharing events on new discourse in the food sector with participation of researcher, students, development professionals and policy makers. This is recently becoming an important part of tourist attraction to promote traditional food culture.

Previously, In-Situ project (Sthapit et al 2006) has done some exemplary work on product

diversification and marketing. In that program, along with other means of promotion, the products were promoted using fairs and exhibition (Mahotsab). Lately, the department of food technology and quality control has organized the traditional local food fairs, and the organic fairs organized by Department of Agriculture (DoA) also merged organic products fair with food fair. Local Crop Project (LCP) with funding from the United Nations Environmental Programme, Global Environmental Facility (UNEP-GEF) and the Swiss Agency for Development and Cooperation (SDC), the Nepal Agricultural Research Council (NARC), Department of Agriculture (DoA), Local Initiatives for Biodiversity, Research and Development (LI-BIRD), and Bioversity International have been utilizing such platforms for raising awareness on local and traditional food products and lesson learned is being documented in form of good practice (www.himalayancrops.org).

B. Objectives

- To raise awareness and educate consumer on the importance of local food products highlighting nutrient contents of them and its way of production
- To showcase possibility in marketing of local food culture and recipes
- To link traditional food culture with tourism and entrepreneurship for economic benefit generation
- To bring farming community, local institutions and consumers in same platform so that they can exchange knowledges and feedbacks for better outcome and set future direction

C. Methods and Process

This segment explains the steps to be followed in organizing the food fair. The methods in value addition and food diversification are being presented as a separate good practice in this book. The food diversification and value addition forms the base of food fair but it has to be performed ahead of the event. The general steps and points to be taken care of is presented in **Figure** 1.

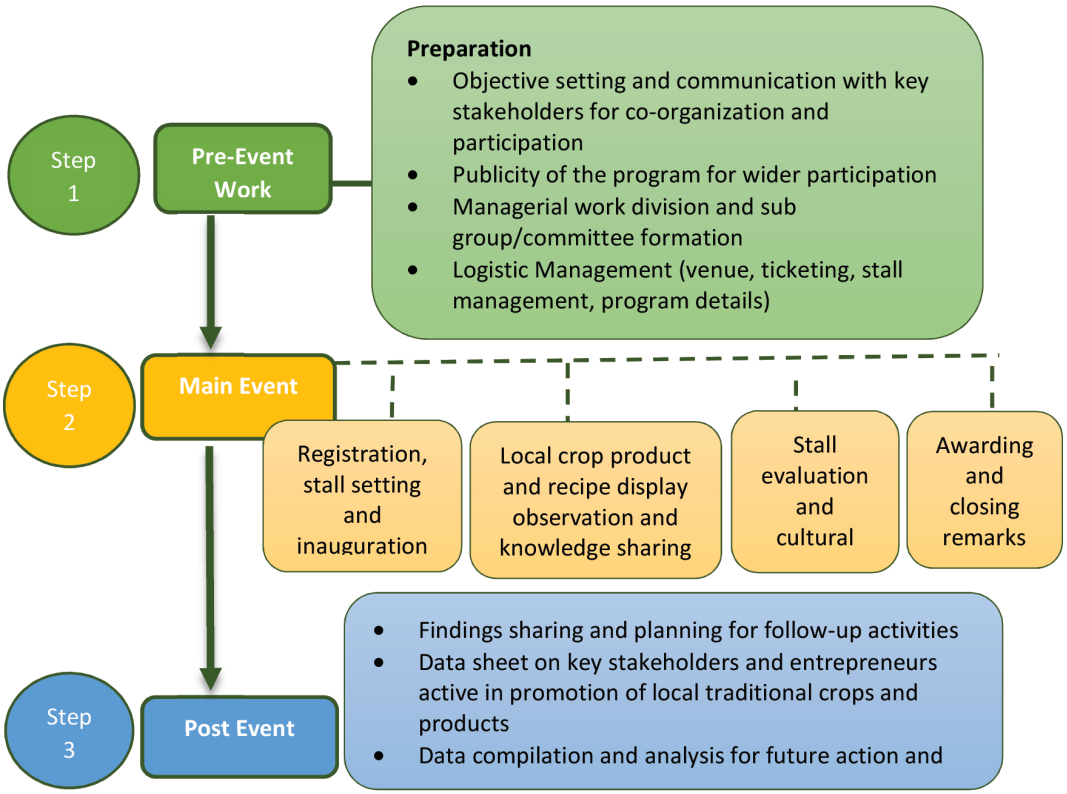

Figure 1. Diagrammatic presentation of process for organizing food fair.

There is not much difference between food fair and other event organization process, but there are some prerequisite and important point to note into during organization of the food fair which is stated as below but not limited, since it can be as creative as it can be for promotion of local crops and maximum utilization of the platform for better outcome.

1. Key stakeholders and their participation: The key stakeholders of the food fair is organizations and community institutions working in conservation and promotion of local and traditional crops through research and marketing through product diversification, value chain development, research institute on nutritional value analysis, eco-tourism sector. These institutions either can be participants or observant in the event. Invitation can be sent to different educational sectors for raising awareness and business houses for probable collaboration in scaling up of the products and recipes. Side events on sharing the work done in sector of local crop, product diversification can be organized for generating better impact and wider participation of different key stakeholder for developing future action plan and alliance for collective efforts.

2. Information and quality assurance: Since, the fair is associated with food, the quality, safety and cleanliness has to be assured. The food served and product displayed and sold have to be adequately packaged and labelled. This is part of value chain as well and in due process new entrepreneur and community will also be educated and they will be made responsible and their capacity is enhanced. Most importantly, the knowledge and information are key of these food fairs. So, the information and facts associated with the local crops, products and new recipes can be shared in any form such as flyers,news blogs and audio-video means.

3. Appropriate time of food fair organization: The event is most appropriate during the slack season of the year, mainly November to February in the mid hill and Tarai of, Nepal. This is good time, because, farmers will become free from their regular job in this time of year, and the weather is also pleasant, which is one of the factors for ensuring higher participation.

4. Promotion and Advertisement: The event has to be advertised through different mass media and communication means for ensuring wider participation. The catchy slogan can be used. Key stakeholders have to be invited for greater support and impact. To promote greater participation, musical event/cultural shows can be integrated in food fair. Seed or diversity fair can be combined with food fair to have better promotion of local crop seeds and products.

5. Award for Recognition: Award is key attraction of the food fair events as this is not only associated with cash prize but also linked with the recognition at national forum for the work done by them. This will create their work visibility and opens door for further collaboration and boost the motivation. The criteria for evaluation of stalls have to be made beforehand for making fair attractive and competitiveamong diverse participating actors. Some key areas for awarding can be research efforts in product diversification of local crops, innovative efforts made for commercialization and marketing efforts of local products, value chain development with labelling and packaging, innovative display and taste of traditional food recipes, promotion of traditional food items/recipes, integration of local food and recipe in homestays, ecotourism, organic product promotion etc.

6. Sanitation and Waste Management: Food consumption is associated with drinking water, food waste generation and waste disposal. Organizers should have clear-cut plan for food waste management, availability of drinking and cleaning water as well as toilets. Locally made leaf plates/reusable water bottles instead of plastic cups can be used. Multiple trash collection boxes and waste food disposal should be arranged. For visitors convince and health safety, hygienic toilets is crucial.

D. Advantages and Disadvantages

Advantages

- Helps to creates consumer awareness and market demand of local foods and crops
- Brings all key actors, from producer/farmers, researchers, eco-tourism sector, business houses, consumers and policy makers, of food system at same place, thus creating platform for co-learning, sharing and partnership for better outcome
- Platforms for newly established entrepreneurs and homestays to showcase their products and thus link to different sectors for marketing
- Ensure markets for local crop seeds and provide economic incentives to farmers
- Platform for discussion and debates on setting direction in food system development
- Helps to educate consumers and develop social and cultural cohesiveness among diverse actors

Disadvantages

- High investment and time needed for organization of food fair
- Concrete action plan and follow-up plan needed for full utilization of the platform, otherwise it would become a onetime event failing to provide future steps
- Quality control of raw food items and recipes showcased from relatively new entrepreneur is a challenge for organizing committee

E. Success Cases

The GEF UNEP Local Crop Project (LCP) has utilized food fairs, agricultural and organic forum linking with Diversity Fairs to raise awareness among consumers on traditional local crops from nutrition perspective and supportlocal entrepreneurs and researchers on potentiality of commercialization (www.himalayancrops.org). This initiative has generated positive impact on market demand of seeds and products of local crops especially minor millets-such as foxtail millet, proso millet and bean mixture from Karnali region- Humla and Jumla. In the last four years, community based institution, community seed bank (CSB) and homestay group of Ghanpokhara, Lamjung and CSB of Jungu, Dolakha, entrepreneur from Humla have successfully participated and contributed in the success of Regional and National food fairs organized by Department of Food Technology and Quality Control (DFTQC) of the Ministry of Agricultural and Livestock Development (MoALD) in 2016, 2017 and 2018. The LCP project facilitated and supported them technically and financially to participate them in these events.They received prizes- second in national food fairs, organic fair organized by Crop Development and Agricultural Biodiversity Conservation Centre (CDABCC) of the Department of Agriculture in 2019 as well. This recognition in national forum have motivated them to continue to work in this sector. The local food items showcased and served foxtail millet pudding, finger millet flour ring bread (*selroti*), amaranth grain sweet (*laddu*), and other local items, along with display and market promotion of proso millet grain, finger millet

flour and other local products. Now, as a result of encouragement received from the participation in national food fairs and other for a, now Ghanpokhara Lamjung's women homestay group is serving traditional food recipes of foxtail millet, finger millet and other local crop products to their guests thus promoting agroecotourism linking with local products. Promotional activities made during food fair and organic fairs, there is an increasing demand from entrepreneurs and development workers requesting seeds and products of traditional crops mainly foxtail millet, proso millet bean mixture andbuckwheat. Participation and implementation of food fairs are also helping to enhance seed and food value chains of traditional crops and promotingresearch and investment and traditional food culture in Nepal.Food fairs and organic fairs have been helpful especially in motivating the local community, entrepreneurs and linking or joining different key actors of the whole food system. Therefore, food fair has become an important platform for awareness raising and promotion of local crops in Nepal.

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15. Diversity Field School (DFS) for Managing Agrobiodiversity

Niranjan Pudasaini, Bharat Bhandari, Rita Gurung, Santosh Shrestha and Devendra Gauchan

A. Introduction

Various Community based Biodiversity Management methods, tools and approaches have been developed to promote on-farm conservation and use of Plant Genetic Resources (PGRs) and increase local seed security in various parts of the world. Several good practices have been developed for on farm management of agricultural biodiversity which needs to be systematically packaged for community practice and greater impact. For this purpose, LCP realized a regular community based platform to practice agro biodiversity management good practices, interact with experts, share knowledge and skills learn from each other. Hence, the concept of Diversity Field School (DFS) has been emerged and piloted by the LCP project in Nepal.

DFS is defined as a community centered learning and action platform where farmers participate to understand the value of biodiversity and manage agricultural plant genetic resources (APGR) by practicing various diversity management approaches, methods, tools and sustain successful initiatives through collective actions. It has been conceptualized by gathering insights of various on-farm agro-biodiversity management practices and approaches including Farmers Field School (FFS), Diversity Field Flora (DFF) and Community based Biodiversity Management (CBM). The weaknesses of conventional FFS is that it does not address diversity view point and the role of inter and intra-specific diversity to manage pest and diseases. FFS is more rigid and focused for a specific crop and season. While DFS is flexible, holistic and decentralized approach where farmers particularly women and custodians get mobilized to lead and manage field activities looking with the lens of diversity. It brings several agrobiodiversity management tools into practices such as Diversity Block, Diversity Fairs, Diversity Kits, Community Seed Bank (CSB), and Participatory Plant Breeding (PPB) and so on. DFS has been effective to develop and mobilize custodian farmers and paving the way in realizing the need of CSB, its establishment and institutionalization.

B. Objectives

- To create community/local level learning platform for promoting informal learning, participatory action research and capacity building of famers particularly of women and custodians on conservation and sustainable utilization of PGRs
- To systematically develop, test, practice, validate and disseminate good practices

on agricultural biodiversity management in an participatory way

- To establish/strengthen community institution such as CSB and sustain agro biodiversity management initiatives through promoting collective actions

C. Methods and Process

DFS is primarily based on four key principles that includes a) valuing farmer's knowledge, experience and their involvement in decision making process; a) participatory and holistic approach on managing agricultural biodiversity for food and nutrition security; c) promoting farmer- to-farmer learning and sharing as a part of local capacity building process; and d) customization of the actions as per the local context for sustainability of agro biodiversity management good practices. Basically, DFS works as a farmer's field school but packaging of contents is gradual, designed to gain cumulative results that also builds an effective farmer's institution at climax. It has a framework of curriculum which is based on the concept of To Know, To Do and To Sustain. Depending on requirement, DFS models 1 and 2 can be practiced discretely as well as in a holistic approach. Each modules have their unique objectives and expected outcomes (**Figure** 1).

