NGB-44/023

Evolutionary Plant Breeding in Nepal: Training Guides and Protocol

Presentations of key persons during project period (2019-2022)

Compiled by
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National Genebank, National Agriculture Genetic Resources Center

Local Initiatives for Biodiversity, Research and Development

Alliance of Bioversity International and CIAT

International Fund for Agricultural Development

Kathmandu, Nepal
March 2023

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March 2023

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Acknowledgements

With the support from IFAD and Alliance of Bioversity International and CIAT, NARC and LI-BIRD have implemented the project, Use of Genetic Diversity and Evolutionary Plant Breeding for enhanced resilience to climate change, sustainable crop productivity, and nutrition under rainfed conditions (EPB project) from 2018-2022 in Jumla and Lamjung districts. This document is the compilation of different trainings and workshop presentations, research protocol and research paper. Major target of this document is to make access to interested people on different activities and presentations, approaches and protocol. It is expected that this manual will be useful for understanding EPB, conducting EPB trials for agriculturists, researchers, plant breeders, students and farmers. Farmers and community leaders who have involved in generating, testing, and practicing these tools and methodologies are highly acknowledged. We highly appreciate the contributions of all project staff, seniors of NARC, LI-BIRD, MoALD and DoA, breeders and others. Financial support provided by IFAD via the Alliance of Bioversity International and CIAT is greatly appreciated.

EPB Project

The project entitled, Use of Genetic Diversity and Evolutionary Plant Breeding for enhanced resilience to climate change, sustainable crop productivity, and nutrition under rainfed conditions (EPB project) has been approved by IFAD in 2017 for financial report and Bioversity International was the main executing agency and responsible for reporting to IFAD. This project has been implemented in six countries, namely Uganda, Ethiopia, Iran, Jordan, Nepal and Bhutan.

Goal, objectives and expected outcomes: The goal of the project was to sustainably increase crop productivity and enhance the resilience to climate change of farming communities under low-input, rainfed and less favoured production conditions and organic production systems. The specific objective was: The resilience of target low-input poor farmers in the project area is enhanced through developing EP populations with higher and stable yields under the local farm agronomic and stress conditions, including drought, salinity, pest and diseases. The expected outcomes of the project are: 1) The use and management by farmers of a wide range of genetic resources from genebanks has resulted in enhanced crop performance and adaptation in at least five different cropping systems and agro-ecological settings; 2) 5000 farmers are trained and are practicing EPB for their major food and feed crops; 3) Cost benefit analysis comparative studies on EPB vs conventional breeding and analysis of production costs of EPs are undertaken for the target crops and areas; and 4) Reviews of national policy and legislation for varietal registration and seed systems completed, and based on field evidence, relevant suggestions for policy dialogue provided to enhance the national potential for scaling up of EPB approach.

Key activities by component

Component A: Participatory assessment of the role of plant genetic resources in the resilience of smallholders to CC

1. Development of the participatory toolkit adapted for the rapid farmers' assessment of their livelihoods, income level and sources, status of local genetic resources and use, seed sources and quality, cropping patterns and farming systems, livelihood vulnerability, adaptation and coping strategies facing CC
2. Undertake participatory assessments of targeted farmers and farming communities to understand present livelihood situation, coping strategies and resilience to climate change, especially in relation to plant genetic resources
3. Use of the participatory toolkit as a monitoring tool of the grant to evaluate the increase in the intra- and intercrop biodiversity in the community and the resilience of targeted farmers and their income level through the grant

Component B: Establishment of evolutionary populations (EPs) in farmers' fields

1. For each selected target crop and participating country, identify the farming communities to be involved in project activities based on the targeting strategy to be described in the project proposal (targeting poor farmers)
2. Through close collaboration between breeders and researchers, obtain the needed germplasm from the genebanks, and prepare the selected mixtures to be provided to farmers for the establishment of the EPs
3. Train national researchers, breeders and extension agents and relevant stakeholders on the principles of EPB and means of monitoring the adoption of EPs and their dissemination among farmer communities
4. Train farmers on the management of EPs in their fields (selection, mixtures, evaluation, in-situ genebanks, etc)
5. Evaluate EPs for their yields, their nutritional quality and their value in organic farming
6. Support in the promotion of products from the EPs in agrofood processing enterprises
7. Develop knowledge management products and stories from the field with emphasis on South-South cooperation

Component C: Economic and cost-benefit analysis of using the evolutionary plant populations

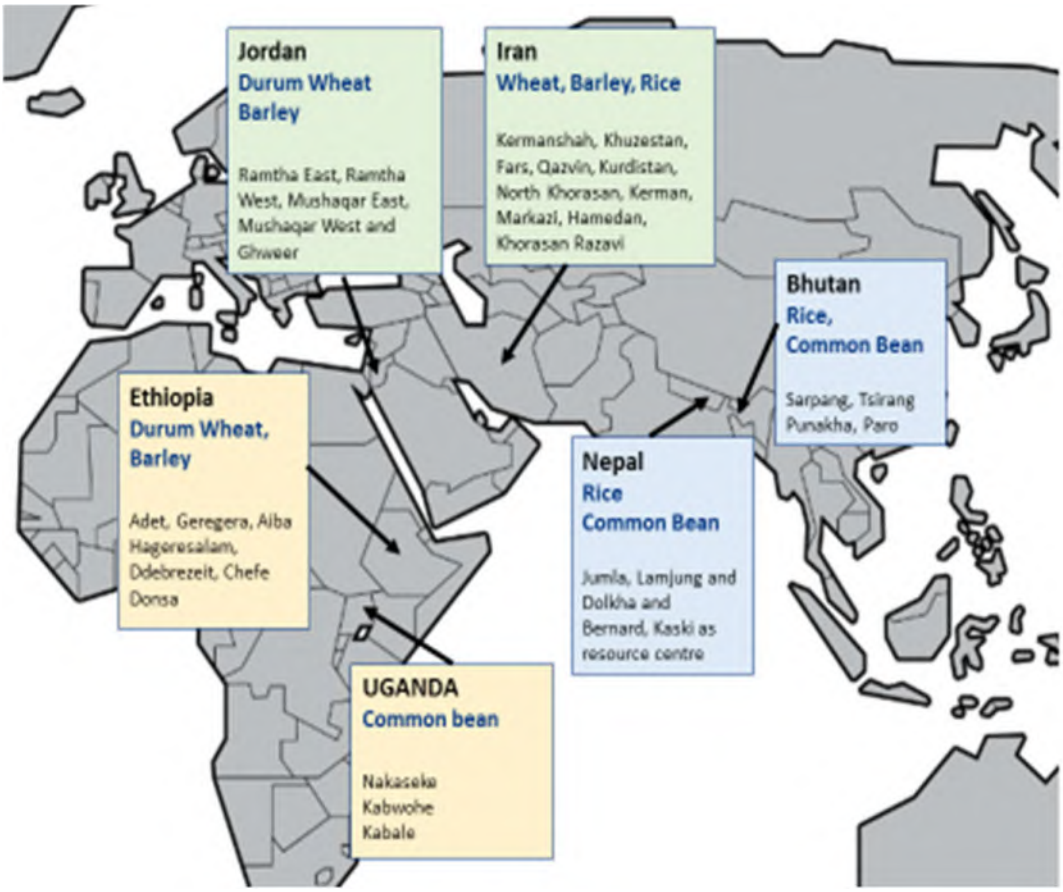
1. Undertake a cost-benefit analysis at the farm level comparing the use of recommended improved varieties, landraces, and evolutionary plant populations in terms of yield, input costs including use of seeds, agrochemicals, and labour, selling prices, etc as well as their nutritional, health and environmental benefits
2. Undertake a comparative cost-benefit analysis and SWOT analysis of national systems for conventional breeding, participatory plant breeding and EPB and for the related seed production and marketing systems for each of the selected crops and the targeted smallholder farmers in rainfed or marginal areas

Component D: Enhancing the policy and regulatory frameworks for use of plant genetic resources for food and agriculture (PGRFA) in the beneficiary countries

1. Based on the evidence from the field and review of national policy and legislation for varietal registration, seed multiplication and trade, and the use of genetic resources, and learning from experience in Europe, suggest areas for policy engagement, if deemed needed, to enhance the relevant regulatory framework of beneficiary countries, in favour of use of increased biodiversity and EPB use in low input and vulnerable marginal farming areas.

In Nepal, National Genebank, LI-BIRD and Bioversity International have jointly executed this EPB project from 2018-2022 in Jumla and Lamjung districts. Target crops were rice in Lamjung and Jumla and bean in Jumla. The project has been conducted in the UNEP/GEF project sites for leveraging the partnership and building upon previous work on the ground. NARC is providing an institutional framework to implement the project activities in collaboration with LI-BIRD by provisioning genetic resources conserved in the National Genebank, establishing evolutionary populations of selected crops in farmers' fields, evaluating evolutionary populations for their yield and yield stability, their nutritional quality and their value in organic farming and capacity building of the methodology to the national breeders. The overall goal of the project is to sustainably increase crop productivity and enhance the resilience to climate change of farming communities under low-input, rainfed and less favoured production conditions and organic production systems. And the specific objective of the project is the resilience of target low-input poor farmers in the project area is enhanced through developing evolutionary populations (EP) with higher and stable yields under the local farm agronomic and stress conditions, including drought, salinity, pest and diseases.

The major targeted groups of this project are local, indigenous and minority ethnic communities. The farmers of Nepal will be benefited directly from the deployment of genetic diversity where it reduces their vulnerability to production and income losses, and to the negative effects on their health of unsafe use of pesticides. The total cost of the project for Nepal is (NARC/LI-BIRD) US$ 200,000. The first LoA with the total cost of US$ 31,683.70 has been taken placed and first installment of the project US$ 12,673.48 has been received by NARC.



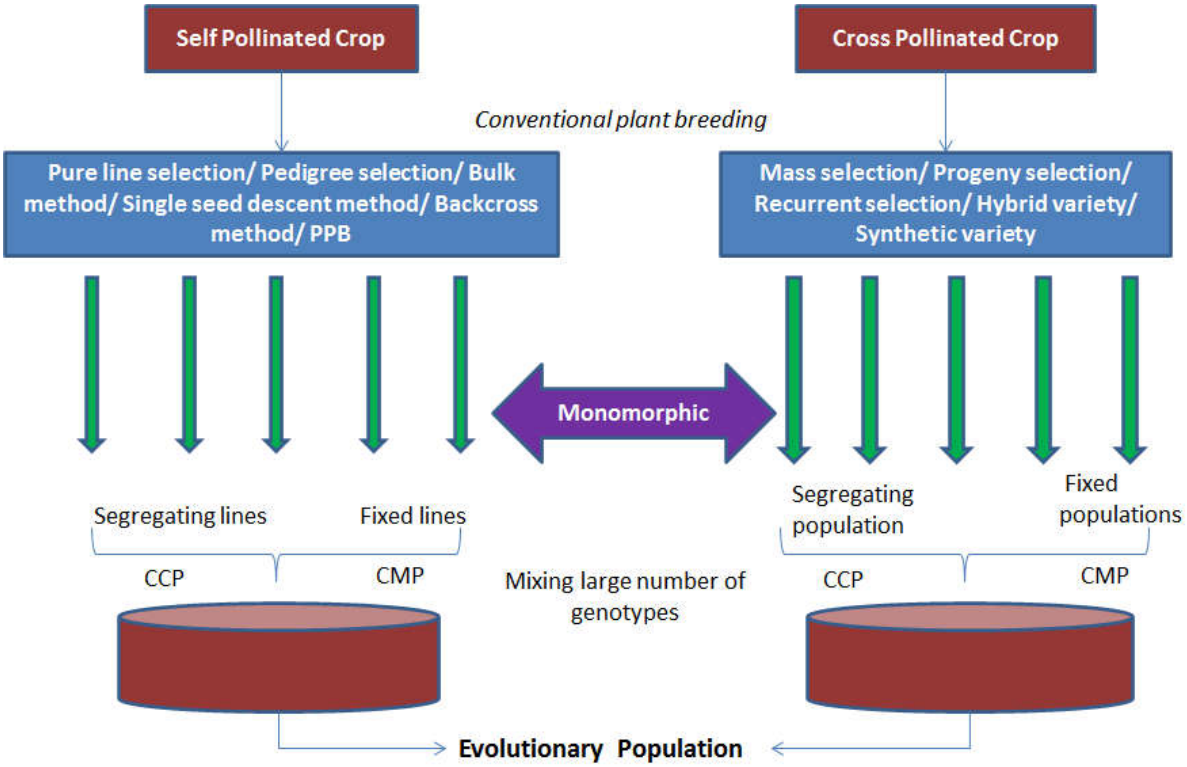
Introduction

Evolutionary Plant Breeding (EPB) is a practice that allows consideration of an even wider genetic base, which favors increasing the rate of evolution of the crop population, promoting use and conservation of crop diversity and developing dynamic population to cope with change. Evolutionary Populations (EP) of crops can adapt to climate change and heterogeneous agro-ecological environments, increasing farmers' resilience and enhancing on farm biodiversity (Petitti et al., 2018). EPB create and maintain high degree polymorpho typic populations for accelerating development of climate resilient and sustainably high-performance varieties (Ceccarelli, 2009). Evolutionary populations (EPs) of maize, barley, bread wheat, durum wheat, common bean, tomato and summer squash are currently grown in Jordan, Ethiopia, Iran, and Italy (Ceccarelli, 2017). EPB can also be applied where there is a lack of crop breeding programs, specifically in addressing the needs of organic low input agriculture, high stress environments, and limited access to institutional support.

In 2008, EPB was first implemented in barley and wheat in a formal project supported by the International Fund for Agricultural Development (IFAD) in Iran (Rahmanian et al., 2014). In 2015, the National Gene bank of Nepal started an EPB program in Jumli Marshi rice with the aim of enhancing conservation through creating a dynamic gene pool. EPB maintains and creates a high

level of genetic diversity in crop populations by planting a much larger mixture of different varieties, relying mainly on natural selection, and does not necessarily aim to arrive at single variety. When EPB involves active participation of farmers on farm with limited influence by plant breeder throughout the breeding process, it becomes decentralized-participatory EPB. All the alleles in a population are under natural selection and evolve naturally depending on their association with fitness (Döring et al., 2011). Those individuals within a population, which increase their frequencies in the subsequent generations under the pressure of natural selection, are generally considered naturally fit. In addition to its effectiveness in coping with the changes in both biotic and abiotic stresses due to climate changes, it manages agricultural biodiversity through use, conservation and maintenance of dynamic plant populations, continued evolution and natural selection (Rahmanina et al., 2014; Raggi et al., 2017; Phillips & Wolfe, 2005; Ceccarelli, 2017).

EPB is a simple and inexpensive method for developing broad genetic base population or variety (may be called composite or pool variety). Mixing diverse genotypes (10, 20, 100 or 1000 or even more) and growing together in a larger plot is the main method of EPB followed globally (Raggi et al, 2017; Ceccarelli, 2009; Suneson, 1956). Components of population may be landraces, improved varieties, hybrids, segregating lines, breeding lines, wild relatives etc. EPB is equally applicable to self-pollinated, cross-pollinated and vegetative propagated crops. As presented in figure below, the general method of EPB includes stable lines or segregating lines developed through conventional or modern plant breeding methods which can be bulked without selection, or selected individual plants (lines) can be mixed at the end. A heterozygotes and heterogeneous population, or “variety” is the product of EPB, and the variety is released for general cultivation at the end of breeding program. Farmers can continue growing the evolutionary population variety over the years by keeping mix seeds from their own field without purchasing seeds from market. This can help to overcome the monopoly of market seeds, giving small holder farmers additional options to improved single variety and hybrids. Detail steps of EPB are described below.



Methodological description of EPB following conventional plant breeding methods, CCP, composite cross population; CMP, composite mixture population

Presentations

BY BK Joshi

Concept of Evolutionary Plant Breeding (EPB) and Strategies for Mainstreaming EPs

Ma1

BK Joshi | EPB.Genebank | 2022

Knowledge sharing and policy interaction workshop on Evolutionary plant breeding
National Genebank, Khumaltar, Lalitpur; 28 Baishakh, 2079 (11th May, 2022)

For National Agrobiodiversity Year 2079

Concept of Evolutionary Plant Breeding (EPB) and Strategies for Mainstreaming EPs

Use of Genetic Diversity and Evolutionary Plant Breeding for Enhanced Farmer Resilience to Climate Change, Sustainable Crop Productivity and Nutrition under Rainfed Conditions

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BK Joshi | EPB.Genebank | 2022

Crops phenomenon in Nepal

- Released and registered a total of 723 uniform (mono genotyped) varieties; >70% of them are introduced & 45% introduced hybrids only
- 53% households are smallholders with less than 0.5 ha land holding
- Informal seed system: 80-100%
- Dependency higher for imported foods and germplasm
- Barren land increasing with outmigration

Joshi et al 2020

Varieties in Farming land, Market and Breeding Station

- Landraces
- OPV
- Pure line/ Inbred
- Bulk/ Composite generations
- First, Second, Third… Generations (Partial Hybrid)
- …

- Mutants
- Multiline
- Synthetic generation
- Polyploidy
- **Engineered generation (GMO)**
- **F1 hybrid**
- **…**

Evolutionary population in research station but static population in farm land

BK Joshi | EPB.Genebank | 2022

Branches of Plant Breeding: So many areas within a subject

- Evolutionary breeding
- Analytical breeding
- Molecular breeding
- Crop breeding
- Crop improvement
- Heterosis breeding
- Resistance breeding
- Mutation breeding
- Polyploidy breeding
- Inbreeding
- Shuttle breeding
- Participator plant breeding (PPB)
- Landrace enhancement and conservation (LEC)
- Combination breeding
- Conventional breeding
- Classical breeding
- Backcross breeding
- Introgressive breeding
- Population breeding
- Transgressive breeding
- Quality breeding
- Stress resistance breeding
- Multiline breeding
- Maintenance breeding
- Space breeding
- Genetic engineering

बिदेशी, एक रुपिय जात वाट परेको समस्य

गरिमा धान
९ वटा जिल्लाको १५३३ हे.
धान मा बाला नलागेको

Environmental shock?