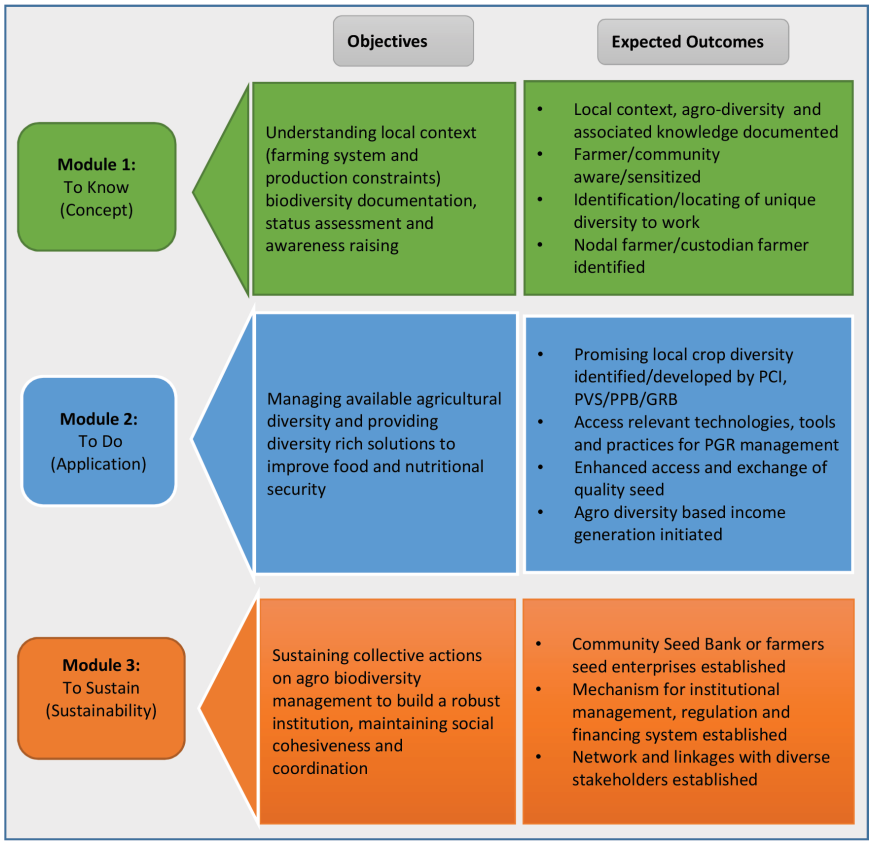


Figure 1. Modular concept of DFS with specific objectives to guide developing context specific DFS curricula with expected outcomes.

Each module comprises of distinct objectives which can be achieved by adopting various participatory tools of agro-biodiversity management. Series of interactions, practical trainings and exposure visits is required to obtain expected results from the DFS as outlined in Table 1. DFS requires active participation of local farmers preferably women and custodians and their institutions in which the role of local government, development agencies and stakeholders is important to create an environment by motivating them and providing needed support. Developing common agreement, allocating resources and time, sharing skills and experiences and fulfilling long term commitment of participation are crucial for the success of DFS. Initially, program and project should provide technical and financial support to start up the DFS with gradual transfer the role to local stakeholders and communities. At first, it can simply be started with a group discussion and planning meeting with local farmers and gradually built on depending on local context and priorities. It is important to keep participants interested and motivated to continue DFS sessions on a regular basis which is only possible when they appreciate value of maintaining biodiversity and learn something useful to improve their farming system and livelihoods. Followings are some of the indicators that guides while planning activities and measuring success of the DFS.

- Diversity richness (inter and intraspecific) at household and community level
- Source of information, seeds/planting materials and its flow
- Level of awareness and change in perception towards appreciating and using agro biodiversity
- Income from biodiversity based sources
- Adoption of a set of good practices that promote and enhance agro biodiversity| conservation and management such as seed saving and exchanges, use of local crop varieties, etc)
- Number of agro biodiversity custodians and Local Resource Persons (LRPs in the village
- Collective actions that promote conservation and utilization of Agricultural Genetic Resources (local breeds, seed banks, value addition and marketing, etc)

Key Elements of DFS

Farmer's Group: DFS is composed of group of enthusiastic, nodal and custodian types of farmers. During the group formation, inclusive representation of farmers from all socio-economic background and geographic locations has to be considered. Participation of women and disadvantaged groups in DFS will help to be a gender balanced forum. For better management and efficient knowledge sharing mechanism, DFS needs to have limited number (25-30 farmer maximum) of participants. Depending on local context, existing farmers groups can be considered as DFS forum with essential modifications.

Table 1. DFS module specific activities and supportive tools

Module	Activities	Tools
To Know	• Awareness raising/sensitizing activities on importance of agro-biodiversity • Policies, plans and strategies: Farmers rights, Access to and benefit sharing • Understanding local context: Farming system, crop diversity, production constraints, disaster assessment/stresses • Assess and document available biodiversity including associated knowledge • Assessing local seed system and seed network	• Participatory Rural Appraisal (PRA) tools • Four Cell Analysis (FCA) • Diversity Fair/Seed Fair and Food fair • Baseline information collection/survey • Other Study: Seed system and seed network study/analysis, custodian farmer identification study, Germ plasm collection mission and passport data • Community Biodiversity Register
To Do	Implementing actions planned based on module 1: • Sourcing new diversity, diversifying seed portfolio and seed exchange • Characterizing and improving local landraces • Conserving and utilizing local PGR, linking to livelihood • Addressing production constraints : Disease-pest control management • Promoting local diversity through varietal registration/release • Establishing community institutions like CSB	• Diversity kit and IRD packet distribution and feedback collection • Participatory seed exchange • Diversity block, characterization and yield trial • PPB, PVS, GRB etc. • Seed Multiplication (on-farm/on station) • Managing on-farm diversity, varietal mixture • Farmer's group registration and management • Revolving fund/CBM fund establishment • Value addition, processing, product diversification
To Sustain	• Institutionalization and strengthening of farmer's organization like CSB/CBSP (administration, finance and self-financing system) • Develop mechanism, guideline to run institution • Initiate agro biodiversity based business, income generating activities under farmer's organization • Develop leadership to coordinate networking and linkages with public and private institutions • Coordinating local government and relevant stakeholder for business, resource leveraging and mainstreaming	• Training and capacity building programmes • CSB Management training and exposure • Business pan development and value chain analysis • Linkage establishment with national and other similar objective oriented organization, agri-product business • CBM fund mobilization in biodiversity based activities • Institutional governance and capacity building trainings • Maintain legal compliances

Facilitator/Resource Person: Facilitator is a competent external person (Agriculture Technician/Expert) who organizes and led the DFS. Facilitator plays a vital role on organizing discussions and must have clear concept on on-farm agro-biodiversity management. Facilitator is also responsible for coordination and developing linkages between local farmers and resource persons (who provides specific trainings as per need). In long run, capable participants of DFS can take responsibility of facilitator which is essential for sustainability of DFS at local level.

Discussion Venue and Practice Field: DFS needs a closed space (meeting room) for discussion and theoretical discussions. Community buildings are most suitable venue to run DFS where all participants can come, sit and discuss freely and easily. Similarly, practical fields are also essential component of DFS to practice and demonstrate learned skills of agro biodiversity management. Fields for establishing diversity blocks or trial is needed to practice participatory R and D tools like PVS, PPB etc.

Conducting and managing DFS requires some resources to cover logistics, refreshment and material costs that should come from particular projects implemented by the GOs/NGOs/INGOs in the start-up and establishment phase. Management of the DFS needs to be led by community institution with the support of facilitator and participants. Linking DFS with existing local organization/groups/cooperatives will help to reduce management pressure on facilitator. Since it is a voluntary and knowledge enhancing platform, there should not be any provision of providing daily subsistence allowance (DSA) or direct monetary supports to the participants. As a motivational packages; seeds, agricultural tools and useful materials can be provided to the participants as per local need and availability of the resources. If resource person is invited to conduct any specific trainings/discussion sessions, he/she must be compensated.

D. Advantages and Disadvantages

Advantages

- Provide a regular platform farmers to meet, interact and practice various agro biodiversity management tools and practices,
- Provide opportunity to document traditional knowledge and its holders ie custodians, promote cross learning and sharing and conduct action research to find solutions of their problems
- Effective to make realize community in the importance of agrobiodiversity and its conservation and management and establishing community seed banks
- Promote collective actions and develop strong sense of community ownership to give continuity in practicing good practices, add value for community benefit and sustain community based institutions an actions,

- Build farmers particularly women's technical and leadership skills and capacity and

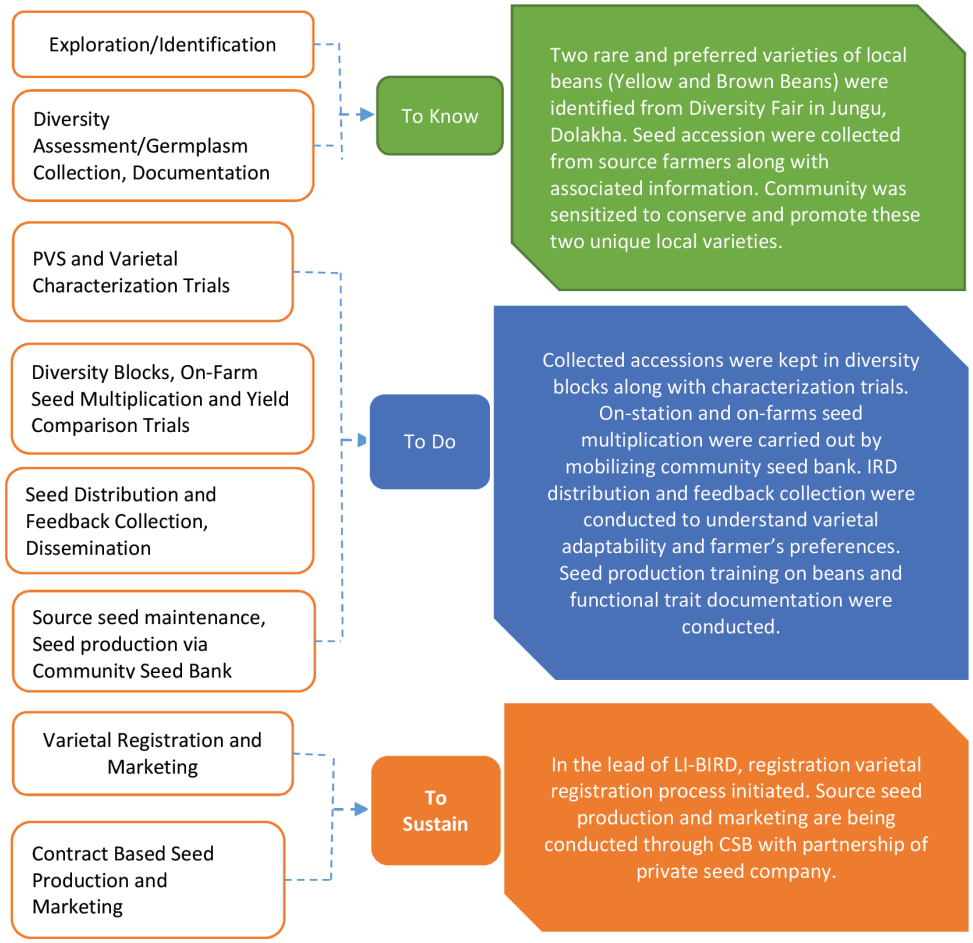
Disadvantages

- It is a gradual and longtime approach hence, not recommended to use in short term projects
- Requires resources, commitment for regular participation of farmers and facilitators, technical involvement and systematic follow up processes

E. Success Case

From LCP experiences, DFS is an effective approach to sensitize communities particularly the women and custodian farmers (agro-biodiversity rich farmers) and, bringing a strong sense of ownership in conservation and promotion of locally grown important traditional crops varieties with or without establishing CSBs.

Example: Case story of local beans from Jungu, Dolakha under the framework of DFS



In addition, DFS forum is effective to share knowledge and skills among farmers, conduct action research to find solution of their problems such as Participatory Plant Breeding (PPB) and Participatory Variety Selection (PVS), test and promote farmer friendly technologies including tools. As an example, a practical application of DFS by the LCP in its Jungu site has been presented in the figure below.

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Citation

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16. Multiple Strategies and Partnerships in Promoting Traditional Mountain Crops

Bharat Bhandari, Devendra Gauchan and Bal Krishna Joshi

A. Introduction

In mountain areas of Nepal, traditional crop varieties are important source of food and nutrition as they are hardy to grow in marginal land, rich in nutrition, resistant to disease-pest and better adapted to climate stresses such as draught and cold. There are a number of cases of frequent drought reported in mountain districts in the past causing severe food shortage due to lack of sufficient and timely rainfall to grow and harvest crops. Traditional mountain crops such as buckwheat, finger millet, proso millet, bean, barley, foxtail millet, etc have been playing vital role in achieving food and nutrition security and reducing hunger in mountain areas where food insecurity prevails.

Despite unique adaptive traits and qualities, most of these traditional crop varieties are increasingly being marginalized and neglected as farmers are less interested to continue growing them due to labor intensive production practices, poor market incentives, improvement in road connectivity, access to improved major crop varieties, youth out-migration and changes in the food habit of young generations. To revive and support cultivation and use of such climate resilient and nutritious traditional mountainous crops, single approach and strategy may not work hence, require multi-pronged approaches and strategies to effectively promote these crops in the production and market systems.

From more than two decades long joint work experiences of LI-BIRD, NARC and Bioversity International in Nepal, we suggest multiple strategies to promote local and traditional crops that include documenting unique traits and use values; functional trait analysis; creating nutritional awareness as healthy foods linking with organic farming; diversifying products and creating local demands in partnership with private sectors such as processers, hotels, home stays and developing and selecting better performing genotypes and their registration; establishing community seed banks for securing access to seeds; improvement in post-harvest processing and value chains and providing policy support. To effectively implement such strategies, there is a need to build partnerships with multiple agencies and stakeholders and build incentives for farmers to grow and benefit from traditional crops. From the experience of Local Crop Project (LCP) in the last five years, , there is an important role of multiple partnership of research and extension agencies, local governments, private sectors

and consumers to play. Hence building strategic partnerships is the key for success of local crop conservation and promotion in mountain areas where market incentive is limited due to geographical limitation and limited scale of production.

B. Objectives

- To bring multiple agencies and stakeholders together to share their knowledge, experiences, perspectives, values, and capacities in planning, implementing, evaluating the interventions that identify challenges and provide solutions in promoting conservation and use of traditional mountain crops.
- To empower communities as the key to continue production of local crops and enable them to access information, technologies, quality seeds, technical skills and market services from government and non-government organizations and linking their products with private sectors.

C. Approaches and Methods

The LCP was implemented to fulfill the gaps in research and development of important traditional and underutilized mountain crops aiming to mainstream the conservation and utilization of these resources in the mountain agricultural production landscapes in Nepal. Community based conservation program often target local communities but under estimate the important role of government and other sector stakeholders to engage, achieve and sustain conservation outcomes (Mcdougall et al 2008). The project therefore adopted different strategies while implementing LCP in remote mountain areas focusing on sensitization, mobilization communities and building partnership with local government and non-government agencies including private sector stakeholders. In doing so, we adopted community centered, coordinated and integrated approach to make realize the value of local crops by communities, local government and non-government stakeholders including civil society organizations and private sectors. The details of the approaches with its objectives, methods and stakeholders worked with are summarized in the **Table** 1.

Table 1. Approach, methods and stakeholders mobilized in the LCP in promoting traditional mountain crops

Approach Adopted	Objective	Method and Process	Stakeholders Worked with
Awareness and sensitization	To raise awareness and sensitize communities and stakeholders to appreciate, actively take part and support LCP processes and develop sense of ownership to sustain project outcomes	Orientations about food and nutritional values, diversity cum food fair, exposures, production and dissemination of materials	Communities, Agriculture university and collages, local government, private sectors (hotels, homestay operators

Approach Adopted	Objective	Method and Process	Stakeholders Worked with
On-farm demonstration, documentation and registration	To demonstrate and document traits, use values and associated knowledge To test, select and promote promising varieties of target traditional mountain crops in a participatory way	Diversity block, functional trait analysis, varietal catalogue of local crops, travelling seminar, registration proposal development and submission	Communities, Custodians, NARC stations, Seed Quality Control Center (SQCC), Seed Entrepreneur Association of Nepal (SEAN) and Anamole seed company
Community seed bank	To establish a community mechanism to conserve, produce and increase local access to quality seeds of traditional and other community demanded mountain crops	Community sensitization, training and exposure, mobilization and building partnership with local government and stakeholders	Community institution (group and cooperative), local government, agroshops(Koseli ghar)
Joint planning, monitoring and learning	To engage and influence famers, local leaders, private sectors, policy makers and planners to promote local and traditional crops	Formation of Site Management Team (SMT), review and planning workshop, travelling seminars, Project Steering Committee at the national level	Former District Agriculture Development Office (DADO)/ASC, Federal Ministry and Department of Agriculture, local governments, NARC Divisions, seed Companies, farmers groups and cooperatives
Improvement in processing technique	To save time and reduce drudgery of women and men farmers in processing of traditional mountain crops	Development, testing and promotion of finger millet and proso millet thresher cum de-husker	Communities, NARC Engineering Division, Agro-tools manufacturer company
Value addition and market linkages	To promote consumption of traditional crops at household and markets by diversifying product recipes, linking with hotels/bakeries/homestays and promoting its use value among consumers	Food recipe trainings, nutrition analysis, participation in local, regional and national food fairs, linking with private entrepreneurs	Partnership with food research and food quality control departments, Chamber of Commerce and Industries, agreement with private sectors

D. Advantages and Disadvantages

Advantages

- Effective to build on each other's strength, mobilize networks and leverage resources
- Includes multiple stakeholders such as communities, local government, researchers and value chain actors including private sectors
- Useful approach to motivate and support farmers, build and sustain their initiatives

beyond the project support through providing necessary support services on a longer-term basis
- Easy to provide feedback that helps to refine and bring improvement in the technology and support services

Disadvantages
- Require significant effort and the resources to create an environment and include and mobilize multiple stakeholders and local government in the beginning
- Pre-existing background and experience on joint working relationships with key stakeholders needed
- Very difficult, almost impossible to demonstrate the results in a short time period

E. Successes and Learning

LCP organized two days orientation cum interaction workshop for newly elected leaders that included chair persons, vice-chair persons and ward chair persons from project implemented Rural Municipalities (RMs), CSB committees, Cooperatives and Members of the site management committees. The interactive workshop was successful to sensitize them and identifying the areas of joint work to promote local crops through establishing CSBs, testing and promotion of processing technologies appropriate for traditional crops and building capacity of local institutions and communities. As a result, local government leaders of LCP sites remained very open to listen, started engaging CSB committee in local agricultural planning process and allocating resources for organizing seed fairs, distributing CSB produced seeds, providing grants for building CSB storage facilities, supporting processing machines and providing seed production training in all sites in partnership with LCP. Within a period of two years, community leveraged a total of NPR 3.78 million (USD 37,000) from local governments in four project sites for strengthening CSBs, buying seeds for local distribution, processing machines and seed storage structures. CSB farmers also started coordination with local agrovets Sishir Agrovet (Beshishar, Lamjung) and seed companies such as Anmol Biu, local seed cooperative ie Ekata Agriculture Cooperative (Mainapokhari, Dolakha), for linking their local seeds for marketing. In 2018, Jungu CSB sold 14 kg of amaranth seed (Ramechhap Hariyo Latte) which is first registered variety of amaranth species with the support of LCP and seed system project. Similarly, CSB of Ghanpokhara sold 80 kg seed of Biramphool-3 rice (PPB bred variety), bean and cowpea through local agrovet in Lamjung.

The LCP focused on bringing former District Agriculture Development Office (DADO), local governments, private sectors and more recently the Crop Development and Agriculture Biodiversity Conservation Center (CDABCC) together and build partnership with communities. Through this integrated effort, we were successful to make realize and recognize the vital role of CSB and its integration in local agricultural policy, plans and programs. CSBs of LCP

sites are linked with Association of Community Seed Banks in Nepal (ACSBN), as the network was established for collective learning, sharing of experiences and bringing CSBs agenda into the policy discourse such as recognition and participation of CSBs in decision making processes including issues of farmers' rights and access and benefit sharing of local PGRs conserved and maintained by communities and CSBs (Gauchan et al 2018).

Linking production with improved processing with the use of women friendly machines and adding value through diversifying products has contributed significantly for valuing traditional crops and its increased utilization. Strengthening the capacity of local farmers, community leaders and other stakeholders in the value chains is one of the important aspects of the process. Development and demonstration of finger millet thresher cum dehusker and proso-millet dehusker by the project and its scaling up in partnership with communities and rural municipalities (Palikas) are proved to be instrumental in reducing human labor, drudgery of women and improving quality of the processed products. The project has facilitated linkage of local farmer cooperative and community seed bank groups with local agro-entrepreneurs to market, process and promote final products focusing on healthy, organic and nutritious wholesome foods and their food recipes (Gauchan et al 2019).

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17. Nutrition Dense Native Crops and Food Recipes

Pravin Ojha, Roman Karki, Achyut Mishra, Ujjwol Subedi and Bal Krishna Joshi

A. Introduction

Native crops are the crops native to that region i.e. an inhabitant of that particular region. Nepal is an agro-diversity dense country with various crops specific to that area, hence, the food system is also diverse in the country. Buckwheat (*Fagopyrum esculentum* and *F. tararicum*), cold-tolerant rice (Oryza sativa), common bean (*Phaseolus vulgaris*), finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), grain amaranth (Amaranthus caudatus and A. leucocarpus), naked barley (*Hordeum vulgare* var. *nudum*), and proso millet (*Panicum miliaceum*) are the major native crops grown in the mid-hills and the high hills of Nepal (Parajuli et a l 2016, UNEP GEF 2013). However, with easy access to major crops like rice and wheat and increased promotion of imported food products these crops have not been utilized properly. The major constraints for utilization of these native crops are lack of, a) milling facility(efficient milling to grit, flour etc in terms of time, energy, and manpower), b) product diversification, c) awareness of nutrient and health benefits of these crops, and d) market linkage (both crops and their product).

Native crops like proso millet, foxtail millet, amaranth, buckwheat are considered Himalayan super foods (www.himalayancrops.org) and also to be future smart crops t because they are nutritious, locally available and adaptive to changing climate (Li and Siddique 2018). Analysis is carried out by Food Research Division (FRD) of Nepal Agricultural Research Council (NARC), has shown that these crops have high protein content with considerable amount of calcium and iron (FRD 2016, FRD 2017, FRD 2018). Researches have demonstrated various potential health benefits (low-glycemic index, anti-cholesterol activity, anti-oxidant activity) of these crops (Kalinova 2007). So, these can also be formulated for functional food (food that provides a health benefit beyond nutritional benefit).

Despite their high nutrient content and other potential health benefits, these crops in Nepal still fall under under-utilized species and their value chain is not well developed (Gauchan et al 2019). Food recipe development is an important tool to increase value chain development and the utilization of these crops. Food recipe development is meant to present food in a more acceptable form (more adaptable to local people) through product diversification, which helps reduce the import of available market foods, create jobs, and can link to food

tourism and market with good packaging and branding. One of the important tools for value-addition is product diversification.

Traditionally native cereals are used for *dhido, roti, haluwa, khir, malpuwa*, etc and more in alcoholic beverages (*Jand*). Though these products are mainly locally home-made still recipe validation is essential through survey (though it may differ from home to home). Along with this, commercial and modern food products like cake, bread, biscuit, noodles, *nimki, ladoo*, and bar can be made from these crops, despite they are prepared in limited scale in some locations.

B. Objectives

- To enlist some recipes from underutilized traditional cereals. To make aware of the health benefits of these crops.
- To highlight the methodology for developing redefining recipes of traditional and modern foods from NUS crops.

C. Methodology to identify nutrient dense crops

Nutrition dense crops are those crops having a high amount of minerals, vitamins, phytochemicals and anti-oxidant property. Those crops are also considered as nutrient-dense crops which contain good fat (phytosterol), high dietary fiber and lean protein. Normally, whole grain foods are considered nutrient-dense crops. Local people believe that these native crops are heavy. This means that the same mass of native crops satisfies one's satiety for long times (do not feel hungry for a long time) compared to rice and wheat flour. There are different ways to identify nutrient-dense crops, which are:

a. Survey: Communication with local people will help to identify nutrient-dense crops. For example, people believe that rato kaguno has medicinal benefits, this means it is nutrient-dense. Some people believe that feeding millet will help them to work longer in their field without being hungry. This shows that millet is also nutrient-dense crops. Besides that people generally consume rice and wheat in refined form, while these native crops are consumed as whole flour. This also makes these crops having more satiety than refined crops.

b. Laboratory analysis: Laboratory analysis of crop can also be carried out to determine whether the crops are nutrient-dense or not. As said earlier, laboratory analysis of native crops shows a high amount of dietary fiber, mineral and calcium in considerable amount than rice and wheat flour. Many research has shown that buckwheat contains rutin (rutin shows anti-cholesterol activity) (Atanassova and Bagdassarian 2009). Similarly, foxtail millet, proso millet, and amaranths have a good amino acid balance compared

to rice and wheat flour. These crops are also low-glycemic index crops, break slowly in the stomach. Research showed that natural colored crops have high antioxidant activity, which helps to develop immunity against cancer (Kachiguma et al 2015, Kalinova 2007).

The process of redefining the traditional recipe is as given in **Figure** 1.