बन्नी हाइब्रिड मकै
२५० हे मा दाना
नलागेको

Working Principles

- On-farm conservation (of AGRs) through use
- **Agrobiodiversity formula**: Genetic diversity at inter/ intra population (varieties, breeds, genotypes) ∝ Resilient (climate changes, stresses) population (adaptability)

- Policy and breeding target in the past: Monomorphic (Homogenous and homozygotes) and wide adaptability
- Farmers not able to maintain seed themselves, looking for higher SRR

Evolutionary Plant Breeding (EPB)

- Maintaining and creating high level of genetic diversity in crop population for production
  - planting a much larger mixture of hundreds or thousands of different varieties, and do not necessarily aim to arrive at single varieties
- Use of partial heterosis (hybrid phenomenon)
- Mainly focused on natural selection
- Functional diversity leads to **higher stability** (Petchey and Gaston 2002)

- For any problem/ any target/ sites/ crops
  - Agricultural biodiversity
  - Continued evolution and selection

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Cultivars Mixture for better understanding EPB

- Growing more than one landrace/ variety together (mixing)
- A simple and sustainable genetic resources management system
  - to increase yield, provide yield stability
  - to conserve genes
  - to manage diseases (buffer against disease loss)
  - Restrict the spread of disease considerably
- Mixtures of cultivated varieties growing simultaneously on the same parcel of land with no attempt to breed for phenotypic uniformity (Mundt 2002)
- Some traits enhanced and some suppress in mixture?

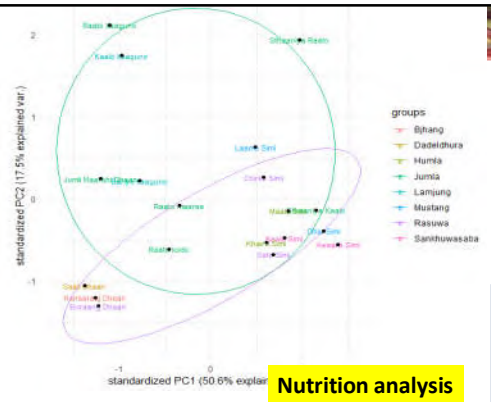
Why EPB

- To increase the **resilience of agricultural production** in the face of increasing biotic and abiotic stresses. Resilience is understood as the ability of a system to remain functional when under external stress, for example to produce acceptable yield levels when the availability of resources decreases or when climatic conditions become more extreme.
- Rapidly **enhances the adaptation** of farmers' crops to climate change
  - The EPB populations are more resistant to weeds, diseases and pests, drought, heat
- Each year, the types produce more seed and **gradually the population becomes better adapted** to the specific and changing circumstances of farmers
- To brings greater yield stability, also greater aroma and quality
- EPB mixtures have been shown to produce higher yields and perform better in **adverse conditions** than their local or improved counterparts.

Nutritionally better

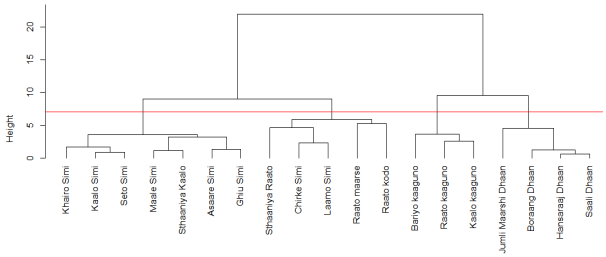
Jumli Maarsee

Jumli Simee



Nutrition analysis

- Balanced nutrient in native landraces
- Higher CHO in improved varieties
- Higher protein in Kaalo simee
- Amaranth better than quinoa



Rice
Amaranth
Foxtail millet
Proso millet
Bean
Buckwheat
Quinoa
Sorghum
Finger millet

Joshi et al 2021

History of EPB

- In 1956, this method was proposed by American agronomist Coit Suneson as the evolutionary plant breeding method (barley)
  - Composite cross populations (CCP) formed by assembling seed stocks with diverse evolutionary origins, recombination of these stocks by hybridization, the bulking of F1 progeny, and subsequent natural selection for mass sorting of the progeny in successive natural cropping environments
- In 2008, EPB was first implemented in a formal project in barley and wheat in Iran (IFAD)
- 2015 in Jumli Marshi in Nepal (enhancing conservation through use by creating dynamic gene pool on-farm)

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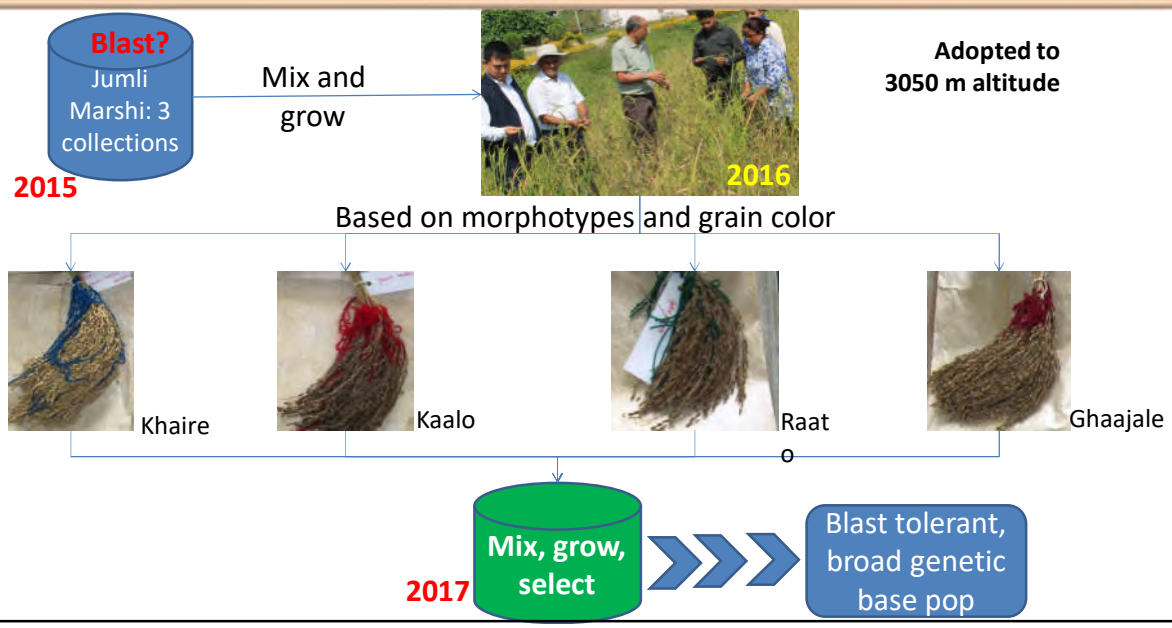
EPB in National Genebank



Evolutionary Population

- Evolutionary plant breeding
- Participatory evolutionary plant breeding

- Multiline variety
- Cultivar mixture

EPB for uncertainty

- Drought problem
- Diseases problem
- Insect problem
- Changes in temperature, rainfall, air circulation, etc
- Nutrient depletion
- Low yield
- Multiple objectives
- Varietal dependency

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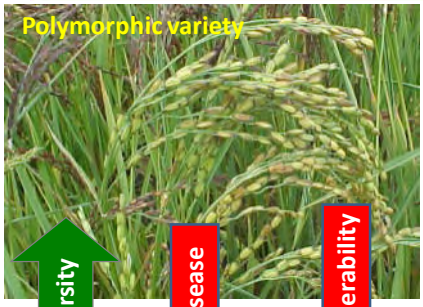
Evolutionary Population

- Evolutionary plant breeding
- Participatory evolutionary plant breeding
- Multiline variety
- Cultivar mixture
- Cross pollinated crop

EPB for uncertainty

- Drought problem
- Diseases problem
- Insect problem
- Changes in temperature, rainfall, air circulation, etc
- Nutrient depletion
- Low yield
- Multiple objectives
- Varietal dependency

Evolutionary vs Static Pop

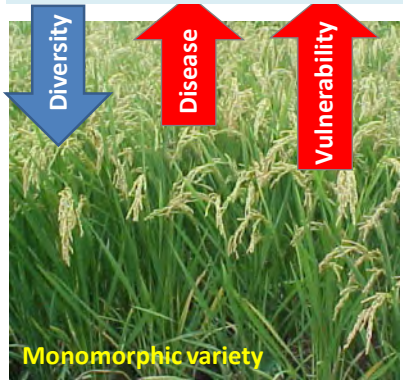


Increasing diversity reduce losses from pests and diseases

- Own see
- Self
- Same … d grain produ
- New e… ock: Zero

Farmers' right favor marketing

Genetic uniformity of monocultures leads to genetic vulnerability



- SRR
- Increa…
- Diver… and grain …
- New e… ck: High

Policy
Guidelines
Incentives

Evolutionary population (66 landraces mixed and grown within small plot)

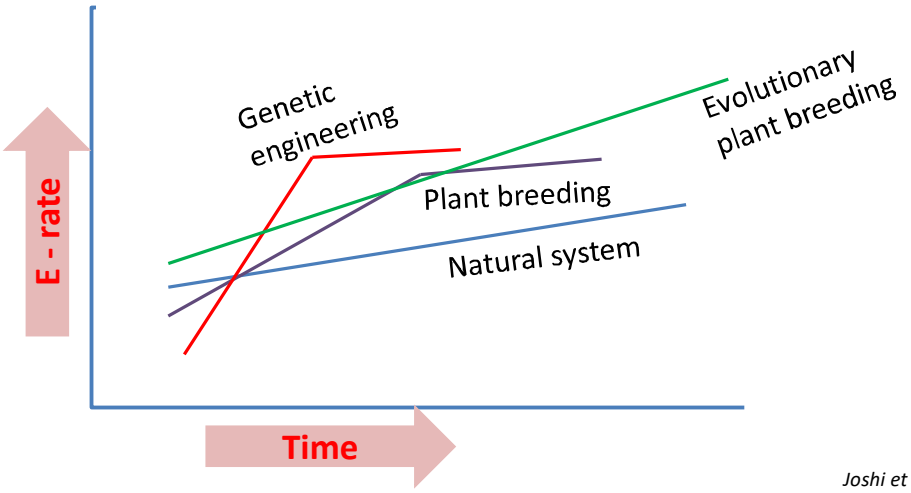
- Own seed
- Self dependency
- Same site for seed and grain production
- New environment shock: Zero

Joshi et al 2020

Use of Evolution

The higher the evolutionary rate, the higher the chance of getting better ones

- **Landrace**
- **Mixture**
- **Improved**
- **EP**



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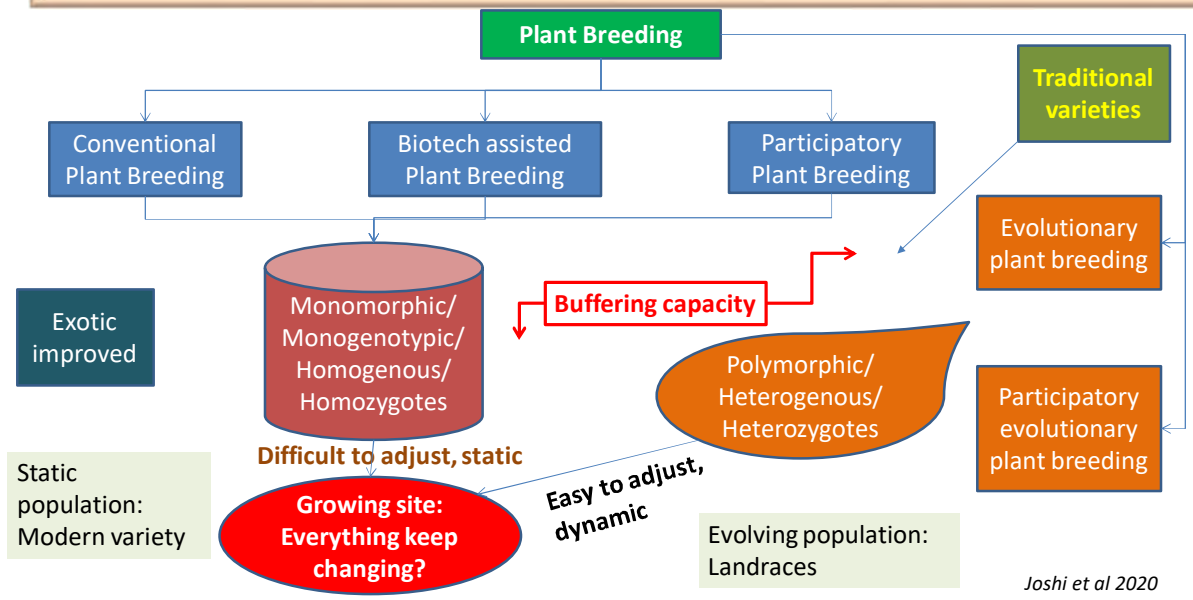
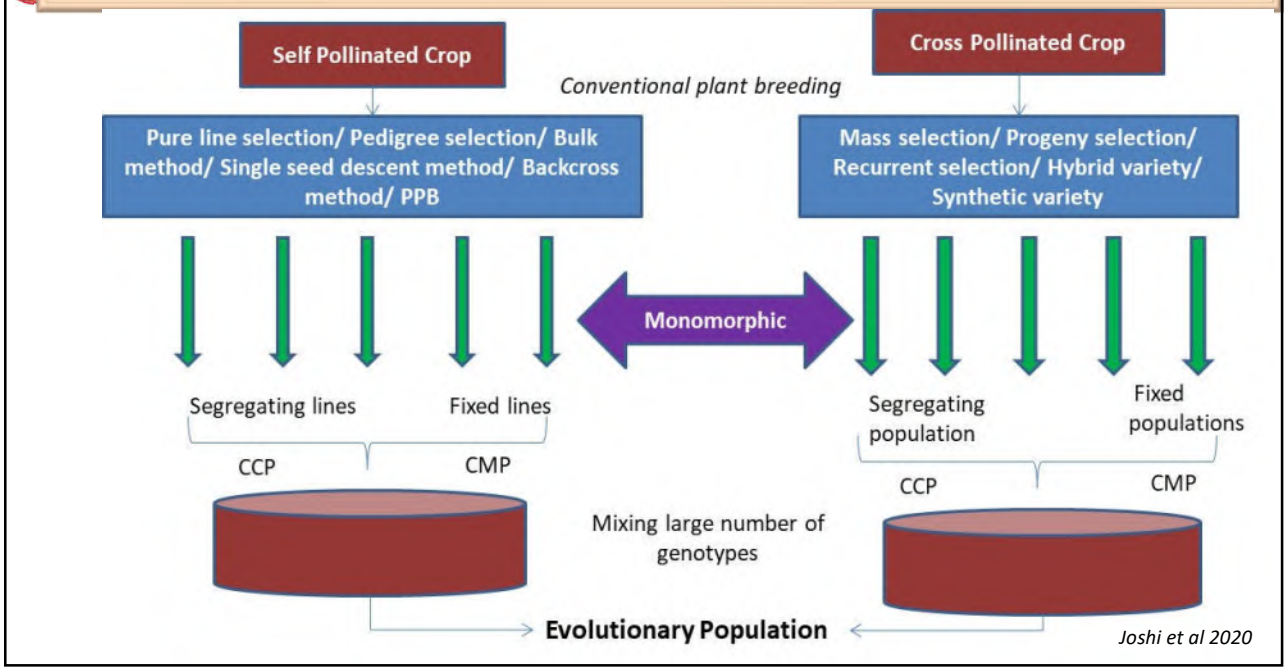
End Product of Plant Breeding: Mono vs Polymorphic

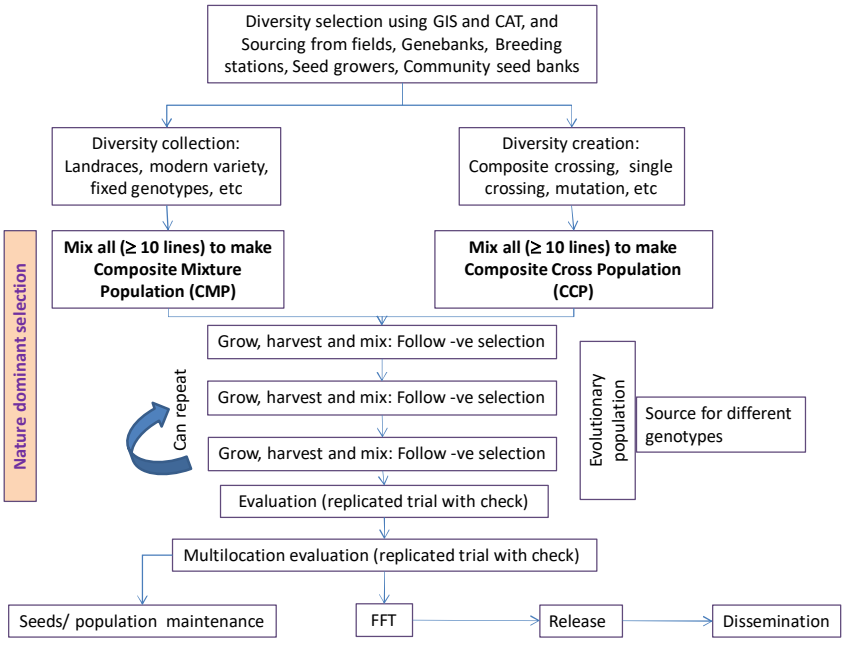


Joshi et al 2020

Evolutionary Plant Breeding



Steps of Evolutionary Plant Breeding



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Identification of genetic materials

- Landraces of target location
- Climate analog sites and similar variety recommended domain
  - GIS/CAT based on target environment
  - Review and visit
- Functional traits

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Important Traits in Evolutionary Population

For space use (all dimensions)

- Different root length
- Different plant height
- Different plant structure, shape
- Different size

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

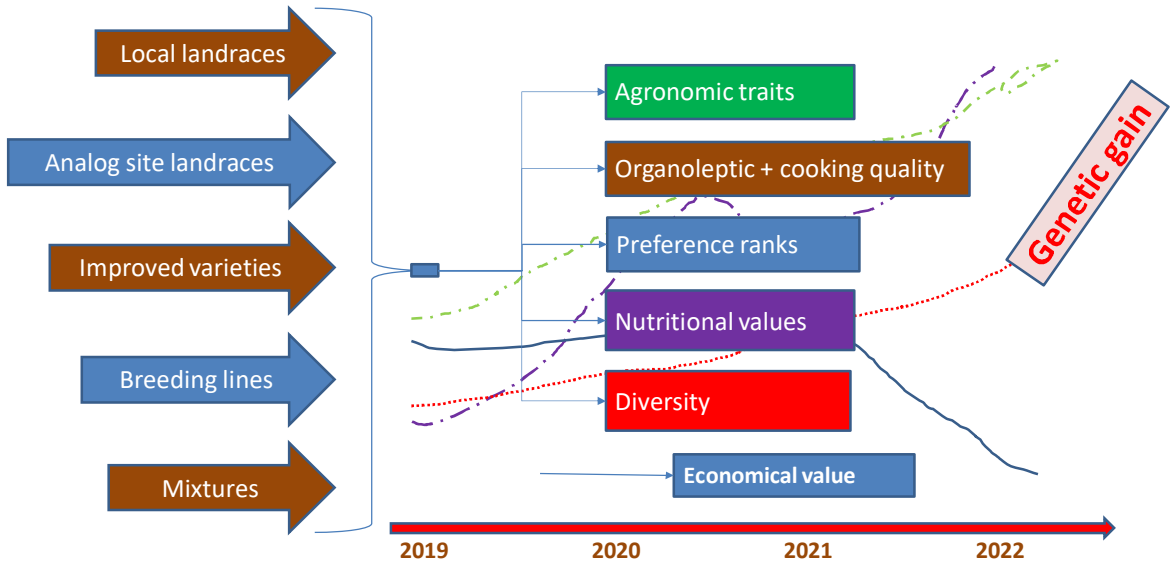
- Deep root
- Erect plant/leaf
- Different plant height
- Large leaf but few in number

Similarity

- Maturity
- Cooking method/ time
- Milling
- Acceptable eating quality

Joshi et al 2020

Research Agenda



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Success Cases

- The usefulness of mixtures for disease management well demonstrated for **rusts and barley powdery mildews of cereals** (Finckh et al 2000, Mundt 2002)
- EPs of **maize, barley, bread wheat, durum wheat, common bean, tomato and summer squash** are grown in Jordan, Ethiopia, Iran, and Italy (Ceccarelli 2017)
- EP of **barley** out-yielded the local barley and improved barley cultivar (Rahmanian et al 2014)
- EP of **wheat** yielded more than twice as much as the local varieties.
- The **bread wheat EP** has greater yield stability, and bread obtained from its flour has a better aroma and taste
- EP has been done in Italy on **zucchini** by intercrossing 11 commercial hybrids.
- Farmers growing EPs reported higher **yields**, lower **weed** infestation and **disease** presence, and with lower **insect** damages (Rahmanian et al 2014)

Cultivars Mixture for better understanding EPB

- A simple and sustainable genetic resources management system
  - to increase yield, provide yield stability
  - to conserve genes
  - to manage diseases (buffer against disease loss)
  - Restrict the spread of disease considerably
- Mixtures of cultivated varieties growing simultaneously on the same parcel of land with no attempt to breed for phenotypic uniformity (Mundt 2002)
- Some traits enhanced and some suppress in mixture?

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Functional Diversification : Main Principle

- Based on the principle of using cultivars with diversified functions to **limit the development of diseases**
- Functional diversity leads to **higher stability** (Petchey and Gaston 2002)
- Prolonging the useful **life of resistance genes** and increasing the crop productivity by taking into account the functional differences in disease resistance and other agronomic traits of cultivars

जातीय मिश्रणमा अनुसन्धान

- जौ : Yellow rust and yield in 1995
- गहुँ : Spot blotch and yield in 1996
- धान :
  - Blast (Biblends of 9 different rice genotypes: landraces, cultivars and ancestors (2005)
  - Competition (wild rice, F1, variety and landrace (1999)
  - Blast and yield in 2015
- सिमि : Anthracnose disease and other stresses in 2015
- फापर : Higher seed setting in 2015

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जंगली धान + हिब्रिड + विकासे जात + रैथाने : जोडीमा

किसान स्तरमा मिश्रीत खेति

- धेरै पुरानो तरिका, धेरै ठाउमा प्रचलित तर नीति नियम मा उल्लेख्य ठाउँ नपाएको
- Farmers grow several cultivars in a field or adjacent field **as a strategy to cope with heterogeneous and uncertain ecological and socioeconomic conditions**

- सिमि : जुम्लामा
- धान : डिकुर पोखरी, कास्की (कालो पातले + माछापुछ्रे + लेकाली) : रोग कम, बादर नलाग्ने र नडलने
- The success of the large-scale farmer participatory experiment in Yunnan, China: **Traditional cultivars and hybrid rice** inter-planted to control **blast and increase yield** (Zhu et al 2000)

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Policy

- Variety registration system with research data
- Simplified registration system for landraces – which ***still demands uniformity?***
- Favor homogenous variety
  - Promote widely adapted uniform and commercial variety/population
- Not possible to register EP?
- Option for registration
  - Policy revision for mixture population registration
  - Component registration

Participatory selection in EP trials in Jumla

Strategy for mainstreaming EP

- Policy environment
- Awareness and technology dissemination
- Technology generation and verification
- Integration in research and education system
- Capacity enhancement (farmers, breeders, students)

In 1896, University of Illinois

- Long term experiment on rice EPB in National Genebank, Khumaltar
- ARS, Jumla
- IAAS, Lamjung campus
- Farmers to farmers (CSB/ cooperatives): Lamjung, Jumla, Kaski, Tanahu,

Publication

EPB briefing paper: 8 pages

https://www.researchgate.net/publication/339301085_utparivartanasila_bali_prajanan_Evolutionary_Plant_Breeding_ke_ho_kina_ra_kasari_garincha_Evolutionary_plant_breeding_What_it_is_why_and_how_it_is_done

उत्परिवर्तनशील बाली प्रजनन् (Evolutionary Plant Breeding) परियोजना

Project briefing paper: 4 pages

https://wle.cgiar.org/concept-and-rationale-evolutionary-plant-breeding-and-its-status-nepal

Journal paper: 11 pages

Journal of Agriculture and Forestry University (2020), Vol. 4: 1-11

Review Article

CONCEPT AND RATIONALE OF EVOLUTIONARY PLANT BREEDING AND ITS STATUS IN NEPAL

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[4]Platform for Agrobiodiversity Research, c/o the Alliance of Bioversity International and CIAT, Rome, Italy;

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ABSTRACT

Nepal has released and registered a total of 623 genetically uniform (mono genotyped) varieties. These varieties were developed by both conventional and classical plant breeding, biotech-assisted plant breeding, and participatory plant breeding methods. However, these varieties have been shown to vary in their yield performance over the years and locations. Smallholder farmers dominate agriculture with 53% of the land-owning households with their land holding size of less than 0.5 ha in Nepal. Farmers are increasingly losing their own saved seeds. There have been impacts of weather variability, often

Acknowledgements

- The Alliance of Bioversity International and CIAT
- NARC
- ARS, Jumla
- LI-BIRD

- CSB: Lamjung and Jumla
- Farmers: Lamjung and Jumla

- International Fund for Agricultural Development (IFAD)

Bean monitoring in Jumla

Project inception in Jumla

Annual Technical Review and Planning Meeting
Seed System Project and Evolutionary Plant Breeding (EPB) Projects
NARC/LIBIRD/ Alliance of Bioversity International and CIAT
11 Jan 2020 (27 Paush 2077), NAGRC, Khumaltar

EPB Project Progress Summary (up to 2020)

For detail, see activity wise report

Bal Krishna Joshi
EBP Team

Rice

Bean

Implementing Partners and Team

National Partner

- NAGRC (National Agriculture Genetic Resources Center)
- LI-BIRD (Local Initiatives for Biodiversity, Research and Development)
- The Alliance of Bioversity International and CIAT

Orientation and planning meeting in Lamjung

Team

1. Bal Krishna Joshi
2. Krishna Hari Ghimire
3. Ajaya Karkee
4. Krishna Kumar Mishra
5. Tirtha Rijal
6. Surendra Shrestha
7. Santosh Shrestha
8. Dipendra Ayer
9. Sundar Raot
10. Purna Poudel
11. Shree Prasad Neupane
12. Devendra Gauchan

Total activities

- 5 Components: All started
- Total activities: 23
- 15 activities started

Project inception in Lamjung

Code	Output/Activity
1	**Participatory assessment of the role of plant genetic resources in the resilience of smallholders to climate change**
1.1	Synthesis of the wealth of participatory diagnostic tools available to create a integrated toolkit
1.2	Participatory assessments of targeted farmers and farming communities
1.3	Use of the participatory toolkit as a monitoring tool
2a.	Establishment of evolutionary populations (EPs) in farmers' fields and ensure sustainable seed supply
2a.1	Train & enhance knowledge of farmers, researchers & other relevant stakeholders on principles and management of EPB
2a.2	Support farmer communities, research and breeders to obtain additional germplasm
2a.3	Participatory selection with women and men farmers for variation in identified traits in evolutionary populations
2a.4	Evaluate EPs for their yields, their nutritional quality and their value in organic farming
2a.5	Develop knowledge management products and stories from the field, with emphasis on South-South cooperation
2b.	**Diversification of seed suppliers, including smallholder farmers who provide seed**
2b.1	Enhance capacity and connections to ensure sustainable supply of good quality source seeds to target local seed producers
2b.2	Build the capacities of target seed producer groups for them to sustainably operate as small seed businesses
2b.3	Enhance connections among seed producer groups themselves and among seed producers and seed sellers and consumers
3	**Cost-benefit analysis and comparative studies on EPB vs conventional breeding and accompanying seed supply systems**
3.1	Train national partners on undertaking of CBA and CEA analysis.
3.2	Undertake a Cost-Benefit Analysis (CBA) at the farm level
3.3	Undertake a Cost Effectiveness Analysis (CEA) and SWOT analysis
3.4	Support the use of CBA and CEA results to promote of products from the EPs in agrofood processing enterprises
3.5	Support the use of CBA and CEA results to promote diversification on seed supply sources
4	**Actions and recommendations that support the adoption and benefit sharing of evolutionary populations**
4.1	Review and analyse a variety of national and international policy initiatives that affect evolutionary breeding products
4.2	National Training on developing and communicating policy proposals that support the use of diversity
4.3	Policy support for the establishment of alternative methods of variety registration and dissemination
4.4	Ensuring prior informed consent of farmers and communities and their participation in the benefits derived from the utilization of local crop diversity
5	**Project coordination, technical management and monitoring**
5.1	Arrangement for overall project administration
5.2	National, site team meetings
5.3	Monitoring and evaluation

Awareness and capacity development (1500 benef

- 4 knowledge products shared widely
- 4 trainings/awareness programs to farmers (quality seed production, inception…)
- Seed actors, researchers and stakeholders interaction workshop

- 2 national training workshops
- 3 Global meetings and workshops
- 2 farmers exchange visits (Jumla and Lamjung)
- 12 participatory evaluation and scoring
- >10 meetings, annual review and planning meeting
- 8 monitoring (national and global)

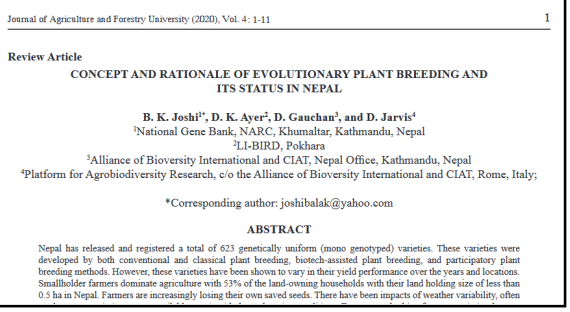
Cross site exchange visit by Jumla farmers in Lamjung

Cross site exchange visit and joint field monitoring visit in Jumla

Publication

Project briefing paper: 4 pages

EPB briefing paper: 8 pages



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Journal paper: 11 pages

Draft documents

Draft Tools Book

Participatory Agrobiodiversity Tools and Methodologies in Nepal

Four sections with total 53 tools

A	Participatory tools and methodologies for agrobiodiversity assessment and documentation	12
B	Participatory tools and methodologies for agrobiodiversity use	13
C	Participatory tools and methodologies for agrobiodiversity research and monitoring	15
D	Participatory tools and methodologies for agrobiodiversity promotion and conservation	24

A Training Manual for Evolutionary Plant Breeding

Chapter I. Understanding EPB = BKJ
13 topics

Chapter II. Implementation of EPB = DA
15 topics

Chapter III. EPB data analysis and interpretation = BKJ
6 topics

Chapter IV. Economics and policy analysis = DG
7 topics

Chapter V. EPB Supplement
5 topics

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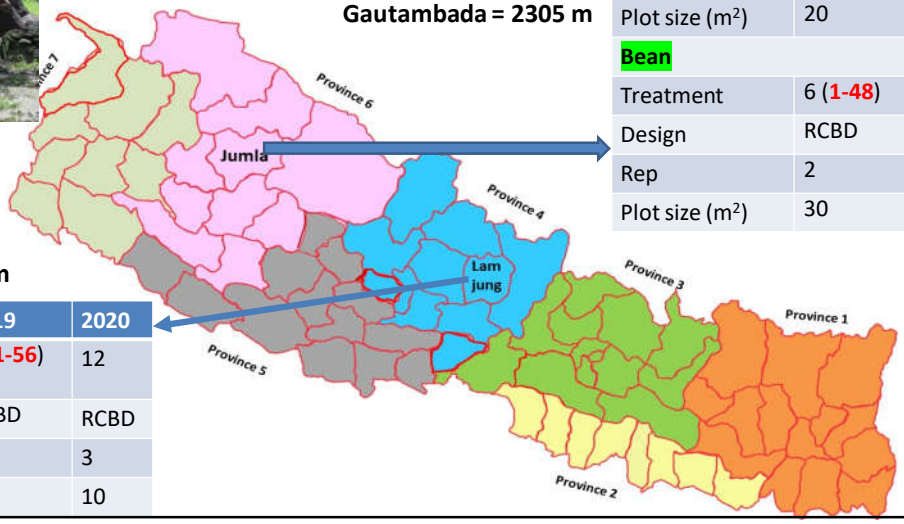
Field trial

Land preparation

Jumla site altitude
Aireni = 2276 m
Gautambada = 2305 m



Lamjung site altitude
Rope phant = 960 m

	2019	2020
Rice		
Treatment	6 (1-66)	9
Design	RCBD	RCBD
Rep	2	3
Plot size (m^2)	20	12
Bean		
Treatment	6 (1-48)	9
Design	RCBD	RCBD
Rep	2	3
Plot size (m^2)	30	18

Rice	2019	2020
Treatment (min-max genotypes, n)	6 (1-56)	12
Design	RCBD	RCBD
Rep	2	3
Plot size (m^2)	20	10

Results in 2019

Rice (kg/ha) in Jumla

- RicEP1 (landrace mix) = 3736
- RicEP6 (improved check) = 3631
- RicEP5 (landrace check) = 3630

Bean (kg/ha) in Jumla

- BeEP5 (landrace check) = 1908.3
- BeEP4 (All mix) = 1879.1
- BeEP3 (Breeding lines mix) = 1744.5

Rice (kg/ha) in Jumla

- RicEP2 (landrace mix analog) = 4250
- RicEP1 (landrace mix) = 4150
- RicEP4 (all mix) = 4016

Seeding rice in Lamjung


Preference ranking in Jumla

Farmers Response, 2019

A. Preferential ranking

Lamjung

Rice

- I: RicEP1 (landrace mix)
- II: RicEP5 (landrace check)
- III: RicEP6 (Improved check)

Jumla

Rice

- I: RicEP1 (landrace mix)
- II: RicEP2 (landrace mix analog)
- III: RicEP5 (landrace check)

Bean

- I: BeEP3 (Breeding lines mix)
- II: BeEP4 (All mix)
- III: BeEP5 (landrace check)


Participatory selection in Lamjung

Farmer preferred traits in EPs

EPB in Jumla

- **Rice**: Early maturing, higher yielding, disease/pest resistant, uniform in maturity
- **Bean**: disease/pest resistant, early maturing, higher yielding, uniform in maturity

EPB in Lamjung

- **Rice**: Higher yielding as those of hybrids, early and late maturing, disease/pest resistant, uniform population, long panicle, uniform in maturity

B. Organoleptic test

Jumla
Rice
Farmers: 6
Best: RicEP1 (landrace mix)
RicEP4 (all mix)
Bean
Farmers: 6
Best: BeEP1 (landrace mix)
BeEP3 (impr. var mix)

Lamjung
Rice
Farmers: 9
Best: RicEP1 (landraces mix)
RicEP3 (improved var mix)

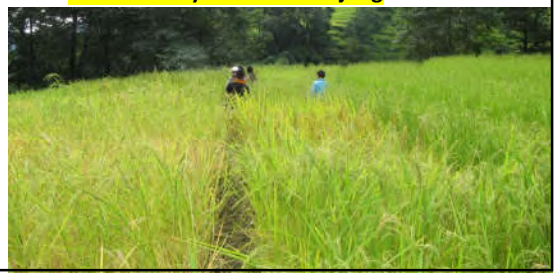
Community seed banks and Diversity block

- CSBs were supported with **seed production trainings, agri-tools /materials and seasonal vegetable seeds**
- CSB members, local government bodies and community farmers were engaged in **interaction workshops, EPB trial establishment, trainings as well as field evaluations**.