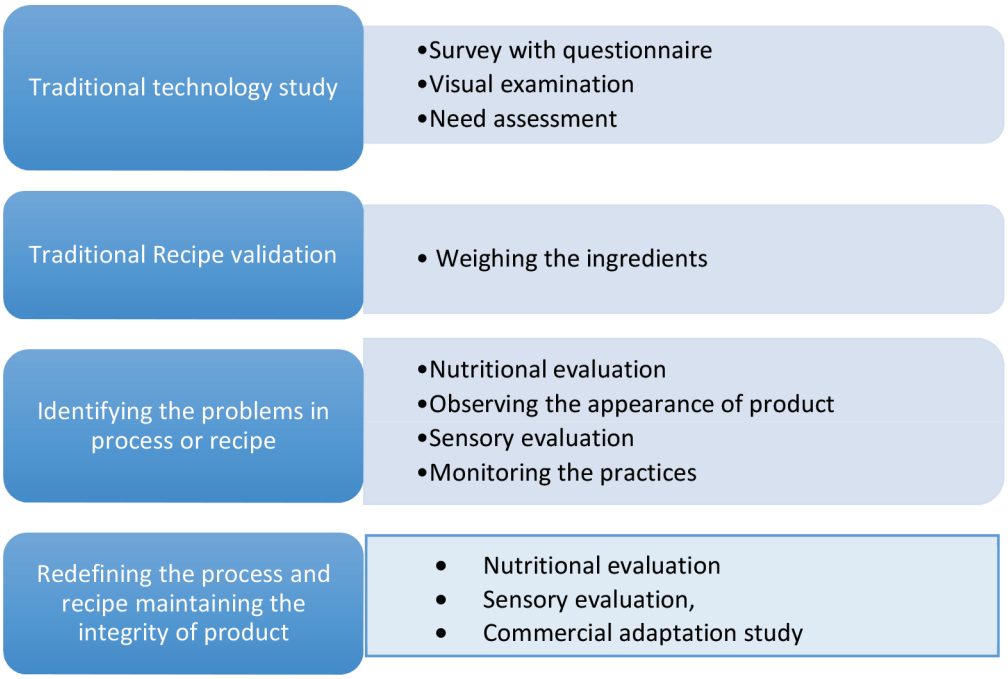

Figure 1. Recipe and Process from native crops either locally adapted or research based.

The process of formulation of important recipes from traditional nutrient dense crops are outlined below.

1. *Khir* of Foxtail millet

Cleaned foxtail millet (1000 g) is soaked in 3.5 L warm water for 2-3 h. Milk was boiled separately. Soaked and strained millet was added in milk and boiling was continued. During boiling, sugar (400 g), and ghee (50 g) was added. Almond, cashew nut, and other spices were added based on taste to the mixture. The mixture was cooked till the consistency was thick with continuous stirring to prevent from burnt taste. The cooked mass was served hot.

2. *Laddoo*/Bar from amaranth seed

Amaranth seed (dry cleaned, 1000 g) is puffed in thick pan and cooled. Sugar/molasses (400 g) is heated with water (300 g) till the °Bx reached 80 or thick consistence. Heated syrup is

filtered. Pour the heated syrup on cooled, puffed amaranth seed, make the shape round with lubricated hand or by using food grade glove.

3. Noodles from native crops

Wheat flour, one of the native crops as in recipe and gluten is mixed. Water is added slowly in it till the dough becomes flaky. Dough is left for 30 minutes covered with wet muslin cloth. Dough is sheeted in rolling machine to 1-2 mm thickness. The sheet is cut in noodles cutter to make stick noodles. Stick noodles is cooled for 3-4 h in the RH 70-80%. Noodles are cut as per size and packed in plastic pouch.

Recipe for noodles

Ingredients	Amount, g
Buckwheat/amaranth/proso millet/ foxtail millet/millet/naked barley/barley flour (sieved to pass through 0.25 mm mesh size)	500
Wheat flour	500
Gluten	100
Salt	5
Water	Around 550 ml

4. Doughnut from native crops

Yeast is activated (5 g sugar in 100 ml water at 37 °C for 30 minutes). Dry ingredients and ghee is mixed as per recipe. Add the activated yeast and water slowly in the mixture to make dough. Dough is left for two hours covered with muslin cloth. Make the round shape ball of dough as per required size and is left for 30 minutes. Now, shape the ball into the shape of doughnut/sel roti and leave for one hour in flat surface. After that, deep fried the shaped doughnut in oil or ghee with subsequent turn, till it turns reddish brown.

Recipe for doughnut

Ingredients	Amount, g
Buckwheat/amaranth/proso millet/ foxtail millet/millet/naked barley/barley flour (sieved to pass through 0.25 mm mesh size)	200
Wheat flour	800
Granulated Sugar	100
Yeast	20
Ghee	50
Salt	15
Water	Around 600 ml

5. Cake from native crops

Mix dry ingredient and half of the sugar required as per recipe. The baking powder was mixed with 5 g sugar in glass filled with water. Remaining sugar is mixed with melted ghee to make cream. Beat the egg in cream, and flour is added slowly in the cream with addition of water to prepare batter. Activated baking powder was also mixed with batter. Batter is now poured in mould (cup) to fill it half. It is then baked in oven (190 °C for 25-30 minutes), cooled and packed in plastic.

Recipe for cake

Ingredients	Amount, g
Buckwheat/amaranth/proso millet/ foxtail millet/millet/naked barley/barley flour (sieved to pass through 0.25 mm mesh size)	400
Wheat flour	600
Sugar	600
Ghee	500
Egg	75
Baking powder	10
Water	Around 350 ml

6. Biscuit/Cookies from native crops

Flour and gluten is mixed as per recipe. Half of the granulated sugar and skim milk powder is mixed in melted ghee to make cream. Baking powder, ammonium bicarbonate (for biscuit only), granulated sugar in half of the required water. Dry ingredients, cream and the above solution are mixed to make dough (for cookies dough is short textured compared to biscuit). The dough is sheeted to 4-5 mm thick and die is used to give the shape of biscuit. It is baked for 25-30 minutes at 170 °C in baking oven, cooled and packed in plastic pouch.

Recipe for Biscuit/cookies

Ingredients	Amount, g for biscuit	Amount, g for cookies
Buckwheat/amaranth/proso millet/ foxtail millet/millet/naked barley/barley flour (sieved to pass through 0.25 mm mesh size)	400	400
Wheat flour	600	600
Gluten	50	50
Salt	5	10
Ghee	100	200
Baking powder	20	20
Ammonium bicarbonate	15	-
Skim milk powder	10	50
Egg	-	30
Water	Around 250 ml	Around 350 ml

7. Bread from native crops

Yeast is activated (5 g sugar in 100 ml water at 37 °C for 30 minutes). Dry ingredients and ghee is mixed as per recipe. Add the activated yeast and water slowly in the mixture to make dough. Mix the dough for 20 minutes and leave the dough at 37 °C for 1.5 h covered with wet muslin cloth. Make the round shape ball about 200 g and leave in baking mould for 1 h. It is then baked at 210 °C for 25-30 minutes in baking oven, cooled it and packed in plastic pouch.

Recipe for bread

Ingredients	Amount, g
Buckwheat/amaranth/proso millet/ foxtail millet/millet/naked barley/barley flour (sieved to pass through 0.25 mm mesh size)	400
Wheat flour	600
Sugar	100
Ghee	50
Gluten	100
Yeast	10
Salt	10
Water	Around 500 ml

D. Pros and cons in food recipe development

- **Adaptation:** Unlike food products made of refined ones the products from native ones have coarse texture and coarse taste, which in general has not been found palatable to consumers. However, people in the search for healthy food do like it.
- **Food habit:** Food habit of Nepalese people is mainly eating rice and wheat flour (refined flour), which are low in nutrition. Changing food habit takes time. It is necessary to aware the consumers about the health benefit of nutrition dense food crops through mass media and other means to increase their demand. Product diversification and clinical nutrition trials will also help to speed up the process
- **Commercialization:** Food recipe development is one of the important tools for commercialization of these native crops. This will help development of small-scale bakeries and local people carrying out homestay. Food festivals and display of foods| from native crops can be used to promote both agro- and food-tourism.

E. Success Case

There are now some restaurants and bakeries named like raithane (Lalitpur), kodo restaurant (Bajura), Humla Delights (Humla) among others, preparing foods from native crops. They prepare cake (baked and pan), bread, biscuit from millet, buckwheat and other native crops. Raithane is not only preparing foods from native crops but also focused on the indigenous recipes. Training on food diversification and their enthusiasm have made them success.

Similarly, recently many more food recipes restaurants and food stalls are emerging in the country.

Conclusion

Native crops, if utilized properly through product diversification, value chain development and market linkage, will not only raise the income source and ensure nutrition security of the people but also conserve these crops, maintaining agro-biodiversity in the country. Therefore, it is important to identify suitable technology for product diversification and food recipe formulation and specific research is required for specific crops to identify proper product technology to link with the market and value chain development. Further, product diversification will improve the native crop utilization and may reduce the import of other snack foods. This will also reduce the household investment improving the nutrition and livelihood.

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Citation

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18. Conserving Traditional Knowledge of Local Plant Genetic Resources through Farmers Varieties Catalogue

Rita Gurung, Niranjan Pudasaini, Devendra Gauchan, Bal Krishna Joshi, Bharat Bhandari and Santosh Shrestha

A. Introduction

Nepal is rich in agricultural diversity with 599 species of edible genetic resources out of which 225 indigenous species are under cultivation (Joshi et al 2017). Nepalese farming communities are relentlessly engaged in conserving, managing and utilization of plant genetic resources (PGR) and these efforts have helped to maintain the agrobiodiversity richness. Furthermore, farming communitiesalso possessthe knowledge of the unique traits of the local germplasm of various crops such as adaptability to diverse climatic conditions, socio-cultural importance, disease and pest and their cultivation practices. This knowledge is important for crop improvement either through a simple selection to introgression of the desirable traits to preferred crop varieties which are resilient to climate change and better yielding. However, the introduction of modern varieties has constantly threatened the existence of local plant genetic resources. Displacement of local adapted germplasms by the uniform modern varieties and hybrids not only results in loss of adaptive traits and stress tolerant germplasm but also the knowledge associated with them. The traditional knowledge of a crop/variety has been passed on from one generation to another, however, they have been rarely documented. There is a huge risk of losing such valued knowledge with the declining trend on utilization and conservation of the local crop genetic resources. Thus, it is important to document the knowledge and traditional practices of each local crop genetic resources that will help to promote their use and preserve the information which may be useful on understanding the importance and potentialities of such plant genetic resources PGRs for future crop improvement. Moreover, it also establishes ownership and acknowledges the efforts made by farming communities in the conservation of plant genetic resources.

Community biodiversity register (CBR) is one of the earliest attempts in Nepal in documenting the farmer's knowledge of agrobiodiversity and become an integral part of a community seed bank (CSB). This is first conceptualized and initiated in Nepal in 1998 with the implementation of global in-situ agrobiodiversity project in Nepal (Gauchan et al 2006, Subedi et al 2006). CBR has been helpful in raising awareness of the communities on available local PGRs, promote their use and document their status or availability in the community

(Sthapit et al 2006, Subedi et al 2006). Important traits, uniqueness of the landraces and their socio-cultural relevance are registered. Later, projects implemented by LI-BIRD in partnership with SWISS Resource Foundation, Swiss Development Cooperation (SDC) and Bioversity International (BI) in Begnas Tal Rupa Tal (BTRT), further improvised the information collectedin CBR by adding other relevant information and pictorial demonstration of the distinguishing traits of the landraces/varieties. Similar farmer's landraces catalogue of rice cultivated in Bara was published in coordination with CSB of Kachorwa, Bara in 2017. A catalogue of farmers' varieties (landraces) that serves more advanced form of community biodiversity register (CBR) consisting information of local genetic resources and traditional knowledge of eight different indigenous crops from the high and mid-mountain areas was publishedrecently from GEF UNEP Local Crop Project (Gurung et al 2019). The catalogue contains the landraces agronomic description and their morphological characters/traits of the crop. The description of the crop/landraces provided can be broadly categorized as general information, agronomic traits, and current status of that landraces in the community, its use-value mainly nutritional qualities and market traits and its adaptability range. The information collected from the farmers' community was supplemented by the field trials/experiments where applicable and accompanied by photographs of different stages of crops and their distinguishing traits. The target audiences of the catalogues are the farming communities, researchers, extension workers and policymakers. The catalogue is a part ofLocal Crop Project (LCP) funded by the United Nations Environmental Programme, Global Environmental Facility (UNEP-GEF) and the Swiss Agency for Development and Cooperation (SDC) and jointly implement by the Nepal Agricultural Research Council (NARC), Department of Agriculture (DoA), Local Initiatives for Biodiversity, Research and Development (LI-BIRD), and Bioversity International.

B. Objectives

- To document the existing local diversity and local knowledge about the traditional crops and their crop varieties
- To provide information on farmers' local crop varieties to farmers and all stakeholders to serve as an important repository of crop varieties of Nepal
- To acknowledge the local farming communities and farmers and their collective and individual efforts for management and conservation of such valued local varieties and their knowledge.

C. Methods/Process

Collection of information regarding the farmers' varieties or landraces can either solely be a primary activity that can be integrated intoa project based onplant genetic resources identification and uses. The agro-morphological data and descriptive images of a landraceare essential components of a catalogue. The steps adopted for farmers varieties cataloguepreparation is presented in **Figure** 1.