- There were 37 rice and 27 bean diversity blocks in Jumla, 63 rice diversity blocks in Lamjung maintained through CSB.
- Other crops (finger millet, foxtail millet, buckwheat, proso millet, potato) were also maintained on-farm growing diversity blocks through CSB and with technical support from EPB staffs

Community seed bank in Lamjung

Rice diversity blocks in Lamjung



Diversity use and on-farm conservation

- New concept (EPB) in the fields
- Farmers are familiar with the advantages of mixture, therefore easy to adopt EPB
- First time the highest number of landraces/genotypes (66) of crop species within a small unit of land
- Conservation and utilization of landraces through two CSBs

Farmers' choice in diversity in Jumla

Selection plot in Lamjung

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Field monitoring visit in Jumla

Global, national experts with locals in the field

Bean evolutionary population

Rice evolutionary population

Field monitoring in Lamjung

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Policy

- In house policy dimension meeting, 31 Dec 2020
- Variety registration system with research data
- Simplified registration system for landraces – which ***still demands uniformity***
- Favor homogenous variety
  - Promote widely adapted uniform and commercial variety/population
- Not possible to register EP
- Option for registration
  - Policy revision for mixture population registration
  - Component registration

Participatory selection in EP trials in Jumla

Major work plans

Pending works

- Agrobiodiversity tools and methodologies finalization by Dec 2020
- EPB training manual finalization by June 2021
- Policy analysis and recommendation draft by June 2021
- RAM (R for Agrobiodiversity measurement) training by March 2021

Next phase major works

- Training to farmers and researchers
- Cost benefit analysis training
- Field trials and monitoring
- Data analysis and writeshop
- Nutrition and organoleptic analysis in EPP
- Cos benefit analysis
- National training workshop

EPB training in Kathmandu

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Problems and issues

- Covid 19
  - Field work not much affected (staff stayed in the site)
  - Could not organize training
  - Could not monitor or organize field visit programs
  - Limited participatory EP evaluation and ranking
- Difficult to organize travelling seminar for researchers, policy makers due to remotely located sites and Covid 19
- Mainstreaming EPB still challenging
- Site specific evolutionary population

Lamjung monitoring, now difficult

BKJ Genebank, Nepal

Launching, Orientation and Planning Meeting on EPB Project
27-28 December 2018 (12-13 Paush, 2075), Besisahar, Lamjung
Bioversity International/NARC/LI-BIRD

Development of EPB Populations and their Evaluation Methods

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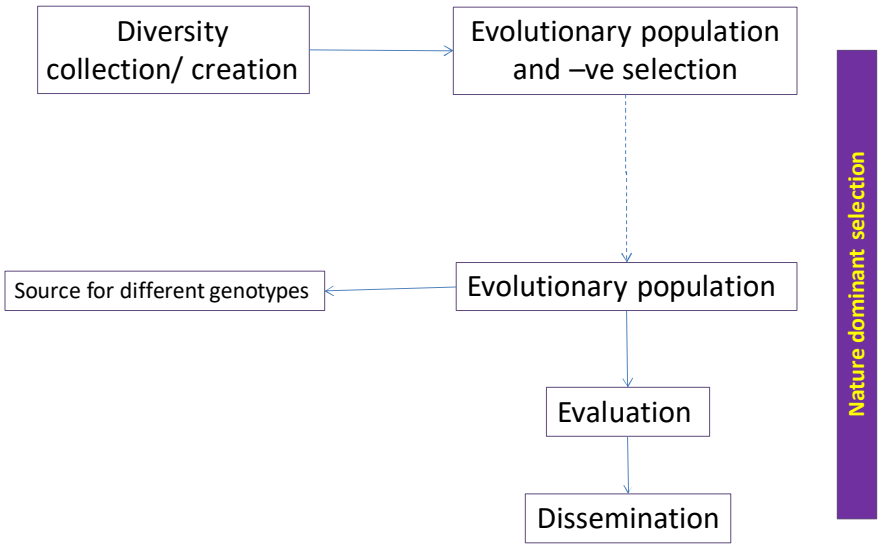
Use of genetic diversity and Evolutionary Plant Breeding for enhanced farmer resilience to climate change, sustainable crop productivity, and nutrition under rainfed conditions (EPB Project)

BKJ Genebank, Nepal

Steps of Evolutionary Plant Breeding



Types of Evolutionary Population

- Composite Cross Population (CCP)
  - by crossing
- Varietal mixture
  - by physical mixing seed of existing varieties

- Both are evolving populations: The frequencies of different genotypes in the population change from season to season, depending on the genetic variation available and the strength and direction of environmental variables

BKJ Genebank, Nepal

Bean e-population

- BEP Population) 1: Composition of 20-50 landraces

- BEP (Population 2): Composition of 12 landraces, 6 breeding lines and 2 released varieties

- **Genetic diversity: BEP1 < BEP2**

Rice e-population

- REP (Population) 1: Composition of 20-50 landraces
- REP (Population 2): Composition of 20 landraces, 5 breeding lines and 5 released varieties
- **Genetic diversity: REP1 < REP2**

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Sources of Genetic Materials

- On-farm: Landraces
- Genebank: Landraces, released varieties
- Research station: Breeding lines, released varieties, segregating populations

Identification of genetic materials

- Climate analog sites and similar variety recommended domain
  - GIS/CAT based on target environment
  - Review and visit
- Functional traits

BKJ Genebank, Nepal

Important Traits in Evolutionary Population

For space use (all dimensions)

- Different root length
- Different plant height
- Different plant structure, shape
- Different size

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
- Large leaf but few in number

Similarity

- Maturity
- Cooking method/ time
- Milling
- Acceptable eating quality

Evaluation

- Sensory evaluation
  - Eye determination
  - Tongue and skin determination
- Measurement based evaluation
  - Over the year against base population and landrace/ local check (trend analysis)
  - Target traits and adaptation traits
  - New genotypes
- Adaptation
  - By farmers
  - In environment

By R Gurung

Profile of target sites and status of diversity of Rice and Beans

Use of genetic diversity and evolutionary plant breeding for enhanced farmer resilience to climate change, sustainable crop productivity and nutrition under rainfed conditions

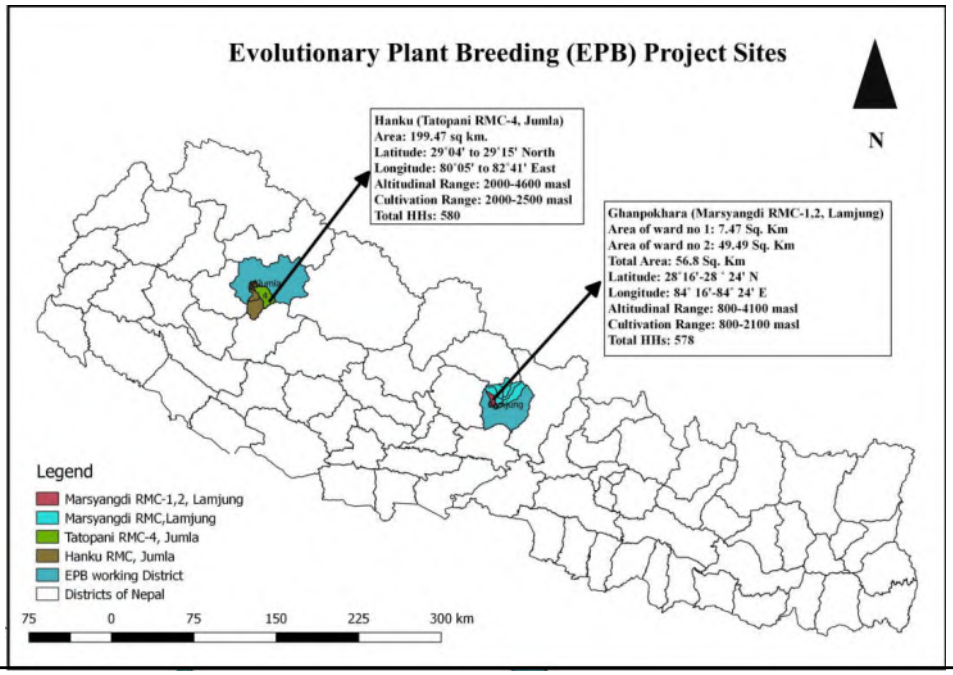
Profile of target sites and status of diversity of Rice and Beans

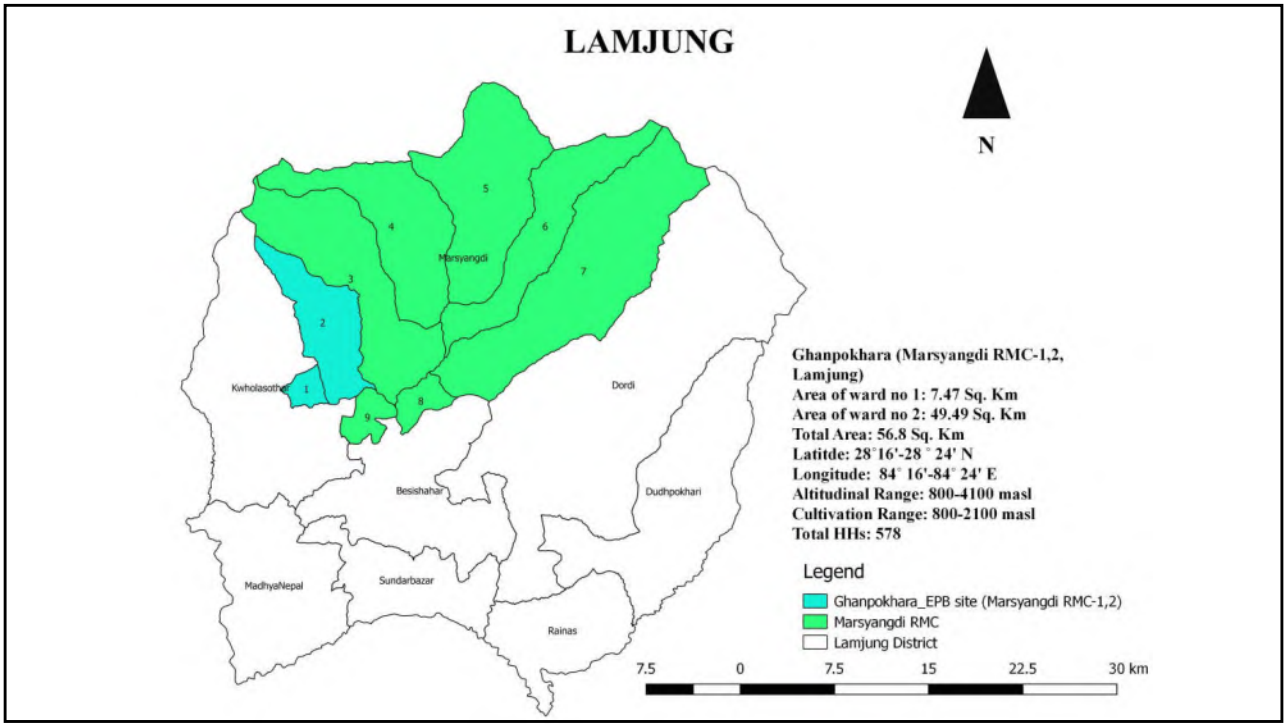
Orientation and Planning Workshop
27-28 December 2018
Beshisahar, Lamjung

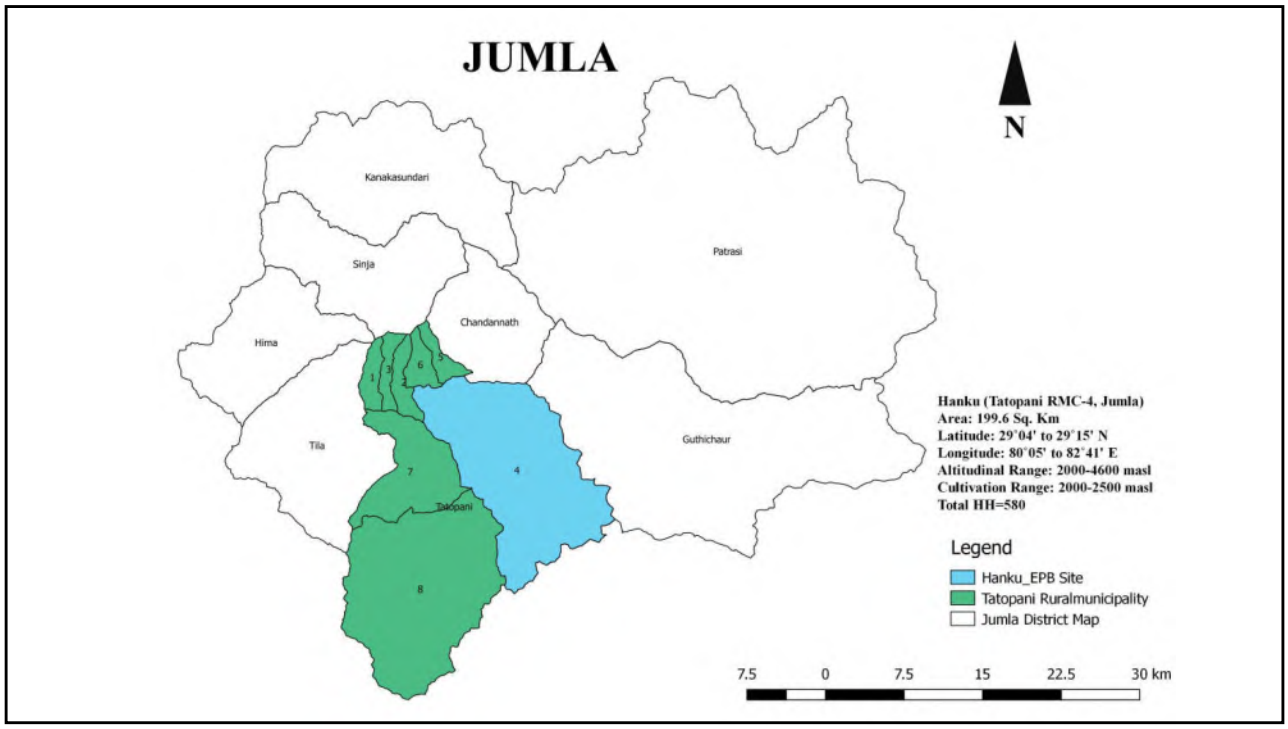
Rita Gurung, Dipendra Ayer, Pragati Babu Paneru, Purna Paudel

Project Sites

Evolutionary Plant Breeding (EPB) project sites in Nepal







Site Profile

Description	Hanku, Jumla	Ghanpokhara, Lamjung
Geographical Location	29˚04'-29˚15' N to 82˚05'-82˚16' E, 2200-4600 masl (Cultivation Range: 2000-2500 masl) Mountain	28˚16'-28˚24' N to 84˚16'-84˚24' E, 900-4100 masl Cultivation Range (800-2100masl) Mid hill
Climate and Ecology	Cool temperate to alpine climate,	Sub tropical to alpine, temperature range-15 to 27 C, 152.2 mm per year
Land Use	Forest, Pasture land and Agriculture land	80% forest and rangeland, 20% cultivation and settlement
Farming System	Khet, bari and lek areas (land classified based on availability of irrigation)	Terrace farming, rain fed, livestock integrated farming system
Major Crop	Rice, millets and beans in summer Barley major winter crop	Maize-finger millet-wheat Rice-fallow/wheat-rice Potato-potato
Crops per year	2 crops per year	3 crops per year

Source: LCP Baseline Report 2015-16

Socio-economic and Demographic Status

Characteristic	Hanku, Jumla	Ghanpokhara, Lamjung
Ethnic Composition	Brahmin, ChhetriDalit	Gurung, Dalit, Chhetri, Brahmin
Major source of income	Agriculture (83%)	Agriculture (40%), Remittance (30%), Pension (16%)
Household resources (Average landholdings (Ropani)	Khet- 2.64 Bari-3.24	Khet: 6.76 ropani Bari: 2.31 ropani
Food Sufficiency Status (month)	Cereal: 5.52 (Chhetri/thankuri- 7.73, Dalit-3.67) Pulses: 5.99 (Chhetri/Thakuri-8.55, Dalit-4.16)	Cereal: 7 month (Gurung highest-8 month, Dalit 4 month) (buy rice from nearby market)
Migration Status	Seasonal Migration	88 % of HH have at least 1 member working outside
Decision making	Jointly 59%, Male 19%, Female 22%	52% jointly, 28% female, 16% male, labour contribution: 1.3 male, 1.5 female

Note: 20 Ropani=1 hectare
Source: LCP Baseline Report 2015-16

Status of EPB target crops in Jumla and Lamjung, Baseline Report 2015-16

Crop	Area ± SE (Ropani)	Productivity (kg/Ropani)	# HHs (%)	Avg. HH richness ± SE	Community richness
Jumla					
Barley	2.20 ± 0.15	101.87 ± 5.35	81 (98)	1.00 ± 0.00	1 (1)
Bean	1.88 ± 0.14	49.84 ± 3.86	82 (99)	2.10 ± 0.14	11 (10)
Buckwheat	0.69 ± 0.09	43.99 ± 11.35	17 (20)	1.12 ± 0.08	3 (3)
Finger Millet	1.03 ± 0.09	90.18 ± 7.11	74 (89)	1.00 ± 0.00	3 (3)
Foxtail Millet	0.07 ± 0.02	2.24E2 ± 88.39	8 (10)	1.00 ± 0.00	4 (4)
Rice	2.57 ± 0.18	187.01 ± 6.29	83 (100)	1.49 ± 0.07	6 (4)
Lamjung					
Bean	0.38 ± 0.09	51.62 ± 4.2	4 (5)	1 ± 0.00	1 (1)
Finger Millet	2.52 ± 0.25	89.16 ± 14.66	48 (58)	1.06 ± 0.03	14 (14)
Rice	7.37 ± 0.50	77.29 ± 4.63	78 (94)	2.17 ± 0.11	24 (22)

figure in parenthesis are richness of local varieties

Target Crop Diversity

Target Crop	Hanku, Jumla		Ghanpokhara, Lamjung	
	Richness	%HH farming	Richness	% HH Farming
Amaranth	5 (5)		3 (3)	
Barley	4 (4)		1 (1)	
Bean	**32 (29)**		**9 (9)**	
Buckwheat	7 (7)		1 (1)	
Finger Millet	6 (6)		14 (14)	
Foxtail Millet	6 (6)		7 (7)	
Naked Barley	3 (2)		1 (1)	
Proso Millet	3 (3)		NA	
Rice	**10 (6)**		**38 (36)**	
Cold Tolerant Rice			8 (7)	
Total Richness	**76 (68)**		**72 (70)**	