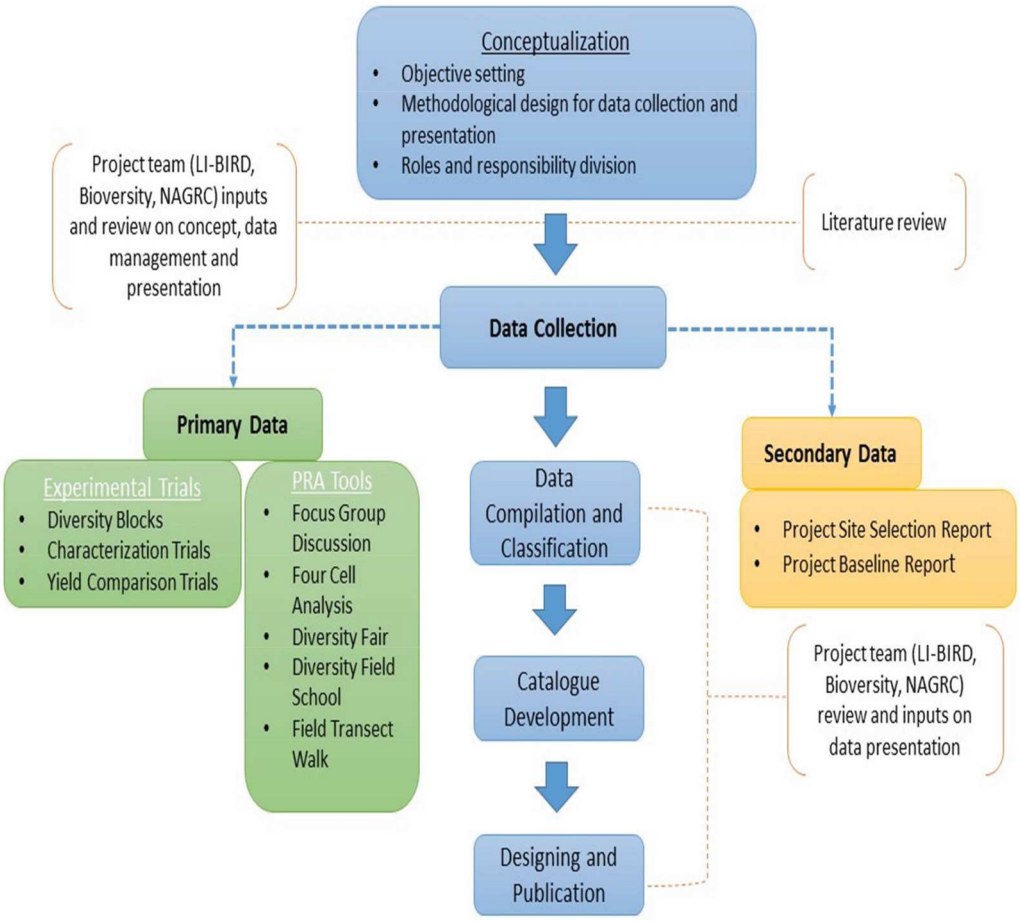


Figure 1. Steps of farmer's varieties catalogue preparation.

The steps followed are briefly explained below:

Conceptualization: The farmer's varieties catalogue development begins with objective setting of the assignment, methodologies to be adopted and roles and responsibilities division. The conceptual framework, objectives and roles of the farming community have to be discussed well in advance.

Data Collection and Developing Crop Profile: Both primary and secondary source of data are important and should be considered. The reports such as site selection, village profile and baseline study are secondary sources of data while the PRA exercise, diversity fair and experimental trials are performed to generate first-hand data based on nature of the information to be collected. The list of information to be included in the farmer's varieties catalogue is presented in **Table** 1.

Data Compilation, Validation and Publication: The data and information collected are compiled and validated in farmer's meeting/discussion. Once it is done, the catalogue is sent to design and publication. The catalogue needs to be designed very simple so that farmers can easily read and understand. Arrangement of photographs should show particular feature and trait of that variety.

Table 1. List of Information included in Farmers Varieties/Landraces Catalogue

Broad titles of the catalogue	Nature of information to be included	Source and Methods/tools for the information collection
General information	Name, scientific name, important village, vernacular name, farmer's descriptor, researcher descriptor.	Literature: Baseline Study, Site selection reports Tools: Transect Walk, Focus Group Discussion, Diversity Fair, Diversity Block
Agronomic traits	Plant height, days to flowering, day to maturity, potential yield.	Baseline Study Report, Diversity Block, Crop Cut
Current status	Average area of cultivation per HH, % of HH cultivating the variety, conservation status, current trend of the variety in cultivation.	Baseline Study Report, Focus Group Discussion, (FGD)Four Cell Analysis (FCA)
Use value	Nutritional quality, market traits, use, organoleptic quality.	FGD, Diversity Fair, Baseline Survey Report
Adaptability	Response to biotic and abiotic factors, adaptation.	FGD, Diversity Fair, Baseline Survey Report and Diversity block data analysis

D. Advantages and Disadvantages

Advantages

- This document serves as a baselineof agricultural biodiversity of a particular area or region.
- Helps to locate rare, unique and important landraces which can be further be promoted and linked to the national seed system for its wider dissemination to a farming community.
- Identifies the endangered and vulnerable PGR requiring urgent attention for conservation.
- It can assist and raise awareness of the concerned agencies, research institution, local and national government, for implementing appropriate action for conservation and promotion of resources.
- Data collection and documentation for landraces registration
- The catalogue can serve as a medium for recognizing the contribution of the local farming community for their effort and knowledge on plant genetic resources

Disadvantages/Concerns

- The process takes a long period of time (at least 1-2 cropping season), different

nature of data needs to be collected, so different tools have to be applied and so the varieties of skills are needed to accomplish it

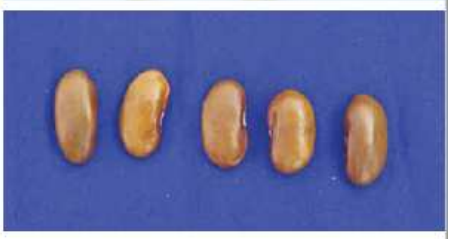
- Coordination with the local community and government unit has to be done for its maximum utilization
- Ownership by the local community and local government for its ownership and continuous monitoring and utilization of the information collected

A. General Information

Crop	Common Bean
Scientific name	*Phaseolus vulgaris* L.
Landrace	Khairo Ghiu Simi (खैरो घिउ सिमी)
Major locality	Darkha, Maula, Rajapu, Gairi, Chhap
Local name	*Simi* (सिमी)
Farmers descriptor (*Huliya*)	Kideny shaped shiney brown grains

B. Agronomic traits

Plant height (cm)	350-400
Days to flowering	55-60
Days to maturity	110-115
Potential yield (kg/ropani)	170-190



C. Current status of the landrace

Area of cultivation (m^2/HH)	10.41 ± 2.66
% of HHs cultivating the landrace	27
Consevation status	Vulnerable
Current trend of the landrace	Increasing

D. Use value

Nutritional qualities	High protein and appetite suppressant
Market traits	Dual purpose (green pod and dry grain), tasty
Uses	*Daal*, roasted cake *Biramla*,

E. Adaptability

Response to abiotic and biotic stresses	Low water requirement, susceptible to anthracnose disease

E. Success Cases

Local crop project (LCP) developed a farmer's landraces catalogue of traditional mountain crops cultivated in Chhipra (Humla), Hanku (Jumla), Ghanpokhara (Lamjung) and Jungu (Dolakha). The crops covered were amaranth, barley, bean, buckwheat, finger millet, foxtail millet, proso millet, and cold tolerant rice.A total of 130 landraces of 8 crops have been documented in the catalogue. The document is a source of farmers' traditional knowledge, which also served as a source of information for landraces registration proposal preparation of some identified landraces of crops from these project sites and they are *Pahenloand Khairo* bean from Jungu, Dolakha, *BariyoKaguno* foxtail millet from Ghanpokhara, Lamjung, *Lal Marshe* and *RatoKodo*- varieties of amaranth and finger millet respectively from Hanku, Jumla and *Dudhe Chino*- proso millet from Chhipra, Humla. The varietal catalogue is being published in both English and Nepali. The document is owned by the community seed bank (CSB) in the project areas.

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19. Community Biodiversity Management (CBM) Trust Fund

Bharat Bhandari, Niranjan Pudasaini, Pitambar Shrestha, Krishna Hari Ghimire and Devendra Gauchan

A. Introduction

Community Biodiversity Management (CBM) trust fund has been initiated to promote and sustain locally led agrobiodiversity management initiatives linking with community seed bank (CSB). It creates a self-financing mechanism for community institutions to meet both conservation and improving livelihoods of its members through providing local access to financial resources (Maharjan et al 2010, Shrestha et al 2011a). The concept of CBM fund in Nepal was started in the context of agrobiodiversity programming. In-situ agrobiodiversity conservation, a global project of Bioversity International (former IPGRI) implemented jointly by Nepal Agriculture Research Council (NARC) and LI-BIRD first piloted the CBM fund during 2000-2004 (Shrestha et al 2011a). With encouraging results, LI-BIRD further tested the practice in Community Biodiversity Management (CBM) project funded by The Development Fund, Norway in Nepal (2006-2016) and scaled up as one of the good practices to promote on farm management of agrobiodiversity linking with CSB (Shrestha et al. 2011b).. Recently, GEF-UNEP funded Local crop project implemented by LI-BIRD, NARC and Biodiversity adopted CBM fund as one of the integral components to establish and sustain CSBs in the context of high mountain districts of Nepal. Agrobiodiversity conservation has been increasingly prioritized by the government as reflected in recent policies, strategies and programmes in Nepal. CBM fund has also been recognized as a mechanism to promote agrobiodiversity in its recently formulated and amended Agrobiodiversity policy (2007) revised in 2014.

CBM trust fund is a self-financing mechanism for sustained operation of the CSB and/or community-based biodiversity management related collective actions successfully applied in the context of Nepal and South Asia. It is mobilized as a collateral free loan at a lower rate of interest rate among members compared to other financing sources such as banks to support household level economic activities. In our experience, this mechanism has greatly enhanced the access to financial resources to the smallholders and marginalized households supporting their livelihoods and promoting conservation of rare and endangered local crop landraces. This fund generates some income in the form of interest on a regular basis which is used to cover management cost of CSB operations, and part of interest generated goes to purchasing local seeds produced by members and custodians for community

seed banks. The prerequisite for this fund is that members who access this collateral free fund must conserve minimum one local crop landraces.

CBM fund is a kind of trust fund with its four key features; a) it is established and managed by the farmer organizations b) Funds are raised from project support, community contributions and its mobilization, c) Farmer's institutions are responsible for decision-making, developing guidelines and ensure to reflect local priorities and needs and, d) fund are accessible to disadvantage and resource poor members on priority basis which promote inclusiveness in community organizations. It serves as a mechanism to motivate and engage poor & marginalized farmers in community initiatives.

B. Objectives

- Create a mechanism of providing easy access to financial resources that binds communities and promote collective actions for on farm conservation of agrobiodiversity and enhance livelihoods
- Establish a regular financial resource generation mechanism to sustain local institutions and ensure their sustainability

C. Process and Methods

Community empowerment and local institution building is the key initial process of CBM fund establishment and management. There should be community self-realization of the need and the plan to use CBM fund for its successful operations and management. Inclusive leaderships will have an important role to successfully implement, manage and sustain the CBM fund linking with conservation and community livelihoods with focus on poor and marginal members.

The CBM trust fund is operationalized and managed by the community-based organizations in the project sites as a revolving fund. CBM fund is generally established as a joint initiative of project and communities. To start with, project provides small fund amount to match which is raised and mobilized on a longer-term basis. Then local institution such as cooperatives or farmers groups are engaged to continue raising the fund through its mobilization to earn interest, collecting additional fund and adding community contributions. It is guided by a fund mobilization guideline with a defined process to apply, disburse, monitor and payback mechanism. The fund mobilization guideline also includes criteria to apply for the selection of loan beneficiary and its users. The overall mechanism of the CBM fund management and its mobilization is shown in Figure 1. In general, it has following five main steps:

- Discussion and agreement with communities about CBM fund establishment
- Formation of inclusive committee/sub-committee for the management of CBM

fund

- Development of fund mobilization guidelines and other user friendly documents to apply and sanction loans
- Collection of fund and its mobilization with emphasis to women, poor and marginalized households and communities
- Monitoring, auditing and reporting of the fund use

The priority of the CBM fund mobilization includes production activities that promotes biodiversity based small-scale enterprises and help conserve rare and threatened crops and seeds. Parts of the income coming as a loan interest are used to produce, procure and disseminate local crop seeds.