Note: figure in parenthesis are richness of local varieties
Source: LCP Baseline Report 2015-16

Rice Diversity in Ghanpokhara, Lamjung

	Altitude (masl)		Altitude (masl)		Altitude (masl)
	900 to 1000m		**1000 to 1300m**		**1300 to 1700m**
	RICE		**RICE**		**RICE**
R1	**DALLE**	R1	**ANGA**	R1	**CHHOMORONG**
R2	EKLE	R2	GURDI	R2	**DAMARLI**
R3	**GAURE**	R3	JURDUNG	R3	**KAALO PATLE**
R4	INDRABALI	R4	**KAALO JHINUWA**	R4	KHAIRO
R5	JAWALI	R5	KAGHIRO	R5	LEKALI BASMATI
R6	JHAI RICE	R6	**KARTIKE**	R6	LEKALI RATO
R7	KANKAA JEERA	R7	**MANSARA**	R7	SETO
R8	LAMA GAUN RICE	R8	MAYALU	R8	SETO KAALO
R9	MORE MARSI	R9	**PAMALI**	R9	**SETO KARTIKE**
R10	NAAULE	R10	**RATO ANADI**	R10	TAMARE/TAKMARE
R11	**PIYAILE**	R11	**SALEN**		
R12	TULSI RICE	R12	SANO MASINO		

Source: CSB Passport data 2014-15

	Site	Ghanpokhara, Lamjung		
	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Rice	40353.2	574.6	170
1	Anadi	97.6	1.5	2
2	**Anga**	**3062.2**	**44.6**	**19**
3	Basmati	2025.2	30	8
4	Bote	1512.8	21	4
5	Chhomorong	1811.2	22	9
6	Chote	244	4	1
7	Dalle	1403	17.5	6
8	**Darmali**	**3342.8**	**45**	**15**
9	**Gaure**	**3952.8**	**59**	**15**
10	Gurdi	732	12	2
11	Jau Dhan	1024.8	9.5	3
12	Kageri	1903.2	25	5
13	Kalo Dhan	1874	26.5	9
14	Kalo Jhinuwa	2488.8	24	9
15	**Kattike**	**2713.2**	**41**	**13**
16	Khairo	380.4	4	1
17	Khumal-4	780.8	11.5	5
18	Lekali Basmati	1268.8	24	6
19	**Pamali**	**6563.6**	**107**	**24**
20	Piyale	976	10.5	4
21	Pokhreli	780.8	12	3
22	Salen	878.4	13	4
23	Seto	292.8	6	1
24	Takmare	244	4	2
	Grand Total	40353.2	574.6	170

Bean Diversity in Ghanpokhara, Lamjung

	Site	Ghanpokhara, Lamjung		
	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Bean	179	56.3	42
1	Barkhe Simi	0	0	2
2	Chirke mirke	2	0	2
3	Hiude Simi	26	2.5	5
4	Kalo Chirbire	0	4	6
5	Local/Sthaniya	30	4.3	3
6	Rato Chepte	1	0	2
7	Rato-Ghiu Simi	10	15	8
8	**Seto**	**100**	**29.5**	**13**
9	Tinmase	10	1	1
	Grand Total	179	56.3	42

Bean and Rice Diversity in Hanku, Jumla

	Site	**Hanku, Jumla**		
SN	**Row Labels**	**Sum of Total production (Kg)**	**Sum of Area (Ropani)**	**Count of Respondent Name**
	Bean	6522.01	154.5	144
1	Bhote	53	2	2
2	**Kalo**	**1490.17**	**35.54**	**37**
3	Kalo Kirbire	106.67	2.2	2
4	Kirbire	260	6.19	5
5	Lamre	33	0.75	1
6	Male	96	2.75	4
7	Mix (all)	480	14.3	7
8	PB0002	60	1.5	1
9	Rajma	95	1.87	3
10	**Rato**	**3512.67**	**80.76**	**72**
11	Rato Kirbire	114.17	1.3	3
12	Seto	221.33	5.34	7
	Rice	40180	213.6	124
1	**Chandannath-1**	**3910**	**22.5**	**24**
2	**Chandannath-3**	**5200**	**25.5**	**23**
3	Darime	1300	6	3
4	**Marshi**	**29170**	**155.6**	**72**
5	Melte	300	2	1
6	Tinmase	300	2	1
	Grand Total	46702.01	368.1	268

Rice Diversity in Jumla	१) मेल्टे २) जुम्ली मार्सी ३) काली मार्सी, ४) पाखे धान, ५) दारिमे	

Bean Diversity in Jumla					
1	Kalo maley	10	Pahelo golo	19	Rato lamo
2	Rato maley	11	Khairo thulo chherkey	20	Kailo Seto Sano
3	Kalo sano	12	Seto lamo	21	Seto Chherkey thulo
4	Rato sano	13	Kalegi Chherkey sano	22	Gheu rang
5	Kalo lamo	14	Kalegi Sada	23	Khairo lamo
6	Besary lamo	15	Gajaley Sada	24	Seto dallo sano
7	Cheelo kalo sano	16	Kalegi Chherkey thulo	25	Gheu rang lamo
8	Sindure	17	Fusro Chherkey	26	Pahelo chherkey
9	Seto Chherkey	18	Khairo Chherkey	27	Kharani Sada
				28	Sindure Chherkey
				29	Coffee rang

Ghanpokhara Community Seed Bank, Lamjung

- Ghanpokhara Biu Utpadan tatha Samrakshan Krishak Samuha registered in 2073 BS
- Total member 55 (40 Male, 15 Female)
- CBM fund management in process of start
- Diversity block management and seed production major activity

Hanku Community Seed Bank, Jumla

Dhauligadh Krishi Jaibik Bibidhata Sanrakshan Samuha

Institutional details of the Community Seed Bank (CSB)

Organization	Total Member	Gender		Ethnicity			Remarks
		Male	Female	BCTN	Janajati	Dalit	
Dhauligadh Krishi Jaibik Bividhata Sanrakshyan Samuha	76	19	57	65		11	Composed of 4 small farmers group based on niches
Dhauligadh Core committee (CSB Management team)	11	7	4	10		1	Members of each small farmer group compose core committee

Status and methods of germplasm collection in rice and beans for EPB project

By
Dipendra Kumar Ayer
Plant Breeder

Site		Baseline Survey 2014			CSB Passport Data		
Ghanpokhara, Lamjung		Rice		Bean		Rice	Bean
	R1	Anadi	B1	Barkhe Simi	R1	AAUGA	
	R2	Anga	B2	Chirke mirke	R2	CHEMONG	
	R3	Basmati	B3	Hiude Simi	R3	DALLE	
	R4	Bote	B4	Kalo Chirbire	R4	DAMARLI	
	R5	Chhomorong	B5	Local/Sthaniya	R5	EKLE	
	R6	Chote	B6	Rato Chepte	R6	GAURE	
	R7	Dalle	B7	Rato-Ghiu Simi	R7	GUDIR	
	R8	Darmali	B8	Seto	R8	INDRABALI	
	R9	Gaure	B9	Tinmase	R9	JAWALI	
	R10	Gurdi			R10	JHAI RICE	
	R11	Jau Dhan			R11	JURDUNG	
	R12	Kageri			R12	KAALO JHINUWA	
	R13	Kalo Dhan			R13	KAALO PATLE	
	R14	Kalo Jhinuwa			R14	KAGHIRO	
	R15	Kattike			R15	KANKAA JEERA	
	R16	Khairo			R16	KARTIKE	
	R17	Khumal-4			R17	KHAIRO	
	R18	Lekali Basmati			R18	LAMA GAUN RICE	
	R19	Pamali			R19	LEKALI BASMATI	
	R20	Piyale			R20	LEKALI RATO	
	R21	Pokhreli			R21	MANSARA	
	R22	Salen			R22	MAYALU	
	R23	Seto			R23	MORE MARSI	
	R24	Takmare			R24	NAAULE	
					R25	PAMALI	
					R26	PIYAILE	
					R27	RATO ANADI	
					R28	SALEN	
					R29	SANO MASINO	
					R30	SEETO	
					R31	SEETO KAALO	
					R32	SEETO KARTIKE	
					R33	TAMARE	
					R34	TULSI RICE	

Based on Passport data form Lamjung CSB…

	Altitude (m)		**Altitude (m)**		**Altitude (m)**
	900 to 1000m		**1000 to 1300m**		**1300 to 1700m**
	RICE		**RICE**		**RICE**
R1	DALLE	R1	AAUGA	R1	CHEMONG
R2	EKLE	R2	GUDIR	R2	DAMARLI
R3	GAURE	R3	JURDUNG	R3	KAALO PATLE
R4	INDRABALI	R4	KAALO JHINUWA	R4	KHAIRO
R5	JAWALI	R5	KAGHIRO	R5	LEKALI BASMATI
R6	JHAI RICE	R6	KARTIKE	R6	LEKALI RATO
R7	KANKAA JEERA	R7	MANSARA	R7	SEETO
R8	LAMA GAUN RICE	R8	MAYALU	R8	SEETO KAALO
R9	MORE MARSI	R9	PAMALI	R9	SEETO KARTIKE
R10	NAAULE	R10	RATO ANADI	R10	TAMARE
R11	PIYAILE	R11	SALEN		
R12	TULSI RICE	R12	SANO MASINO		

Rice and Bean Landraces in Lamjung-baseline data

	Site	Ghanpokhara, Lamjung		
	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Rice	40353.2	574.6	170
1	Anadi	97.6	1.5	2
2	**Anga**	**3062.2**	**44.6**	**19**
3	Basmati	2025.2	30	8
4	Bote	1512.8	21	4
5	Chhomorong	1811.2	22	9
6	Chote	244	4	1
7	Dalle	1403	17.5	6
8	**Darmali**	**3342.8**	**45**	**15**
9	**Gaure**	**3952.8**	**59**	**15**
10	Gurdi	732	12	2
11	Jau Dhan	1024.8	9.5	3
12	Kageri	1903.2	25	5
13	Kalo Dhan	1874	26.5	9
14	Kalo Jhinuwa	2488.8	24	9
15	**Kattike**	**2713.2**	**41**	**13**
16	Khairo	380.4	4	1
17	Khumal-4	780.8	11.5	5
18	Lekali Basmati	1268.8	24	6
19	**Pamali**	**6563.6**	**107**	**24**
20	Piyale	976	10.5	4
21	Pokhreli	780.8	12	3
22	Salen	878.4	13	4
23	Seto	292.8	6	1
24	Takmare	244	4	2
	Grand Total	40353.2	574.6	170

	Site	Ghanpokhara, Lamjung		
	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Bean	179	56.3	42
1	Barkhe Simi	0	0	2
2	Chirke mirke	2	0	2
3	Hiude Simi	26	2.5	5
4	Kalo Chirbire	0	4	6
5	Local/Sthaniya	30	4.3	3
6	Rato Chepte	1	0	2
7	Rato-Ghiu Simi	10	15	8
8	**Seto**	**100**	**29.5**	**13**
9	Tinmase	10	1	1
	Grand Total	179	56.3	42

Site		Baseline Survey 2014				CSB Passport Data		
Hanku, Jumla		**Rice**		**Bean**		**Rice**		**Bean**
	R1	Chandannath-1	B1	Bhote	R1	Jumli marsi	B1	Besary Pahelo
	R2	Chandannath-3	B2	Kalo	R2	Kalimarsi	B2	Cheelo kalo sano
	R3	Darime	B3	Kalo Kirbire	R3	Pakhedhan	B3	Coffee rang
	R4	Marshi	B4	Kirbire			B4	Fusro Chherkey
	R5	Melte	B5	Lamre			B5	Gajaley Sada
	R6	Tinmase	B6	Male			B6	Gheu rang
			B7	Mix (all)			B7	Gheu rang lamo
			B8	PB0002			B8	Kailo Seto Sano
			B9	Rajma			B9	Kalegi Chherkey sano
			B10	Rato			B10	Kalegi Chherkey thulo
			B11	Rato Kirbire			B11	Kalegi Sada
			B12	Seto			B12	Kalo lamo
							B13	Kalo maley
							B14	Kalo sano
							B15	Khairo Chherkey
							B16	Khairo lamo
							B17	Khairo thulo chherkey
							B18	Kharani Sada
							B19	Pahelo chherkey
							B20	Pahelo golo
							B21	Rato lamo
							B22	Rato maley
							B23	Rato sano
							B24	Seto Chherkey
							B25	Seto Chherkey thulo
							B26	Seto dallo sano
							B27	Seto lamo
							B28	Sindure
							B29	Sindure Chherkey

Rice and Bean landraces in Hanku, Jumla-baseline data

	Site	Hanku, Jumla		
SN	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Bean	6522.01	154.5	144
1	Bhote	53	2	2
2	**Kalo**	**1490.17**	**35.54**	**37**
3	Kalo Kirbire	106.67	2.2	2
4	Kirbire	260	6.19	5
5	Lamre	33	0.75	1
6	Male	96	2.75	4
7	Mix (all)	480	14.3	7
8	PB0002	60	1.5	1
9	Rajma	95	1.87	3
10	**Rato**	**3512.67**	**80.76**	**72**
11	Rato Kirbire	114.17	1.3	3
12	Seto	221.33	5.34	7
	Rice	40180	213.6	124
1	**Chandannath-1**	**3910**	**22.5**	**24**
2	**Chandannath-3**	**5200**	**25.5**	**23**
3	Darime	1300	6	3
4	**Marshi**	**29170**	**155.6**	**72**
5	Melte	300	2	1
6	Tinmase	300	2	1
	Grand Total	46702.01	368.1	268

Site		Baseline Survey 2014				CSB Passport Data		
Chhipra, Humla		**Rice**		**Bean**		**Rice**		**Bean**
	R1	Chandanath-3	B1	Dalle	R1	KALI MARSI	B1	KALO
	R2	Chandanath-4	B2	Kale	R2	KALO LUMSERO	B2	KALO MALE
	R3	Chandanath-5	B3	Male	R3	THAPACHINI	B3	PAHELO
	R4	Chandanath-6	B4	Mix (Kalo, Malae)			B4	RATO MALE
	R5	Chandanath-7	B5	Mix (Kalo, Malae, Dallae)			B5	SETO MALE
	R6	Chandanath-8	B6	Mix (Kalo, Malae, Jumli, Dallae)				
	R7	Chandanath-9	B7	Mix (Kalo, Seto, Malae)				
	R8	Dudhae	B8	Seto				
	R9	Jugiya/Juge						
	R10	Kalo Marshi/Jumli						

Based on CSB data from Chhipra, Humla

Altitude (m)	1250
1200-1300m	

Count of Farmer's or Donor's Name	Column Labels	
Row Labels	**PAHELO**	**Grand Total**
BEAN	**1**	**1**
PAHELO	1	1
Grand Total	**1**	**1**

Altitude (m)	(Multiple Items)
1300-1500m	

Count of Farmer's or Donor's Name	Column Labels		
Row Labels	**KAALO**	**KAALO MAALE**	**Grand Total**
BEAN	**1**	**1**	**2**
KALO	1		1
KALO MALE		1	1
Grand Total	**1**	**1**	**2**

Altitude (m)	(Multiple Items)
1500-2200m	

Count of Farmer's or Donor's Name	Column Labels			
Row Labels	**DHAN**	**SEETO MAALE**	**SIMI**	**Grand Total**
BEAN		**1**	**1**	**2**
RATO MALE			1	1
SETO MALE		1		1
RICE	**3**			**3**
KALI MARSI	1			1
KALO LUMSERO	1			1
THAPACHINI	1			1
Grand Total	**3**	**1**	**1**	**5**

Rice and Bean landraces in Chhipra, Humla-baseline data

	Site	Chhipra, Humla		
SN	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Bean	2202	2541	91
1	Dalle	70	205.3	4
2	**Kale**	**599**	**660.6**	**30**
3	**Male**	**873**	**1236.8**	**35**
4	**Mix (Kalo, Malae)**	**495**	**426**	**15**
5	Mix (Kalo, Malae, Dallae)	50	0.5	1
6	Mix (Kalo, Malae, Jumli, Dallae)	30	0.5	1
7	Mix (Kalo, Seto, Malae)	5	0.5	1
8	Seto	80	10.8	4
	Rice	1966	183.95	45
1	Chandanath-3	6	0.5	1
2	Chandanath-4	40	0.25	1
3	Chandanath-5	100	1	1
4	Chandanath-6	120	1	1
5	Chandanath-7	50	1	1
6	Chandanath-8	60	2	1
7	Chandanath-9	30	0.5	1
8	Dudhae	275	3.5	6
9	**Jugiya/Juge**	**345**	**160**	**11**
10	**Kalo Marshi/Jumli**	**940**	**14.2**	**21**
	Grand Total	4168	2724.95	136

Site		**Baseline Survey 2014**				**CSB Passport Data**		
Jungu, Dolakha		**Rice**		**Bean**		**Rice**		**Bean**
	R1	Atahattar	B1	Chaumase	R1	Aanga	B1	Aashar(Maki)
	R2	Atte	B2	Dapcha/Dape	R2	Anadi	B2	Halka payalo rato mix(ghu simi)
	R3	Chauhattar	B3	Ghiu Simi	R3	Basmati	B3	Hariyo Tate/Heude
	R4	Chote-Dolakha	B4	Kalo	R4	Chote Marshi	B4	Makai/Kalo
	R5	Ghaiya	B5	Local/Barkhe/Soste	R5	Dudhe Marshi	B5	Nelo(Tumma)
	R6	Gudule Marshi	B6	Paheyli	R6	Gurgure Marshi	B6	Payalo singtame
	R7	Himali	B7	Rajma	R7	Hile Marshi	B7	Singare Gheu Simi
	R8	Jhingamali	B8	Rato/Bikase	R8	Jhingamali		
	R9	Manakamana	B9	Seto	R9	Kaijale Marshi		
	R10	Mansuli	B10	Simtame	R10	Kali Marshi		
	R11	Marse	B11	Singare	R11	Latte		
	R12	Pokhreli	B12	Tate	R12	Paheli Marshi		
	R13	Rambilas	B13	Trisulu/Khairo dana	R13	Pakhi Dhan		
	R14	Ramsari Marshi			R14	Pakhime		
	R15	Taichung			R15	Pani Dhaiya		
	R16	Tilpunge			R16	Rambilas		
					R17	Rato Himali		
					R18	Sano Marshi		
					R19	Seto Himali		
					R20	Sigare Marshi		
					R21	Taichin		
					R22	Tauli		
					R23	Tilpune Marshi		