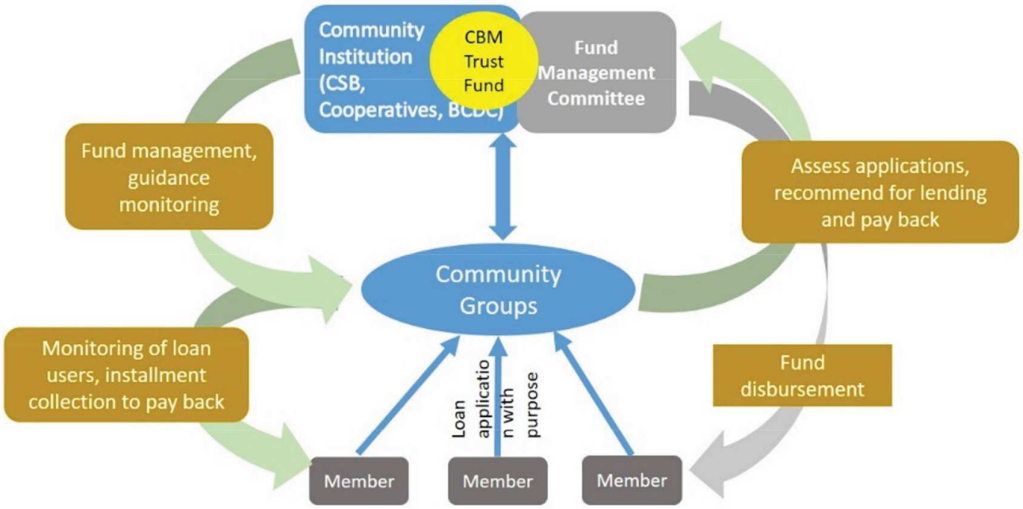

Figure 1. Steps and processes of CBM trust fund establishment and management.

D. Advantages and Disadvantages

Advantages

- CBM fund generate interest, binds communities and promote collective actions to support achieving conservation and livelihood goals
- Provide small collateral free loans linking with local credit and saving schemes for direct support of CSB communities
- Effective mechanism to motivate and incentivize poor and marginalized households to engage in CSBs and hence bring inclusiveness in member base of CSBs
- Serves as a self-financing mechanism for local institutions to sustain collective actions and managerial expenses

- Helps farmer's institutions creating local job opportunity
- Could be an option to implement ABS provisions of the CBD and Nayoga protocol at local level

Disadvantages/Challenges

- Building trust among members is vital to create an environment for establishing CBM fund. It is very much associated with accountability and maintaining transparency of leaders
- Demands a detailed fund mobilization guidelines owned by the local institution to operationalize the fund
- Poor and marginalized members generally left behind, not well informed about the loan provisions and therefore likely to have elite capture sometimes
- Poor fund users sometimes may use loan for consumption purpose causing difficult for them to payback on scheduled basis

E. Success Case

UNEP-GEF local crop project has been promoting CBM fund linking with community seed banks for increased participation of communities by providing easy access of small financial credits to poor and marginalized households. Currently four community seed banks established at mountain sites of Humla, Jumla, Lamjung and Dolakha have managed and operationalized CBM effectively from 2018 AD. In total, project have supported CBM fund of worth NPR 26, 10,000 (USD 26,000) to the newly established CSBs. Within a year of mobilization, 59 (37 women) CSB members are directly benefitting by accessing CBM fund from which NPR 88,945 is generated as revenue.

Among the CBM fund in the project sites, Jungu Dolakha site has managed well linking with group saving and credit scheme. Here we present the success case of the project site Jungu, Dolakha which has supported a total of NPR 4,50,000 to establish CBM fund by signing a formal letter of agreement with CSB implementing local institution Shree Himchuli Multipurpose Cooperative on May 2018. A fund mobilization guideline was developed and endorsed by them. Main provisions of the fund mobilization guideline includes; (i) collator free and lower interest rate fund than prevailing market rate, (ii) loan beneficiary should conserve at least one local variety of any traditional crop, (iii) loan should be mobilized only in the sector of agriculture based income generative activities and 25% percent of revenue should be invested in agro-biodiversity conservation. Besides that, (iv) women and members from marginal communities receives priority for accessing CBM fund. Till the end of year 2019, CBM fund has been utilized by 37 CSB members and have generated 30,100.0- revenue as an interest. Among beneficiaries, 29 members are female and 8 are male members. Most of the women member accessed loan for goat and pig farming while most of the male

accessed loan for crop production activities. In addition, CSB members established group saving scheme and started saving Rs. 100 per month to increase the fund capital. They are using regular monthly meeting to collect, mobilize and monitor fund uses. CBM fund has greatly motivated CSB members to manage CSB and organize regular meeting with full participation. Hence, CBM fund has been instrumental to bind CSB members and promoting collective actions in Jungu, Dolakha project site. The revenue generated from CBM fund mobilization is being invested on continuous conservation of *Dolakha Pahenlo simi* and *Dolakha Khairo Geeu Simi on-farm in the project site which are being* proposed for registration in the national seed system. The fund is also used to maintain and promote *Ramechhap Hariyo Latte* a registered local landrace from the project in 2018 in addition to conservation and use of several locally endangered and preferred local cultivars of the mountain crop.

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Citation

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20. Incentive Measures for Agrobiodiversity Conservation and Use

Devendra Gauchan, Bal Krishna Joshi, Bharat Bhandari, Niranjan Pudasaini, Rita Gurung, Krishna Ghimire and Krishna Kumar Mishra

A. Introduction

The incentives are recognized recently as the important measures for the conservation and sustainable use of agrobiodiversity. Incentives and incentive measures are well recognized by the Convention of Biological Diversity (CBD), which encourages all Contracting Parties to adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of component of biological diversity (CBD 1992). The Oxford dictionary defines Incentive as "a thing that motivates or encourages someone to do something" or "a payment or concession to stimulate greater output or investment. Incentives influence people's behaviour by making it more desirable for them to conserve, rather than to degrade or deplete, biodiversity in the course of their economic activities (CBD 1992, Thiel 2000, Gauchan et al 2016). Incentives play critical role in the conservation and sustainable use of the agrobiodiversity by farmers, plant breeders and other stakeholders. Both market and non-market-based institutions convey incentives that promote or hinder conservation and use of agrobiodiversity. Incentive measures have long been used by governments to manipulate the ways in which macro and sectoral economies work. The Aichi Biodiversity Target-6 (2011-2020) aims to ending or reforming incentives (disincentives), including subsidies, harmful to agrobiodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and use of agrobiodiversity are developed and applied to generate net socio-economic benefits (CBD 2013). In the changing context of economic liberalisation and globalisation, conservation and sustainable use of agrobiodiversity will depend on the availability of incentives for farmers and plant breeders to continue selecting, maintaining and making availability of these resources (Hawtin and Hodgkin 1997, UNEP 2000, Gauchan et al 2005). There are various economic, non-economic and indirect incentives that influence conservation and sustainable use of agrobiodiversity (Gauchan et al 2016, 2017). This paper presents some of the evidence and good practices of direct and indirect incentives measures developed and applied in Nepal for the conservation and sustainable use of agrobiodiversity in Nepal.

B. Research Methods and Process

GEF UNEP Local Crop Project tested and promoted different practical methods and approaches

to promote incentive measures for the conservation and sustainable use of traditional mountain crop diversity in the project sites (Jumla, Humla, Lamjung and Dolakha). Some of these methods and approaches are newly developed while some of them were piloted based on the experience and information generated and validated in the last two decades from the implementation of various agrobiodiversity conservation related projects in Nepal. These include direct incentives (economic or cash support and non-economic or materials and capacity building support), indirect incentives (sociocultural, market, administrative) and perverse incentives (subsidies and support for exotic modern uniform varieties that have negative effect on the conservation and sustainable use of agrobiodiversity. These incentives measures are presented in diagrammatic forms (**Figure** 1).

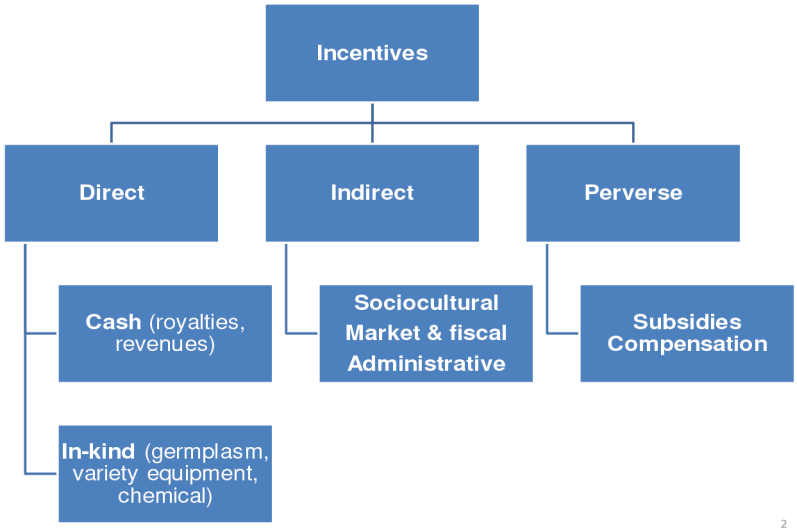

Figure 1. Types of incentive measures for conservation and use of agrobiodiversity.

Source: Gauchan et al 2016

C. Success Cases

Project has developed and piloted some direct and indirect incentives measures to promote conservation and use of traditional mountain crop diversity. The list of direct (economic and non-economic) and indirect incentives are listed in **Table** 1. The project developed incentive measures and provided free access of diverse seed materials, seed storage (bins, bags), and processing equipments (eg finger millet and proso millet threshers) as direct incentives to farmers and communities in project sites including technical knowledge and support in conservation, cultivation, post-harvest handling, value addition, value chain development and marketing including establishment and operation of community seed bank (CSB). The other important direct economic incentive measure support includes the implementation of CBM Fund in the project sites as a collateral free credit access to most poor and needy men and women farmers to cultivate to traditional crop varieties. In the

last 2 years project has supported CBM fund of worth NPR 26, 10,000 (USD 26,000) to the project site community seed banks, in which, 59 (37 women) CSB members are directly benefitted by accessing collateral free CBM fund and promoted regular conservation and use of several traditional mountain crop diversity.

Table 1. Direct and indirect incentives for conservation and use of traditional crop diversity

Direct Incentives		Indirect Incentives
Direct economic incentives	**Direct Non-Economic Incentives**	
Free provision of quality seeds of locally adapted varieties from national Genebank, research centers and other sources	Rewards and recognition to custodian men and women for their role in conservation and promotion of local crop diversity	Facilitate local community seed banks and cooperatives in the development of value chains and market linkages of local products
Free provision of minor millet new electric processing equipment and storage bins for farmers and communities	Capacity building of farmers and community in quality seed production, marketing, business planning and CSB management	Facilitate farmers for improved access to local government funds for seed production, marketing and community seed bank establishment
Collateral free low interest credit to local farmers and community through community biodiversity management (CBM) trust fund	Orientation trainings to farmers, and agroentrepreneurs in value addition, product diversification and marketing	Educational and awareness programs for production and promotion of diverse nutritious local products and native varieties
Price subsidies for Inputs (seed, machinery) for local crops, breeds and landraces	Exposer visits of farmers, community and local leaders in national R&D institutions	Policy, legal and market support for conservation, cultivation and promotion of native crop varieties
Price premium for the seeds and products of local diverse crop landraces	Support of farmers and community leaders in national policy fora, national food and organic fairs	Improved access to quality seeds and planting materials through networks and linkage of the project

The direct non-economic incentive measures supported by the project include provision of capacity building of several men and women farmers and local communities in seed quality maintenance, participatory crop improvement (grass-roots breeding, PVS), community seed bank management, operationalization of diversity field schools and value chain development and marketing traditional crop seeds and products. In addition, the custodian men and women were recognized and awarded to provide incentives to them for further conservation and promotion of traditional crops. A total of 6 custodian women in Humla and 10 custodians (6 women and 4 men) in Jungu Dolakha are rewarded and recognized in the site level project meeting amongst presence of local government and key stakeholders representatives. In

addition, project facilitated logistic support and participation of custodian men and women farmers in the national and regional food fairs, organic fairs, exposer visits and other policy fora and workshops at the national and regional level. As a result, some of them were recognized during national and regional food fairs, organic fairs and diversity fairs by the national and local governments and community-based organizations for their innovative roles in conservation and promotion of traditional mountain crop biodiversity. Women farmers from Ghanapokhara homestay group, Lamjung received national award for their roles in the display and preparation of unique traditional foods from traditional mountain crops in the national food fair held in 2018 and national organic fair held in 2019 both in Kathmandu. Similarly, project supported local entrepreneur from Humla, Mr Mukunda Rokaya also received national award and recognition in these two events in 2018 and 2019 for his role in development, display and marketing of value-added diverse products from traditional mountain crops.

The indirect incentive measures developed and piloted in the project sites include project support for market linkage, value additions and value chain development of local crops in Humla project site through tripartite agreements, providing skills and information for developing modern food recipes. Similarly, project facilitated the operationalization of fair price gift shop (Kosheli ghar) in Jumla for the local crop products leveraging resources from the local government. Educational and awareness programs were implemented in the project sites through Diversity Fairs, Farmers' Diversify Field Schools and linking with local technical and vocational schools (eg Karnali Technical School in Jumla) and colleges for the production and promotion of diverse nutritious local biodiverse products and native varieties. The project is also facilitated in linking local community with national gene bank for the deployment and evaluation of diverse locally adapted crop varieties and mobilizing communities for the establishment of community seedbanks to strengthen local seed security in the remote mountains. The project also created enabling environment by creating platform for the policy dialogue and advocacy for the registration and commercialization of farmers' local crop varieties and support in facilitating policy change resulting in incentives for conservation of agrobiodiversity.

Conclusions

Development, piloting and promotion of incentive measures are critical to encourage farmers and other actors to find innovative and cost-effective options to conserve agrobiodiversity by offering them direct economic, non-economic and indirect incentives. In order to promote conservation and ensure food and nutrition security and livelihood of poor farmers and communities these incentive measures need to be

applied and promoted in the country. In order to minimize negative effect of the perverse incentives created by subsidy and support in modern varieties of major food and cash crops as well as government food subsidy provided to remote mountains, there is a need of both direct and indirect targeted incentive measures for the cultivation and promotion of traditional mountain crops (finger millet, proso millet, foxtail millet, buckwheat, beans, naked barley and amaranth) in Nepal.

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21. Value Chain Development of Traditional Crops for Nutrition Sensitive Agriculture

Devendra Gauchan, Saroj Pant, Rita Gurung, Niranjan Pudasaini, Bharat Bhandari, Bal Krishna Joshi, Krishna Ghimire and Devra Jarvis

A. Introduction

The mountains of Nepal have a high degree of variations in topography, slope, aspect and altitude owing to diverse agro-ecological, socioeconomic and farming system resulted in high biodiversity of traditional crops. Presently it harbours globally important crop biodiversity of traditional crops such as buckwheat, barley (both hulled and hull less), different species of millets (finger millet, proso millet, foxtail millet), amaranth, beans and cold tolerant rice that have unique traits of cold and drought tolerance adapted to harsh risk prone marginal environments (UNEP GEF 2013). The intra-specific diversity of these crops is very high in Nepal mountain as most of these mountain crops are either evolved or located at the centre of diversity in Nepal Himalayan mountains as they are being cultivated by the mountain farmers over millennia in Nepal. These traditional crops currently account for 30-61% of the cultivated area in the many mountainous districts and to the extent of up to 61% of the cropped area in a high mountainous district of Humla (MoAD 2016). Hence, they are locally available, well adapted in the mountain agroecosystem and are critical for food and nutrition of marginalized communities in the harsh risk prone Himalayan region of Nepal mountains in the face of changing climate. Smallholder farmers are growing these food crops organically over generation using integrated mixed farming systems which have great potentials for improving national food and nutrition security (Gauchan et al 2018).

Evidence shows that these traditional mountain crops are highly nutrient dense containing rich micronutrients, dietary fibers, rare amino acids, vitamins, and account for higher protein, calcium and iron as compared to major food staples such as rice, and wheat (DFTQC 2012). Most of them are gluten free and considered “crops for the future” or “future smart foods” under changing climate and market needs (Li and Siddique 2018). In Nepal, the GEF UNEP project has named them as Himalayan Superfoods (www.himalayancrops.org). Therefore, these crops provide globally important gene pools for addressing chronic malnutrition and undernutrition in most impoverished areas of high mountain regions in the world (Gauchan 2019). However, presently the biodiversity of these traditional mountain crops is not adequately exploited by developing markets and value chains for promoting nutrition sensitive agriculture.

B. Objectives

- Highlight the important role of traditional crops in biodiversity-based value chain development for nutrition sensitive agriculture
- Present value chain mapping and analysis of traditional underutilized crops
- Assess the role of traditional mountain crop diversity in nutrition sensitive agriculture for mountain food and nutrition security

C. Research Methods and Process

This study applies methods combining value chains of biodiversity and nutrition sensitive agriculture of traditional crops from four representative high-altitude locations of Humla, Jumla, Lamjung and Dolakha districts. The research employs combination of qualitative and quantitative methods using field surveys for mapping the value chain components, key actors, constraints and suggested potential interventions in the chain. The information is supplemented with available data generated from baseline survey, participatory rural appraisals, field visits, consultation meetings and monitoring of value chain developments based on experiences of UNEP GEF project implemented by Bioversity International in partnership with NARC, Department of Agriculture and LI-BIRD, Nepal from 2014 to 2019.

Biodiversity based Value chains for Nutrition Sensitive Agriculture

Value chain development of traditional food crops can play important role by taking into consideration not only how diverse foods are produced but also how they are processed, distributed, marketed and consumed, a process that is usually referred to as **'value chain'** (FAO 2017, Gelia et al 2015). Agrobiodiversity-based value chain focuses on the use of the crop biodiversity to improve interlinkages and efficiency in each of the value chain component to promote nutrition value in an interactive way (Gauchan et al 2019). There are different potential pathways suggesting ways in which value chain interventions can contribute to enhanced nutrition among the poor by adequate use and management of agrobiodiversity. One pathway is by enhancing access to, and consumption of diverse foods that are naturally rich in micronutrients, such that overall dietary diversity increases (Maestre et al 2017). The second route through which increases in the supply and consumption of diverse nutrient-dense foods can be achieved, is in the production and distribution of diverse foods with increased nutritional value (Chen et al 2013). Traditional nutrient dense food crops such as millets, barley, buckwheat, beans, amaranths etc fall on this group that are biodiverse and rich in micro nutrients, dietary fibers and proteins (DFTQC 20112, Gauchan et al 2019).

Value chain development of traditional diverse nutrient dense food crops can directly improve the livelihoods and nutrition security of poor farmers in marginal mountainous regions by increasing yields, managing marginal lands, decreasing losses during processing, adding value, improving market linkages and promoting consumption of diverse nutrient

rich foods among the households. Adopting a biodiversity-based value chain approach allows for analyzing the roles and incentives of different actors along the chain, and to consider type of policy and regulatory framework that may be conducive for value chain to contribute to dietary diversity and quality for enhanced nutrition including addressing cross cutting issues such as gender and climate change. Therefore, agrobiodiversity-based value chain aims to ensure household food and nutrition security by strengthening and linking four components of value chains that include diversity in production, processing, marketing and consumption (**Figure** 1).

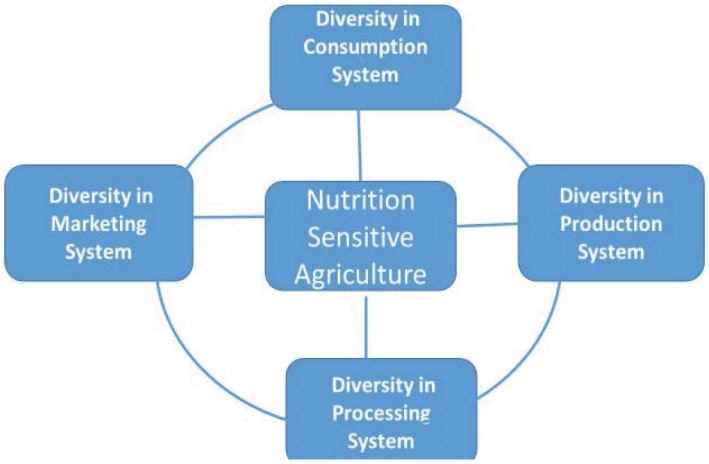

Figure 1. Components of Agrobiodiversity based Value Chains for Nutrition Sensitive Agriculture.

Mapping of Value Chain Actors, Constraints and Suggested Potential Interventions

The assessment of value chain mapping showed the four sub-components with different actors and specific constraints in each of the value chain sub-components (**Table** 1). These constituted production, processing, marketing and consumption systems with specific constraints and interventions needed in each of the chain. However, presently value chains of biodiversity of traditional crops are weak, fragmented and not properly connected among sub-components of production, processing, marketing and consumption system. The flow of knowledge, products and information and interaction among chain actors from production to consumption was low and weak resulting in low productivity, in efficiency in the supply chains and low use among consumers despite their high nutrition value for local, national and global food security (Gauchan et al 2019). Traditional crops also suffer from social stigma of “food for poor and marginalized communities” (Padulosi et al 2014) hindering consumption of diverse available and affordable wholesome nutritious diets from these crops in both rural and urban areas. The performance of each stage of the chain was being influenced by interlinkages between chains and support from external agencies including prevailing policy environment.

The major constraints in “production system” include lack of adequate choices of adapted improved varieties and quality seeds. In “processing system", it was lack of women and youth friendly processing technologies. Absence of awareness of the value and poor market development are key constraints in “marketing system”. Use of low dietary diversity and poor use and awareness of nutrient dense traditional crop diversity in consumption system was key constraint in the consumption. In addition, lack of enabling environment for investment in research, educational institutions and weak seed regulatory framework are also constraining the promotion of production, marketing and consumption of nutrient dense crops.

Table 1. Mapping of value chain components, constraints, actors and interventions

Value chain components	Constraints	Actors	Potential Interventions needed for NSA
Production system	Poor seed quality, low availability and poor crop management with low productivity	Individual farmers, Farmers groups; Cooperatives, Community seedbank	Seed diversity and quality, their availability and adaptability for cultivation and cropping
Processing system	Traditional laborious manual processing, women drudgery; poor or no value addition, diversification	Procurers, processors, entrepreneurs	Improved but simplified and diversified processing techniques suited to diverse species, varieties for threshing and value addition
Marketing system:	Small-scale informal trading, limited market linkage, absence of product standardization, labelling, and branding	Cooperatives, agroentrepreneurs; Whole sellers, retailers, traders	Market linkages with diverse species and cultivars and market promotion through diverse methods
Consumption system:	Use of low dietary diversity, poor awareness of nutrition value of traditional crops, absence of technology for food preparation and use.	Consumers in both rural and urban areas including hotels; homestays, hospitals, Schools' cafeteria	Diversity in the diets through the use of nutrient rich diverse species and varieties, recipe formulation, food preparation and nutrition

NSA, Nutrition sensitive agriculture.

Upgrading Value Chain Components

Considering a poorly developed value chain of traditional food crops and the specific constraints and potentials for improvement, interventions are designed to upgrade value chains for these crops. The interventions for nutrition sensitive agriculture suggest better management of crop biodiversity for improved efficiency, interlinkages and improvement

to promote nutrition value in each of the subcomponent in an interactive way with adequate support from enabling policy environment. The production system is focused with the use and promotion of diverse species and cultivars of traditional nutrient dense crops in farms and landscapes. The processing system involves development of simplified and diversified processing methods that process diverse traditional nutrient dense crops into diverse forms and products as per the flow of products in the production and marketing systems. Diversity in market is also important to promote products of diversified traditional nutrient dense cop species and cultivars to match the food demand and supply (Gauchan 2019). This requires promoting demand for dietary diversity in the consumption system and promoting food culture of traditional nutrient dense foods in both rural and urban areas. Therefore, the focus of diversity-based value chain development needs especial efforts in establishing channels for diverse product procurement, proper processing, transport, and storage and exposing crops to wider markets and consumers to support nutrition sensitive agriculture. Enabling policy environment to improve interlinkages and service provisions that promote and strengthen performance is required to enhance positive and speedy flow of nutrition and health value among different value chain subcomponents.

D. Advantages and Disadvantages

Advantages

- It is useful to identify pathways and opportunities to promote value of traditional crop biodiversity for value chain development and nutrition sensitive agricultural
- The methodology provides concepts and methodological tools to promote nutrition sensitive agriculture from locally available traditional food crops
- It highlights evidence of specific constraints and interventions of promoting nutrition value in each of the value chain subcomponent

Disadvantages

- Methodological approach for agrobiodiversity-based value chain development is complicated due to lack of adequate scientific research and information on the use of unique crop diversity and nutrition value
- Pathways of biodiversity-based value chains to nutrition is not always direct due to presence of diverse pathways and processes

E. Success Cases

GEF UNEP Project designed upgrading strategies and interventions for appropriate program development linking with relevant institutions and stakeholders. The major success cases are establishment and operationalization of community seed banks, participatory variety selection and strengthening local seed networks for improving seed system. Diversity based farmers' field schools (DFSs) are operationalization and strengthened to improve production,

processing and marketing system. Similarly, processing machines for proso millet are designed and piloted, whilst processing machines for finger millet are piloted and promoted to improve processing system and reduce drudgery of women. Marketing system was developed to promote market linkages with value addition, product diversification and food recipe formulation through tripartite contract agreement among producers, project office and entrepreneurs (Gauchan et al 2019). The consumption system is improved with increased diversity in the diets from traditional nutrient-rich crops employing several tools and good practices such as supporting local food entrepreneurs, bakeries, homestays and promoting seed and food fairs, organic fairs and linking with agro-ecotourism. Policy support to facilitate registration and release of traditional crop varieties including support to other seed regulatory frameworks and market and value chain development are identified important steps for promotion and mainstreaming of nutrition sensitive agriculture.

Conclusions and Implications

The process of biodiversity-based value chain analysis and interventions has provided ground base for developing and strengthening value chain of traditional crops for promoting nutrition sensitive agriculture in chronically mal-nourished high mountain region. The value chain has upgraded with better flow of diverse quality seeds, information, diversity rich solutions and products with improved interlinkages and efficiency in the sub-components by adding value, improving market linkages and promoting consumption of nutrient-rich foods. Promoting interlinkages among chain sub-components and strengthening the capacity of actors in the value chains are the important aspects in the process. Special focus is to be given in biodiversity-based value chains with focus on both the supply and demand side and their interface in value chain interventions. The promotion of healthy organic food market chains (retail chains, urban food fairs, homestays and hotels) linking with rich biodiversity of traditional crops is critical to develop the niche value chain of traditional underutilized crops for nutrition sensitive agriculture.