Jungu, Dolakha-CSB data

Altitude (m)	(Multiple Items)
1200-1300m	
Row Labels	**Count of Farmer or Donor Name**
Dhaan	**3**
Hile Marshi	1
Pani Dhaiya	1
Rambilas	1
Grand Total	**3**

Altitude (m)	(Multiple Items)
1300-1500m	
Row Labels	**Count of Farmer or Donor Name**
Dhaan	**7**
Anadi	1
Basmati	1
Chote Marshi	1
Gurgure Marshi	1
Kaijale Marshi	1
Paheli Marshi	1
Pakhime	1
Dhan	**1**
Tauli	1
Simi	**1**
Hariyo Tate/Heude	1
Grand Total	**9**

Altitude (m)	(Multiple Items)
1500-1900m	
Row Labels	**Count of Farmer or Donor Name**
Dhaan	**10**
Aanga	1
Dudhe Marshi	1
Jhingamali	1
Kali Marshi	1
Pakhi Dhan	1
Sano Marshi	1
Seto Himali	1
Sigare Marshi	1
Taichin	1
Tilpune Marshi	1
Dhan	**2**
Latte	1
Rato Himali	1
Simi	**5**
Halka payalo rato mix(ghu simi)	1
Makai/Kalo Nelo(Tumma)	1
Payalo singtame	1
Singare Gheu Simi	1
Grand Total	**17**

Rice and Bean landraces in Jungu, Dolakha-baseline data

	Site	Jungu, Dolakha		
SN	Row Labels	Sum of Total production (Kg)	Sum of Area (Ropani)	Count of Respondent Name
	Bean	769.62	967.33	154
1	**Chaumase**	**38.87**	**91**	**10**
2	Dapcha/Dape	9	3	2
3	**Ghiu Simi**	**110.5**	**177**	**17**
4	**Kalo**	**59.5**	**108**	**14**
5	**Local/Barkhe/Soste**	**234.75**	**88.33**	**36**
6	**Paheyli**	**148**	**202**	**25**
7	Rajma	5	28	2
8	Rato/Bikase	21	48	3
9	Seto	21	37	3
10	**Simtame**	**45**	**93**	**12**
11	Singare	21	51	4
12	**Tate**	**34.5**	**27**	**18**
13	Trisulu/Khairo dana	21.5	14	8
	Rice	36362.5	304.25	99
1	**Atahattar**	**5107.4**	**42.25**	**12**
2	Atte	684	4.5	1
3	Chauhattar	1368	11	5
4	Chote-Dolakha	1778.4	10	4
5	Ghaiya	273.6	1.25	1
6	Gudule Marshi	1026	8.5	3
7	**Himali**	**2313.8**	**25**	**12**
8	Jhingamali	512	3.5	2
9	Manakamana	393	4	2
10	Mansuli	615.6	3.5	1
11	**Marse**	**12386.3**	**119**	**31**
12	**Pokhreli**	**5227.6**	**32.5**	**11**
13	Rambilas	1368	7	3
14	Ramsari Marshi	2257.2	16.5	5
15	Taichung	580.8	6	3
16	Tilpunge	470.8	9.75	3
	Grand Total	37132.12	1271.58	253

Based on phone conversation

Maramche, Kaski- Rice and Bean Resources

SN	Crop name	Local crop name	Remarks
	Rice		
R1	Rice	Kathedhan	Most popular
R2	Rice	Kalo Patle	Most popular
R3	Rice	Juwari	Lower belt
R4	Rice	Maisare	
R5	Rice	***Lumle-2***	**Commercial**
R6	Rice	***Machhapuchchhre-3***	**Commercial**
R7	Rice	Chhomrong Local	Commercial
R8	Rice	Deupare Kathe	
R9	Rice	Silange	Popular
R10	Rice	***Khumal-4***	**Popular**
	Bean		
B1	Bean	Hiude Simi (Tate, Gothe)	Most popular
B2	Bean	Ghiu Simi	Most popular
B3	Bean	Kathe Simi	
B4	Bean	Ghandruke Simi	
B5	Bean	Chaumase Simi	
B6	Bean	Tate Simi	

* Kalo Patle and Machhapuchchhre-3 mixture reduces bird losses, disease outbreak and improves taste (personal communication).

Community Seed Bank, Bhanu-09, Purkot, Tanahun

- Rice:

Rato Anadi, Seto Anadi, Ghiupuri, Aanpbhukte, Chiniya Jethobudho, Kalo Dalle Masino, Kalo Masino, Mansara Kathe, Kalo Patle, Marsi (12 landraces), Chobo, Thathe, Pakhe Jhinuwa, Devkotini (4 landraces)

- Bean:

Tate, Hariyo, Tate Rato (2 landraces)

Sample Collection Methods

- We have **baseline survey and passport data** as a reference.
- CSB also maintains **diversity blocks** of some of the local landraces.
- Seeds can be collected through **CSB**s at respective sites.
- We can go to the **individual farmer**'s location based on passport data from CSB and collect the seeds.
- **Gene Bank** also has some amount of seeds supplied from CSBs and on their own.

Basis of selection???

- Use
- Growth duration and time of cultivation
- Disease and tolerance
- Specific value such as aroma, fineness etc.

- Thank you!

By SP Neupane

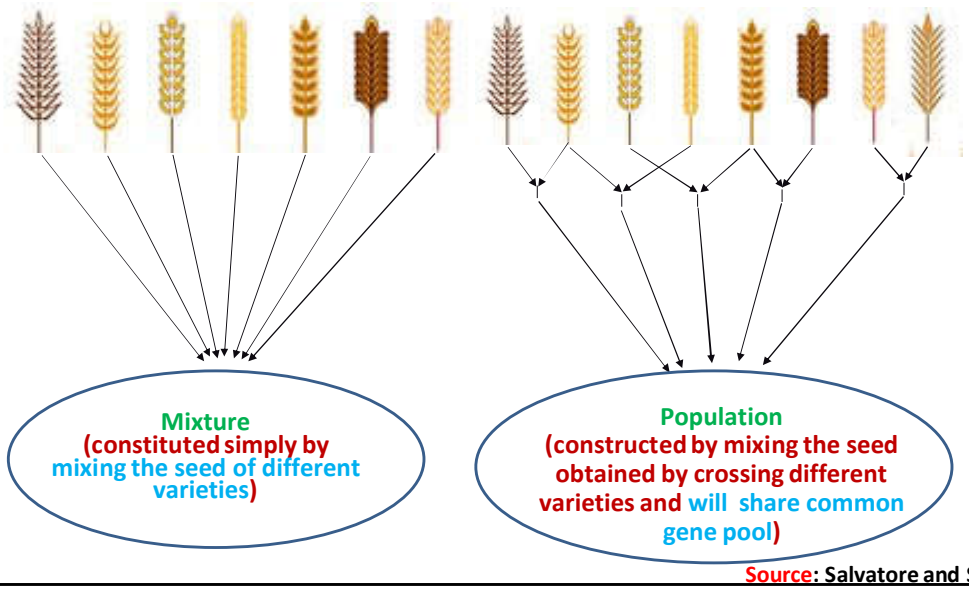
Result Sharing of Evolutionary Plant Breeding (EPB) Project at Provincial Level

Result Sharing of Evolutionary Plant Breeding (EPB) Project at Provincial Level

Shree Prasad Neupane PhD, Thematic Team Leader cum Plant Breeder, LI-BIRD

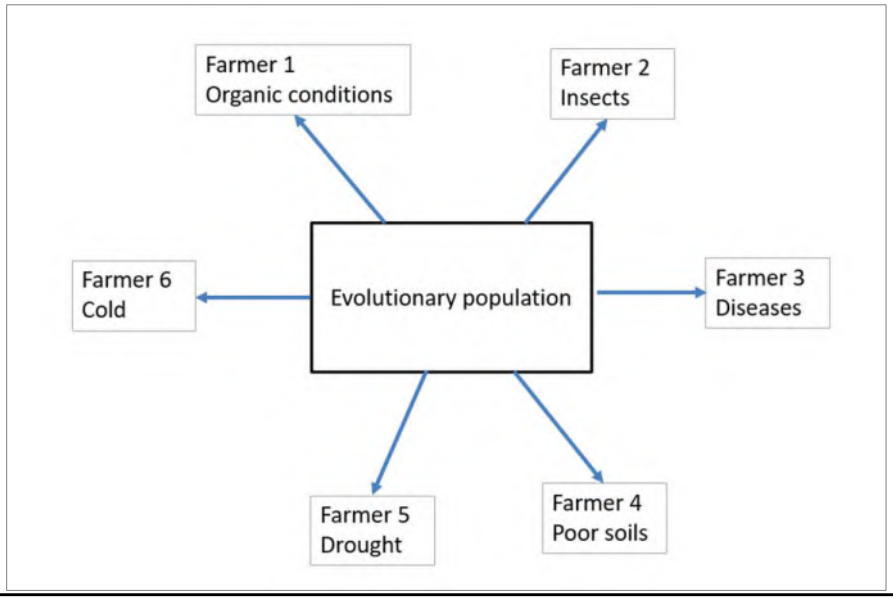
Local Initiatives for Biodiversity, Research and Development (LI-BIRD)
www.libird.org • info@libird.org

Scientific background



Source: Salvatore and Stefania, 2019

Genetic diversity: solution for diverse target environment



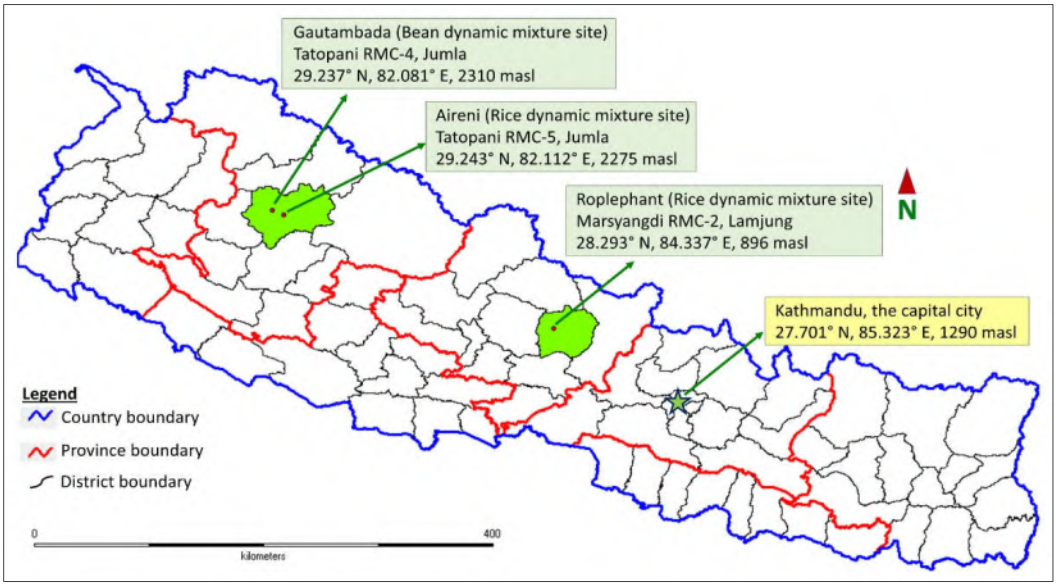
National provision for varietal registration (Where we are !)

Image credit: Ramesh Acharya, DoAR, Lumle

Overview of project

Objectives/ Outcomes	the **resilience of target low-input poor farmers in the project area is enhanced through developing evolutionary crop populations (EP) with higher and stable yields** under the local farm agronomic and stress conditions, including drought, salinity, pests and diseases.
Duration	I June 2018 to 30 March 2023
Funding agency	International Fund for Agricultural Development (IFAD)
Implementing countries	Iran, Jordan, **Nepal**, Bhutan, Ethiopia and Uganda (**6**)
Partners/ Collaborators	LI-BIRD, NARC/National Gene Bank and Bioversity International

Project location



Germplasm sources and composition (Overall)

Location	Crop	Germplasm used	Germplasm source	Total Germplasm used
Lamjung	Rice	Local landrace + released/registered varieties + Breeding lines	Farmers Field, National Gene Bank, Agriculture Botany Division and other NARC stations	56 (#12 entries)
Jumla	Rice	Local landrace + released/registered varieties + Breeding lines	Farmers Field, National Gene Bank, Agriculture Botany Division and other NARC stations	66 (# 9 entries)
Jumla	Bean	Local landrace + released/registered varieties + Breeding lines	Farmers Field, National Gene Bank, and other NARC stations	49 (# 9 entries)

Germplasm composition (Rice, Lamung)

Entry Number	Composition	Entry Abbreviation
1	21 local landraces	LA_MIX1
2	25 landraces from similar agro-ecological domains	LA_MIX2
3	5 improved cultivars	LA_MIX3
4	46 landraces, 5 improved cultivars and 5 advanced breeding lines	LA_MIX4
5	Gaure (**Local check**)	GA
6	Khumal 4 (**Improved check**)	KH_4
7	Early selected sub-population from RicSEP plot in Lamjung (male selected)	EMS_LA_SEP
8	Early selected sub-population from RicSEP plot in Lamjung (female selected)	EFS_LA_SEP
9	Early selected sub-population from RicSEP plot in Lamjung (technician selected)	ETS_LA_SEP
10	Late selected sub-population from RicSEP plot in Lamjung (male selected)	LMS_LA_SEP
11	Late selected sub-population from RicSEP plot in Lamjung (female selected)	LFS_LA_SEP
12	Late selected sub-population from RicSEP plot in Lamjung (technician selected)	LTS_LA_SEP

Germplasm composition (Rice, Jumla)

Entry Number	Composition	Entry Abbreviation
1	4 local landraces	JU_MIX1
2	37 landraces from similar agro-ecological domains	JU_MIX2
3	6 improved cultivars	JU_MIX3
4	41 landraces, 6 improved cultivars and 19 advanced breeding lines	JU_MIX4
5	Jumli Marshi (**Local Check**)	JM
6	Chandannath-3 (**Improved Check**)	CH_3
7	Selected sub-population from RicSEP plot in Jumla (male selected)	MS_JU_SEP
8	Selected sub-population from RicSEP plot in Jumla (female selected)	FS_JU_SEP
9	Selected sub-population from RicSEP plot in Jumla (technician selected)	TS_JU_SEP

Germplasm composition (Bean, Jumla)

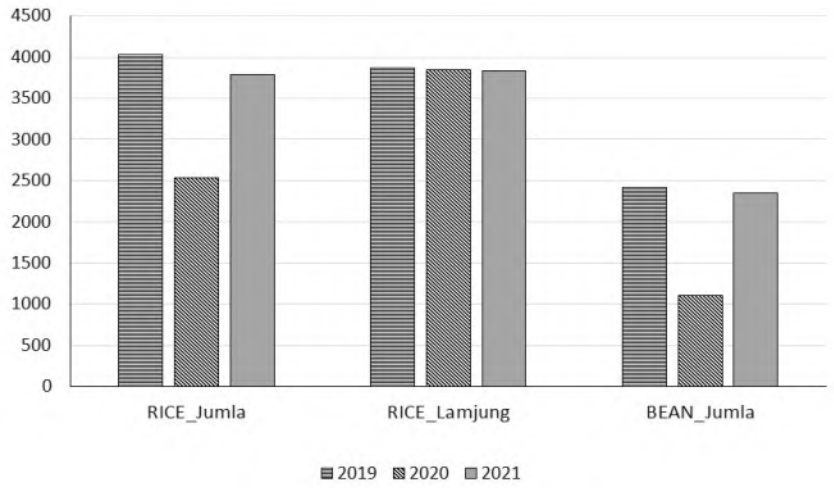
Entry Number	Composition	Entry Abbreviation
1	21 Local landraces	BeEP1
2	21 landraces from similar agro-ecological domains	BeEP2
3	6 breeding lines from Jumla	BeEP3
4	41 landraces and 6 breeding lines	BeEP4
5	Kalo Male (**Local Check**)	BeEP5
6	Trishuli (**Improved Check**)	BeEP6
7	Selected sub-population from BeSEP plot in Jumla (male selected)	BeSEP1
8	Selected sub-population from BeSEP plot in Jumla (female selected)	BeSEP2
9	Selected sub-population from BeSEP plot in Jumla (technician selected)	BeSEP3

Functional Trait Diversity (while making mixtures)

Traits	Germplasm type
Canopy area utilization (below and above ground surface area)	Short, medium and long root length Tall, medium and dwarf plant Different shape, size and color (stem and leaf)
Insect and disease tolerance	Different reaction to insect pests and diseases Smooth and rough (uneven) stem and leaves Aromatic and non-aromatic (for rice) Short and medium awn (for rice)
Drought tolerance	Deep rooted Erect leaves Tall, medium and dwarf plant height Large leaf but few in number (for rice)
Commonalities among traits within varieties	Similar maturity period Easiness in threshing and threshing method Similar cooking time and method Similar milling quality

Diagram of product advancement at field level (2018-2022)

Key Results (Grand mean of grain yield)



Value in Y-axis represents grand grain yield means (Kg/ha) of three trials of rice and beans in Lamjung and Jumla from 2019-2021

Key Results (ANOVA: Rice in Jumla)

Source of variation	DF	DM	PH	NT	NP	PL	TGW	GY[a]
Entries (E)	116.7***	110.3***	1041.7***	78.0***	65.9***	87.3***	16.1***	39.9**
Year (Y)	31822.7***	44043.8***	2069.4***	1013.1***	784.9***	460.4***	356.3***	136.6***
E x Y	9.2**	11.6***	131.4	8.6	9.3	11.4*	3.8	15.1
Plants w. E (P_E)	-		166.0	14.3*	14.0**	6.5		
Residual	3.29	0.44	148.30	10.0	9.8	5.68	3.8	12.7