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22. Community-based Mechanisms for Promoting Access and Benefit Sharing

Devendra Gauchan, Bal Krishna Joshi, Bharat Bhandari, Deepa Singh Shrestha, Santosh Shrestha and Devra Jarvis

A. Introduction

Small farmers in Nepal have made unique, evolutionary and historical contributions to the conservation and development of genetic resources for food and agriculture. Over generations, farmers have selected, domesticated and nurtured crop varieties and their wild relatives by retaining seeds, recycling them for the next planting seasons and exchanging them with their neighbours and local communities to meet various household, social, economic and cultural needs (Gauchan 2011). About 97% of the seed requirements for traditional crops in the mountain region are met through this type of informal or farmers' own seed system (Gurung et al 2018). For major cereal, evidence shows that only 16% of total seed requirement (seed replacement rate) at the national level is met through formal institutionalized production and distribution of seeds (Thapa and Team 2019). This indicates that about 84% of the seed requirement of the major crops and over 90% of the minor traditional crops in Nepal is met through farmers own seed system that promotes informal sharing, exchanges with local communities and local markets.

In the last 2 decades, Nepal has piloted and promoted some of the good practices for community biodiversity management (CBM) approaches to promote access and exchange of seeds and planting materials as well as facilitate benefit sharing to ensure food and nutrition security of households in Nepal. The CBM approaches include diverse community-based participatory approaches ranging from community-based diversity fairs, food fairs, diversity field schools, diversity blocks and diversity kits to community seed bank (CSB), community biodiversity management (CBM) trust fund, participatory seed exchange, participatory plant breeding, participatory seed networks, value addition and marketing (Sthapit et al 2006, Subedit et al 2013, Gauchan et al 2018). However, due to the prevailing focus of centralized homogenized production systems and limited priority given in the local and diverse farmers' seed systems, information and status of community-based mechanisms of access, exchange and sharing benefits arising from local genetic resources are limited.

B. Objectives

- Highlight current initiatives and efforts of community-based approaches for promoting access, exchange and sharing benefits arising from the use of local genetic resources

- Assess role of diverse community biodiversity management (CBM) tools to enhance access and promote benefit sharing among rural households
- Present community seed bank (CSB) as a potential legitimate local level institution for enhancing local level access and promote benefit sharing

C. Methodology

The study used a combination of literature review, key informant interviews and focus group discussion (FGD) with communities and custodian farmers in the UNEP GEF Local Crop project sites Dolakha, Humla, Jumla, and Lamjung. In addition, interaction meetings were carried out by organizing focused consultation meetings and workshops in the last four years with key stakeholders in the project sites and at the national level. The key stakeholders involved are R&D professionals, private seed entrepreneurs, Community Seed Bank Association, Nepal (CSBAN) and CSB leaders from four mountain project sites including from Bara, Nawalparasi and Dalchowki, Lalitpur. Using specific checklists, the information for this study was generated, compiled and synthesized. The concepts, rationale and feasibility of employing CSB as an institution to formalize ABS were also discussed and presented during the 2nd National Community Seed Bank Workshop held in 4-6 May 208 in Kathmandu including in the project review and planning meetings. From these meetings and workshops useful feed backs are collected, validated and incorporated for this paper.

Community-based Approaches for Access and Benefit Sharing

Nepal has piloted and promoted several community-based approaches for agricultural and rural development activities since early 1970s. However, the good practices for community biodiversity management (CBM) approaches to promote access and benefit sharing (ABS) of agrobiodiversity started only after implementation of global in-situ agrobiodiversity conservation project on-farm from 1997 (Sthapit et al 2006, Sthapit and Gauchan 2008). CBM is a community-based approach that is vital for the management and use of both agricultural and natural biodiversity with the participation of local communities. During the implementation of in-situ agrobiodiversity project (1997-2005), several participatory community-based tools are developed and piloted. These include community biodiversity register, diversity fairs, diversity blocks, diversity kits, community seed banks, CBM trust fund, participatory plant breeding, participatory policy analysis, value addition and marketing (Gauchan et al 2003, Sthapit et al 2006, Subedi et al 2013). These tools are further refined, validated and promoted in the recently implemented UNEF GEF Local Crop Project (LCP) from 2014-2019. In addition, the project developed a new CBM tool like Diversity Field School (DFS) and piloted Food Fair in enhancing access, managing traditional crop biodiversity and promoting benefit sharing arising from the use of local crop genetic resources in Nepal. During the last 5 years, Local Crop Project has been able to deploy more than 300 different cultivars of eight underutilized traditional mountain crops to farming communities in the

project sites and the beyond to enhance access of diverse, rare and unique genetic resources to adapt to changing climate and ensure food and nutrition security of the people (Gauchan et al 2019). Diversity fairs, diversity blocks, diversity kits, diversity field schools, community seed banks, CBM trust fund and participatory grass root plant breeding, participatory seed exchange and participatory value addition and market development are key community-based approaches to enhance access and promote benefit sharing. Development of farmers' variety catalogue covering unique functional traits of the traditional mountain crops and sharing them with the project site communities and stakeholders widely has helped to document farmers' traditional knowledge and enhanced access of unique information of local farmers' varieties for their wide use in production and marketing. Participation of small farmers particularly women in on-farm germplasm evaluation and seed production of local crop varieties has increased their awareness of the value of their local crop cultivars and improved their capacity to identify and recognise specific crop varieties, a more focussed approach of ABS. More exhaustive distribution of Diversity Kits to large number of farmers (eg amaranth) has helped supporting local exchanges and wider sharing of genetic resources with communities. Organization of diversity fairs and participatory seed exchanges (PSEs) in the communities in project sites have facilitated greater access and exchange of genetic resources within and between communities and stakeholders. Participation of farmers and community seed bank leaders in the national, regional and local food fairs, exhibition and exposer visits have further strengthened access and exchange of genetic resources.

Community Seed Banks as a Collective Institution for ABS Mechanisms

Community seed banks (CSBs) are emerging as important community-based collective institutions for local level access and exchange of genetic resources, strengthening local seed system, realizing farmers' rights and safeguarding agrobiodiversity. They are also gradually emerging as a local grass-roots institution for crop improvement, variety maintenance and registration of local varieties for increased benefit sharing with farmers and local communities (Gauchan et al 2018). A well-functioning CSB adopts community biodiversity management (CBM) approaches and tools, such as community biodiversity register, diversity field school, diversity fair, community biodiversity management fund, participatory plant breeding, value addition and marketing to promote local access, exchange, use and conserve crop genetic resources using customary rules and practices (**Figure** 1).

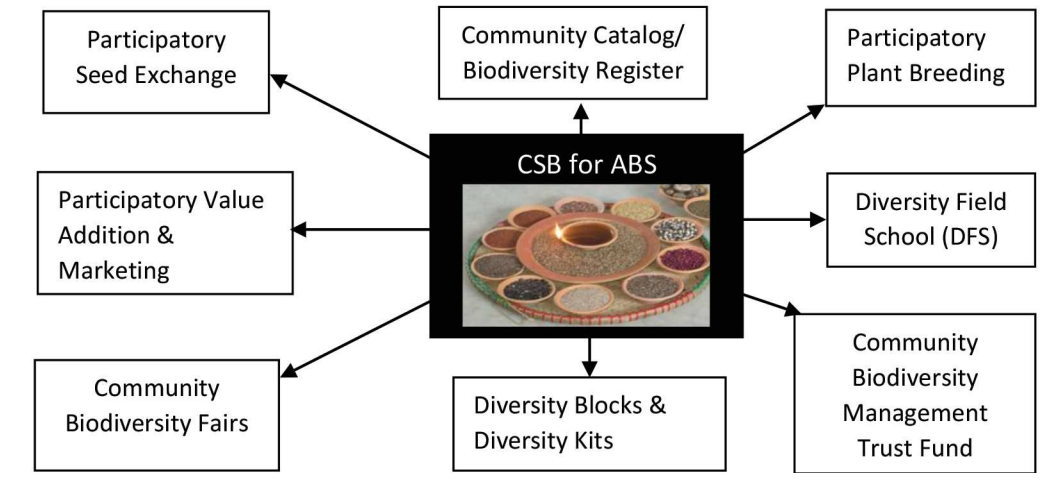

Figure 1. SMechanisms that realize farmer's rights and local level ABS in Nepal.

Considering this situation, we propose a model for developing a community seed bank as a legitimate institution (platform) for Prior-Informed Consent (PIC) and ABS mechanisms and formalizing farmers' rights to genetic resources. According to De Jonge et al (2016), community seed banks can be seen as a collective framework and institutional platform for making decisions about crop cultivation, seed production and conservation of locally adaptive germplasm. As such, they are effective mechanisms to implement farmers' rights and access and benefit sharing. This will, however, require creating incentive mechanisms for custodian farmers and communities and bringing support from formal sector agencies through relevant policies, legislation and programs to promote and sustain community seed banks.

D. Advantages and Disadvantages

Advantages

- Nepal has provided ground base for development and piloting of several community based tools and approaches that promotes ABS mechanism
- CBM tools are important community-based approaches to promote access and benefit sharing as it empowers local communities and support their livelihoods
- It provides mechanism for strengthening local seed system and conservation of agrobiodiversity
- Community seed bank can be legitimate institution for promoting access, exchange and use of genetic resources as it adopts all the CBM tools and perform the function of community biodiversity management.

Disadvantages

- Mainstreaming community-based approaches require changes in the current top-

down mindsets and approaches
- Present policies and programs are not very much supporting for practical implementation of community-based approaches
- Needs to strengthen and legalize community seed banks as an institution for local level ABS and Farmers Rights

E. Success Cases

In the last 5 years UNEP GEF Local Crop Project has implemented and piloted several community-based approaches mainly community biodiversity management (CBM) tools to promote ABS mechanisms, empower local communities and support livelihoods of marginalized mountain communities in the high mountains of Nepal. It has sourced and deployed more than 300 cultivars of 8 underutilized crops to enhance access of rare and unique local crop genetic resources for improving food and nutrition security and supporting livelihoods. About 98 locally adapted and superior varieties have been identified as locally superior and adaptable and their seeds are multiplied and disseminated widely beyond the project sites. Diversity kits of these traditional crop genetic resources are deployed to over 15,000 households. In addition to diversity kits, project also facilitated access to seeds to additional 5000 households with other activities through engagement in seed production, participation in on-farm trials, participatory seed exchange and diversity fairs linking with collaborative projects such as Global Crop Diversity Trust (GCDT) Seed Rescue in earthquake affected areas and SDC seed system. Over 50 local and national trainings, workshops, meetings and exposer visits were organized and facilitated to empower local communities and national stakeholders for creating enabling environment for the promotion of ABS of local crop genetic resources over the last five years. The project is providing benefits to local community linking with national gene bank for the sourcing, deployment and evaluation of diverse locally adapted crop varieties and mobilizing communities for the establishment of community seedbanks to strengthen local seed security in the remote mountains (Gauchan et al 2017). Farmers and local communities are also benefited from increased product diversification, value addition and value chain development of local diverse crops from the project facilitation and technical support (Gauchan et al 2019).

The project also facilitated development and signing of Prior-Informed Consent (PIC) Agreement of the Jungu Community Seed Bank with Anamole private Seed Company for the promotion of two traditional varieties of local common Beans (Khairo and Panhelo Simi). This will ensure ownership rights of local communities for these local common bean varieties that are conserved and improved by the local community of Jungu Dolakha. Once the variety is registered, another agreement is planned with the Anamole Seed Company for sharing benefit arising out from the commercialization of local bean genetic resources. In this process, some notable local and national level training workshops and exposer visits were

carried out in the last five years to build the capacity of farmers and local communities to ensure their rights to genetic resources and promote benefit sharing, Some of these include engagement of custodian farmers and community leaders at the national level policy workshops, review of seed and agrobiodiversity draft legislation and proposal development and registration of farmers local varieties and seed business planning, leadership and governance training. In addition, project has developed some incentives mechanisms to recognize and reward custodian of agrobiodiversity in the project sites and advocate national and local level to integrate and mainstream community-based agrobiodiversity conservation tools, methods and approaches.

Conclusions and Implications

Nepal has developed and piloted several community biodiversity management approaches and good practices for promoting access and benefit sharing of crop genetic resources. From the experience, it is concluded that community seed banks can be an important platform for promoting local level ABS mechanisms, as it is emerging as an important collective institution at the local level in Nepal for conservation and use of agrobiodiversity, strengthening local seed system and supporting livelihoods of small farmers. Community seed banks has been observed as platform for enhancing both informal and formal access and benefit sharing through strengthening farmers' seed system and promoting its linkages with formal sector agencies. They also promote farmers rights by ensuring protection of local genetic resources and traditional knowledge and providing mechanisms for ABS through saving, exchanging, sharing and using farm-saved seeds and promoting prior informed consent (Gauchan et al 2018). In addition, they can be used for enhancement of farmers' varieties, their registration, certification and marketing of quality seeds by strengthening their organizational capacities for promoting commercialization and wider sharing of benefits.

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