*** = P<0.05;** = P<0.01; ;*** = P<0.001**

Key Results (means across years on rice in Jumla)…

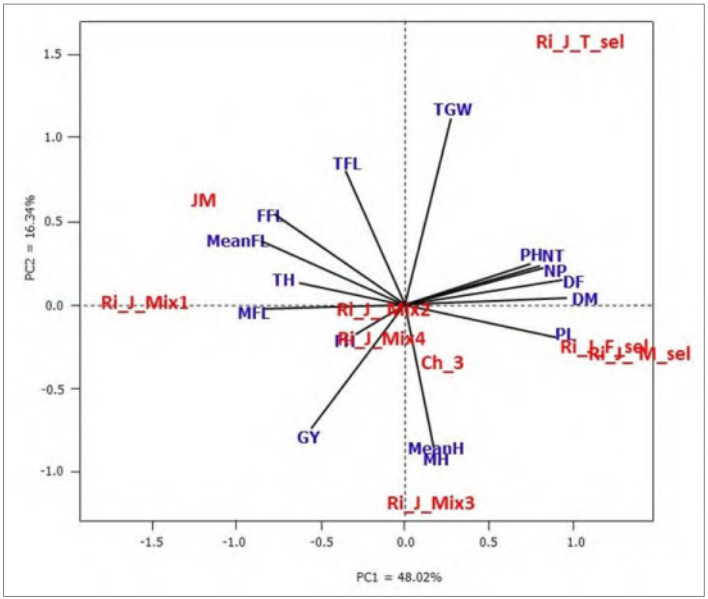
Entry Name[a]	DF	DM	PH	NT	NP	PL	TGW	GY
Ri_J_Mix1	100 cd	148.4 f	91.8 de	6.5 b	6.4 b	18.9 de	30.8 cd	3518 a
Ri_J_Mix2	103 b	149.8 e	92.0 cde	6.7 b	6.8 b	20.2 bc	31.6 abcd	3394 ab
Ri_J_Mix3	101.7 bc	151.8 d	89.5 e	7.1 b	7.1 b	19.8 cd	29.8 d	3495 a
Ri_J_Mix4	100.6 cd	150.4 e	94.8 bcd	6.8 b	6.6 b	19.7 cd	30.9 bcd	3306 abc
JM	98.7 d	148.1 f	91.2 de	6.6 b	6.6 b	18.1 e	33.0 ab	3082 bc
CH_3	103.3 b	151.5 d	98.6 ab	6.8 b	6.7 b	20.8 ab	30.7 d	3140 abc
Ri_J_M_sel	106.1 a	155.0 a	99.4 a	9.4 a	9.1 a	21.6 a	31.6 abcd	3230 abc
Ri_J_F_sel	106.4 a	153.5 c	96.1 abc	8.6 a	8.3 a	20.8 ab	32.8 abc	2925 c
Ri_J_T_sel	105.9 a	154.2 b	96.6 ab	8.5 a	8.4 a	20.6 bc	33.6 a	2949 c

Means with a letter in common are not significantly different (P<0.05)

Key Results (farmers and technicians preference on rice in Jumla)…

Entry Name[a]	FFL	MFL	TFL	FH	MH	TH	MeanFL	MeanH
Ri_J_Mix1	11.6 a	9.5 a	7.9 a	5.3	4.1	6.1 a	9.9 a	3.8
Ri_J_Mix2	4.4 bc	4.9 abc	4.2 b	2.6	3.7	2.9 ab	4.7 bc	2.5
Ri_J_Mix3	1.9 c	3.7 bc	0.8 b	3.5	4.4	1.4 b	2.2 c	3.6
Ri_J_Mix4	5.2 bc	5.6 abc	2.1 b	2.2	3.4	2.4 ab	4.1 bc	2.9
JM	7.6 ab	7.9 ab	2.1 b	3.5	2.0	6.9 a	6.7 b	3.1
CH_3	3.0 c	2.9 c	0.8 b	4.7	2.3	4.6 ab	2.4 c	3.4
Ri_J_M_sel	4.0 bc	4.3 bc	0.0 c	3.3	4.5	3.0 ab	3.1 c	4.1
Ri_J_F_sel	1.5 c	3.7 bc	3.3b	3.7	6.5	4.0 ab	2.3 c	5.1
Ri_J_T_sel	5.3 bc	1.8 c	7.0 a	3.0	0.8	1.3 b	3.7 bc	1.8
$P_{F(Entries)}$	0.001	0.015	0.0006	0.42	0.198	0.032	<0.0001	0.747

Key Results (Biplot of rice in Jumla)



Key Results (ANOVA: Rice in Lamjung)

Source of variation	DF	DM	PH	NT	NP	PL	TGW	GY[a]
Entries (E)	679***	715.8***	17559.1***	2.2**	2.5***	71.9	8.9	145.3***
Year (Y)	33.3	38.5'	4095.4'	2.3'	3.2*	38.9	54.7**	3.4
E x Y	35.9***	9.6***	873.0***	0.5	0.8	35.1***	7.8**	24.7
Plants w. E	-	-	338.0	-	-	7.7	-	-
Residual	2.00	0.43	241.7	0.70	0.65	7.7	2.6	34.6

* = P<0.05;** = P<0.01; ;*** = P<0.001

Key Results (means across years on rice in Lamjung)

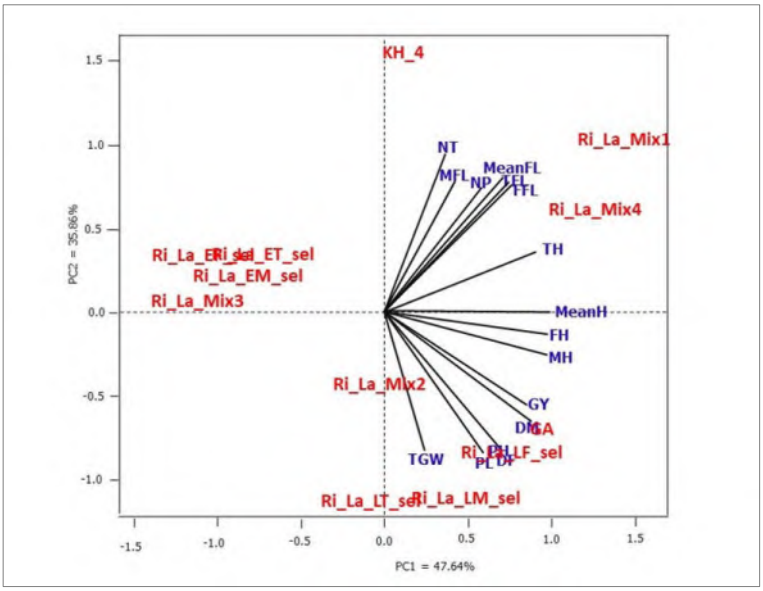
Entry Name[a]	DF	DM	PH	NT	NP	PL	TGW	GY
Ri_La_Mix1	116.4 e	167.7 cd	136.0 d	8.0 a	7.5 a	22.8	26.7	4214 ab
Ri_La_Mix2	126.6 c	167.2 d	141.7 c	7.4 ab	7.1 ab	23.2	28.7	4039 abc
Ri_La_Mix3	108.3 g	149.3 ef	107.9 g	6.6 bc	5.5 d	21.7	26.1	3424 cde
Ri_La_Mix4	116.9 e	167.7 cd	133.4 d	7.4 ab	7.0 abc	22.2	27.6	4053 abc
GA	134.7 a	172.7 a	143.7 c	6.6 bc	6.3 bcd	24.0	26.8	4065 abc
KH_4	108.0 g	148.3 g	114.8 f	7.9 a	7.6 a	21.9	24.4	3630 bcd
Ri_La_EM_sel	105.6 h	148.2 g	120.6 e	6.6 bc	5.8 d	21.4	27.4	3208 de
Ri_La_EF_sel	104.1 h	149.8 e	119.9 ef	6.7 bc	6.3 bcd	21.4	25.9	2908 e
Ri_La_ET_sel	111.1 f	148.8 fg	123.2 e	7.2 abc	6.4 bcd	22.1	26.7	3114 de
Ri_La_LM_sel	128.8 b	168.6 b	152.0 a	6.4 bc	6.2 bcd	24.6	28.4	4478 a
Ri_La_LF_sel	129.4 b	168.2 bc	149.2 ab	6.3 c	6.0 cd	24.1	27.9	4348 a
Ri_La_LT_sel	121.1 d	168.0 bc	144.3 bc	6.0 c	5.8 d	23.8	27.7	4260 ab
$P_{F(Entries)}$	0.001	0.001	0.001	0.003	0.001	0.093	.397	0.005

Means with a letter in common are not significantly different (P<0.05)

Key Results (farmers and technicians preference on rice in Lamjung)…

Entry Name[a]	FFL	MFL	TFL	FH	MH	TH	MeanFL	MeanH
Ri_La_Mix1	5.64 a	4.75	6.21 a	4.11 abc	3.95 abc	6.03 a	5.53 a	4.70 ab
Ri_La_Mix2	1.90 b	3.28	0.68 f	1.57 cde	1.31 de	0.90 de	1.95 b	1.26 ef
Ri_La_Mix3	0.86 b	1.53	1.96 cdef	1.02 e	0.84 de	1.31 de	1.45 b	1.05 ef
Ri_La_Mix4	5.73 a	3.33	5.50 a	4.82 ab	4.91 ab	5.34 a	4.86 a	5.02 a
GA	2.39 b	1.92	2.84 c	5.66 a	5.08 ab	4.96 a	2.38 b	5.24 a
KH_4	5.20 a	4.35	4.62 b	2.78 bcde	2.28 cde	2.97 bc	4.72 a	2.67 cde
Ri_La_EM_sel	1.52 b	3.74	1.16 def	1.36 de	1.95 cde	1.14 de	2.14 b	1.48 def
Ri_La_EF_sel	1.76 b	1.97	1.35cdef	1.13 de	0.54 e	0.94 de	1.69 b	0.87 f
Ri_La_ET_sel	1.56 b	2.14	2.57 cd	0.55 e	0.75 de	2.37 bcd	2.09 b	1.22 ef
Ri_La_LM_sel	1.74 b	1.54	1.96 cdef	2.56 bcde	3.18 bcd	3.36 bc	1.75 b	3.03 bcd
Ri_La_LF_sel	2.36 b	3.18	2.37 cde	3.77 abc	5.74 a	2.16 cde	2.64 b	3.89 abc
Ri_La_LT_sel	1.52 b	1.15	0.95 ef	3.33 abcd	2.54 cde	0.77 e	1.21 b	2.21 cdef
$P_{F(Entries)}$	0.0003	0.174	<0.00001	0.0002	0.00006	<0.00001	<0.00001	<0.00001

Key Results (Biplot on rice in Lamjung)



Key Results (ANOVA: Beans in Jumla)

Source of variation	DF	DM	PH	PodP	PodL	TGW	GY[a]
Entries (E)	76.8	10.9	22630.9'	299.9	406.9'''	4810.4'	770.8
Year (Y)	446.4'''	145.8''	39859.8'	2965.9''	179.3'''	11056.2''	13217.8'''
E x Y	34.0'''	15.2'''	7245.2'''	277.4'''	8.2''	1703.3'''	466.4'
Plants w. E	-	-	363.1	12.7	3.2		
Residual	0.3	1.4	466.6	12.6	3.7	248.6	201.2

* = P<0.05;** = P<0.01; ;*** = P<0.001

Key Results (means across years on beans in Jumla)

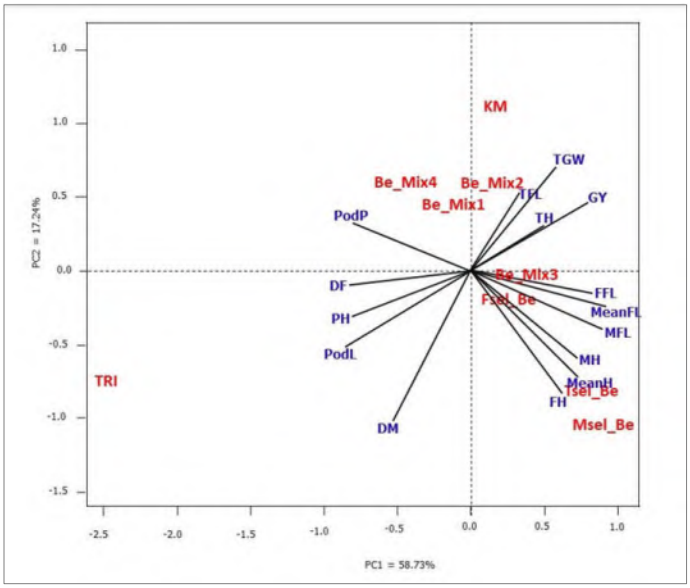
Entry Name[a]	DF	DM	PH	PodP	PodL	TGW	GY
Be_J_Mix1	52.8	92.9	47.7 c	7.56	10.4 b	247.8 bc	1972
Be_J_Mix2	52.6	92.7	45.6 c	8.83	10.2 b	226.5 d	2037
Be_J_Mix3	50.3	92.9	58.0 b	8.04	9.9 bc	272.1 a	1899
Be_J_Mix4	52.3	93.3	48.9 c	8.18	10.0 bc	245.8 bc	1969
KM	47.4	92.6	57.5 b	8.32	9.1 d	279.5 a	1874
TRI	56.8	95.1	84.0 a	10.15	15.8 a	197.1e	955
Be_J_M_sel	49.5	93.7	49.9 c	7.01	9.8 bc	238.3 bcd	1994
Be_J_F_sel	47.8	93.9	45.6 c	6.39	9.5 cd	254.4 b	1674
Be_J_T_sel	48.0	93.5	46.6 c	6.48	10.1 bc	233.0 cd	1929

Means with a letter in common are not significantly different (P<0.05)

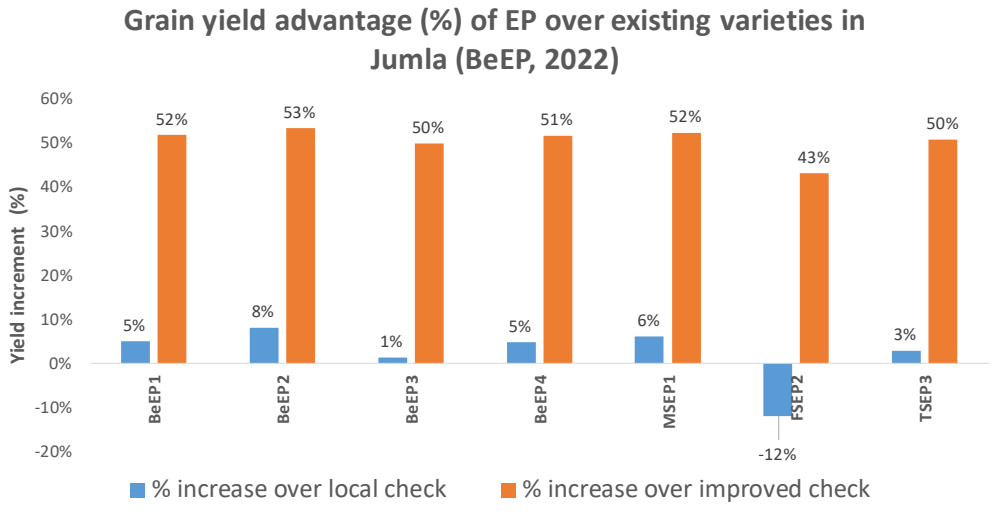
Key Results (farmers and technicians preference on beans in Jumla)…

Entry Name[a]	FFL	MFL	TFL	FH	MH	TH	MeanFL	MeanH
Be_J_Mix1	2.93	2.71	2.78	3.07	2.71 b	2.67	2.76	2.99 cde
Be_J_Mix2	2.64	3.21	4.90	3.90	4.00 b	4.62	3.16	3.82 bcd
Be_J_Mix3	2.99	4.36	2.41	5.47	6.26 b	3.40	3.11	4.84 abc
Be_J_Mix4	3.54	2.83	1.78	0.92	0.93 b	1.40	2.79	0.97 e
KM	4.14	3.48	3.77	0.79	1.98 b	2.51	3.78	1.54 de
TRI	0.55	0.64	1.27	1.35	0.36 b	0.51	0.63	0.76 e
Be_J_M_sel	5.66	5.50	2.02	7.33	6.67 a	3.33	5.11	6.81 a
Be_J_F_sel	5.00	3.67	1.02	3.50	2.67 b	3.33	3.95	2.92 cde
Be_J_T_sel	4.33	5.67	3.68	6.00	6.67 a	1.33	5.00	5.81 ab
$P_{F(Entries)}$	0.373	0.106	0.547	0.262	0.0002	0.5050	0.110	0.048

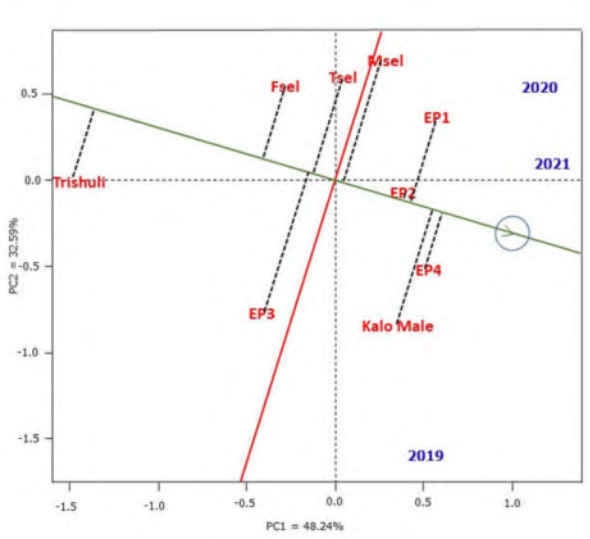
Key Results (Biplot on beans in Jumla)

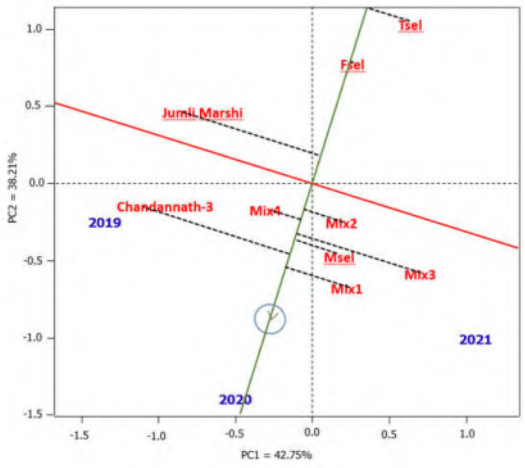


Yield advantage of EP over existing varieties, BeEP, Jumla (Combined data, 2019-2021)

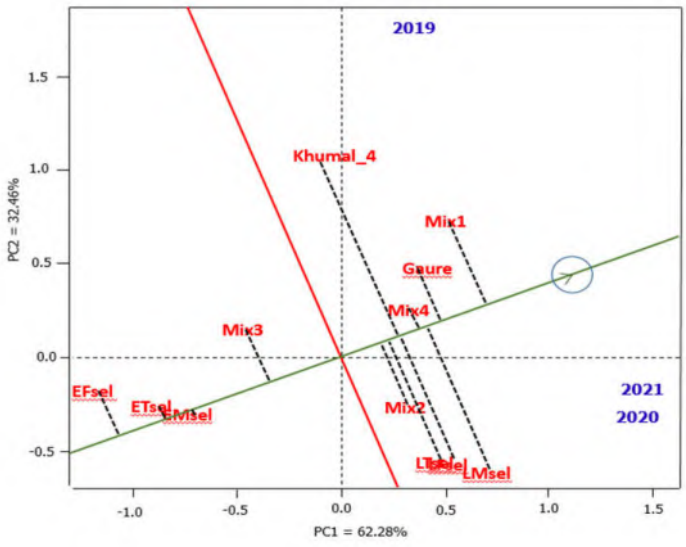


EPB population over years, BeEP and RicEP, Jumla (stability analysis)

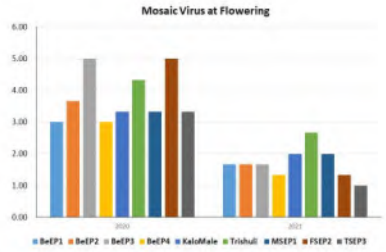


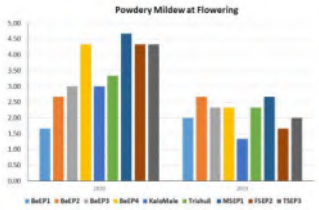


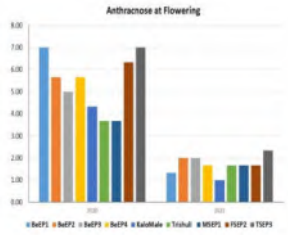
EPB population over years, RicEP, Lamjung (stability analysis)

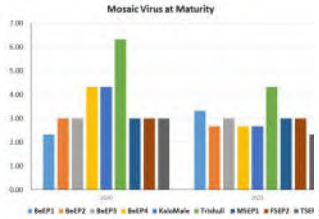


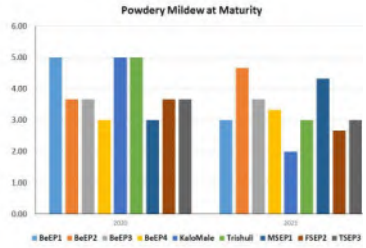
Disease score evaluation over year (Bean pop.)

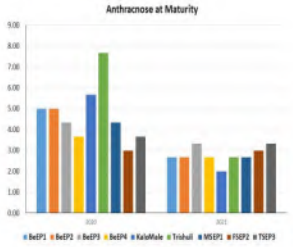






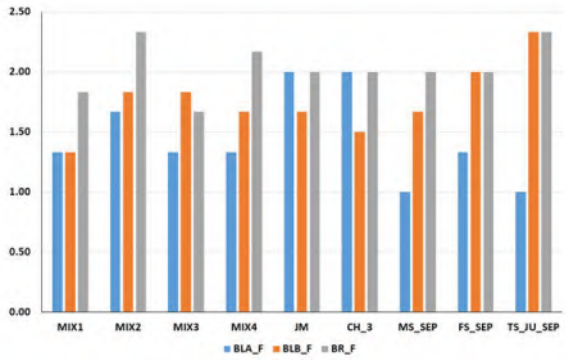




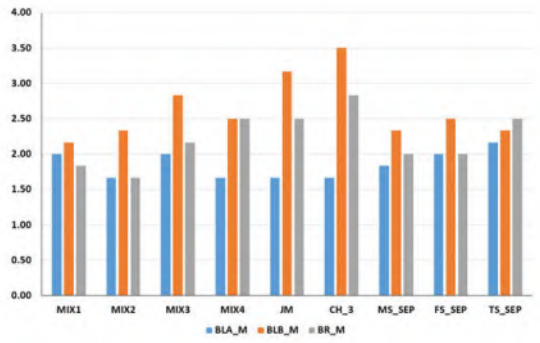


Disease reaction in rice population in Jumla, 2019-2021

Flowering stage

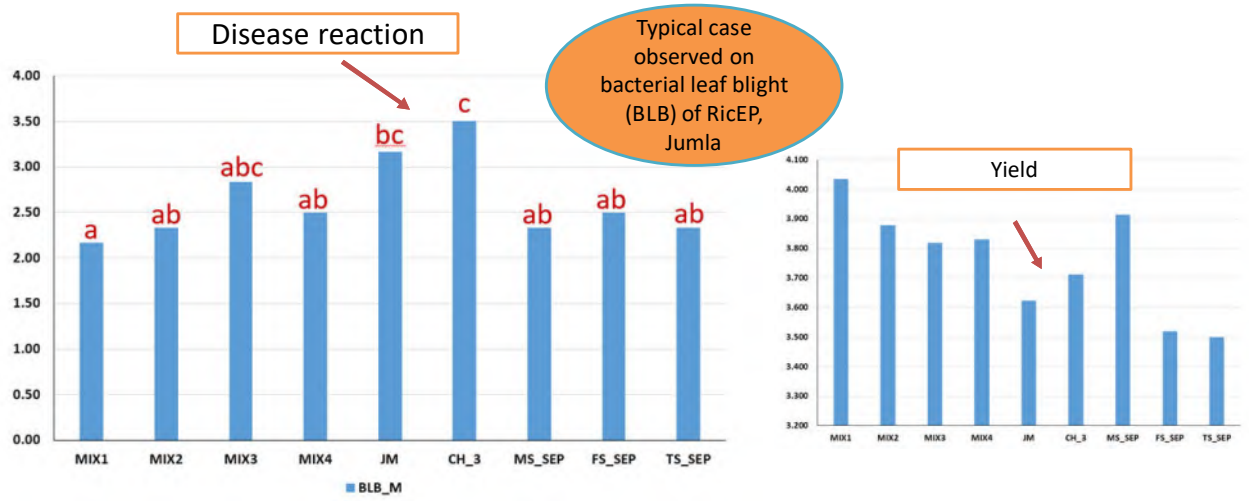


Maturity stage



Flowering stage seems relatively more sensitive to diseases compared to maturity stage

Disease reaction vs yield in rice population, Jumla (2019-2021)



Organoleptic assessment, EP (rice and bean)

Variety	Aroma (3=good, 2=fair, 1=no)	Taste (5=very tasty, 4=tasty, 3=good, 2=fair, 1=poor)	Cooking quality (3=good, 2=fair, 1=poor)
LA_MIX1	2.36	3.18	3
LA_MIX2	1.18	1.72	1.2
LA_MIX3	1.54	2.36	2
LA_MIX4	2.36	2.7	2
GA	1.81	3.18	2
KH_4	1.54	2.5	3
EMS_LA_SEP	2	2.54	2
EFS_LA_SEP	1.54	2.63	2
ETS_LA_SEP	1.54	2.27	1
LMS_LA_SEP	2	2.45	2
LFS_LA_SEP	1.36	1.81	1
LTS_LA_SEP	2.36	3.18	2

Overall, evolutionary population seems superior over improved and local check in 2021

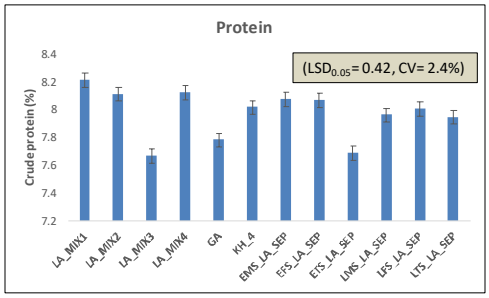
Variety	Aroma (3=good, 2=fair, 1=no)	Taste (5=very tasty, 4=tasty, 3=good, 2=fair, 1=poor)	Cooking quality (3=good, 2=fair, 1=poor)
JU_MIX1	2.36	3.36	2.09
JU_MIX2	1.63	2.55	1.55
JU_MIX3	2	3.27	2.09
JU_MIX4	2.36	3.54	2.54
JM	2.50	4	2.50
CH_3	1.64	2.27	1.54
MS_JU_SEP	2.50	3.18	2
FS_JU_SEP	2.18	3.27	2.27
TS_JU_SEP	1.73	2.36	1.45

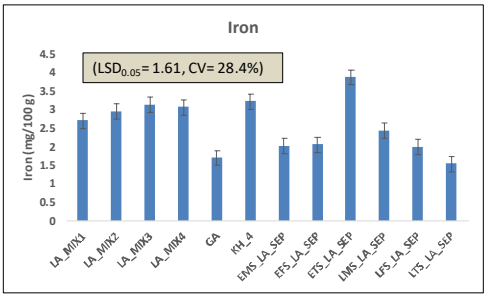
Variety	Aroma (3=good, 2=fair, 1=no)	Taste (5=very tasty, 4=tasty, 3=good, 2=fair, 1=poor)	Cooking quality (3=good, 2=fair, 1=poor)
BeEP1	2	3.1	2.1
BeEP2	2.3	3.5	2.3
BeEP3	2.1	3	2.5
BeEP4	2.5	3.6	2.1
BeEP5	2.6	3.8	2.3
BeEP6	2.1	3.3	2.2
BeSEP1	1.9	2.7	1.9
BeSEP2	1.9	3	2.2
BeSEP3	2.7	4.1	2.5

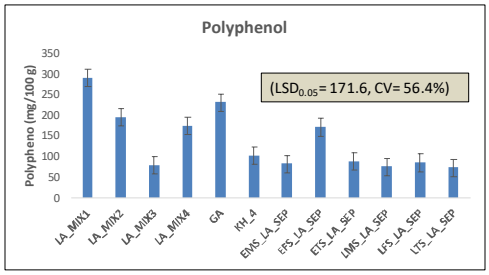
Nutritional analysis of rice evolutionary population, Lamjung

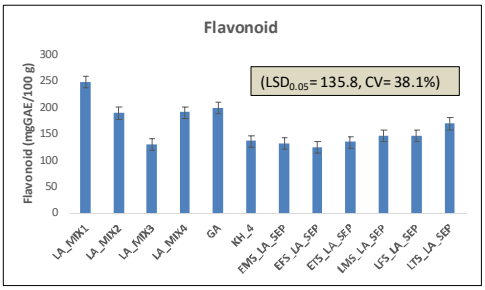
En	Entry Name	MC	ASH	FAT	PROT	IRON	PHOSP	CALCIUM	POLYPH	FLAV	ANTIOX
1	LA_MIX1	10.77	1.105	2.13	8.215	2.72	154.0	60.2	292.0	248.0	91.72
2	LA_MIX2	10.63	1.085	2.06	8.115	2.96	176.8	52.3	196.0	189.0	86.47
3	LA_MIX3	10.74	1.170	2.23	7.670	3.14	198.0	59.3	80.0	130.0	85.95
4	LA_MIX4	10.70	1.175	2.29	8.125	3.08	224.5	70.4	175.0	190.0	91.95
5	**GA**	**10.66**	**1.200**	**2.26**	**7.785**	**1.71**	**201.9**	**51.7**	**232.0**	**199.0**	**92.50**
6	**KH_4**	**10.37**	**1.205**	**2.32**	**8.020**	**3.23**	**207.2**	**63.9**	**103.0**	**136.0**	**89.79**
7	EMS_LA_SEP	10.36	1.175	2.22	8.080	2.03	221.6	74.0	83.0	131.0	93.73
8	EFS_LA_SEP	10.57	1.120	2.18	8.070	2.07	186.5	58.1	172.0	124.0	92.14
9	ETS_LA_SEP	10.79	1.135	2.19	7.690	3.89	200.8	75.4	89.0	134.0	90.59
10	LMS_LA_SEP	11.46	1.120	2.30	7.965	2.44	185.6	83.9	76.0	146.0	87.52
11	LFS_LA_SEP	10.78	1.205	2.47	8.010	2.00	135.2	58.0	86.0	146.0	92.26
12	LTS_LA_SEP	10.77	1.175	2.29	7.950	1.55	116.0	67.0	74.0	169.0	93.15
	$LSD_{0.05}$	**0.5396**	**0.1612**	**0.3127**	**0.4169**	**1.607**	**75.88**	**28.81**	**171.6**	**135.8**	**6.36**
	CV %	**2.3**	**6.3**	**6.3**	**2.4**	**28.4**	**18.7**	**20.3**	**56.4**	**38.1**	**3.2**

Nutritional analysis of rice evolutionary population, Lamjung

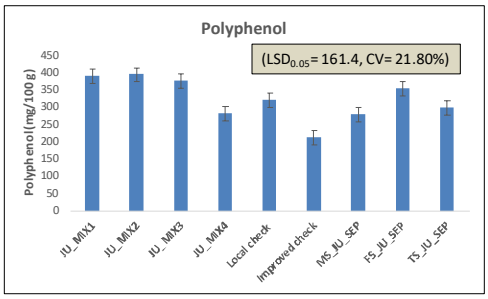


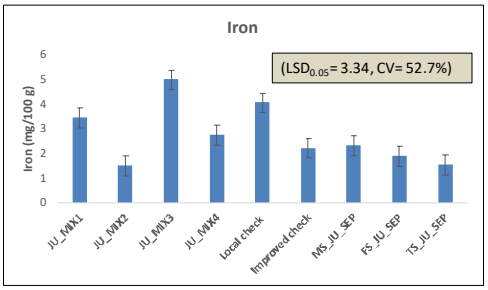


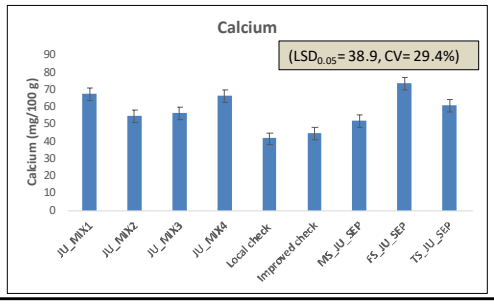


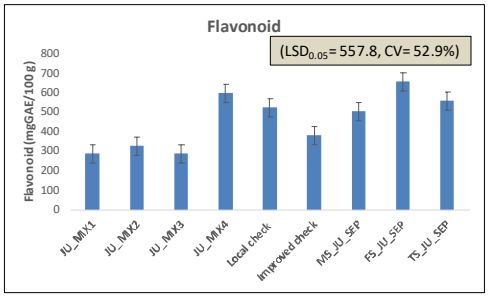


Nutritional analysis of rice evolutionary population, Jumla

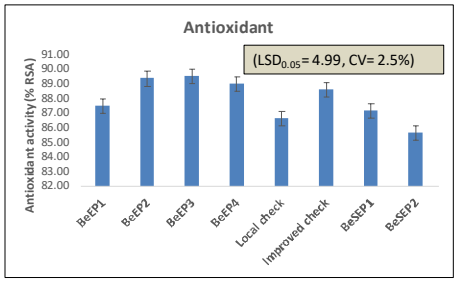


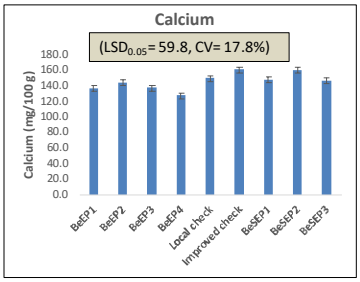


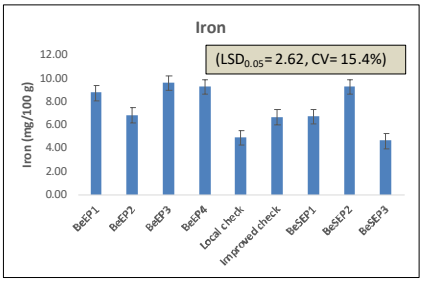


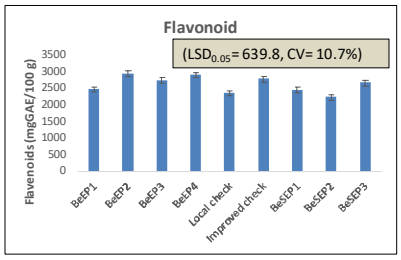


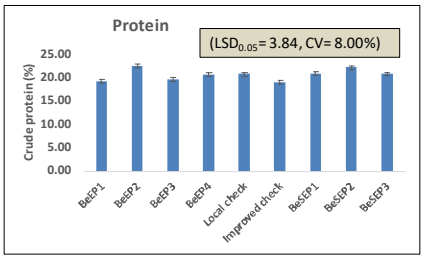
Nutritional analysis of bean evolutionary population, Jumla

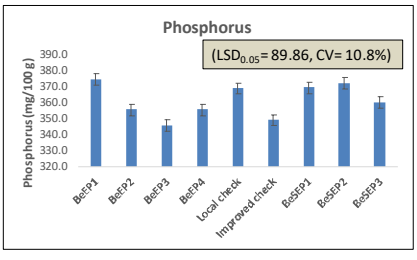








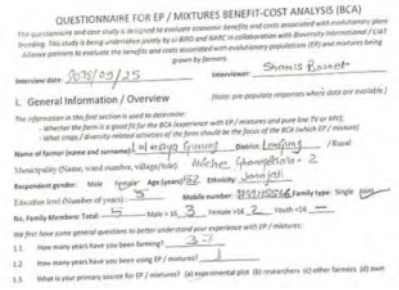




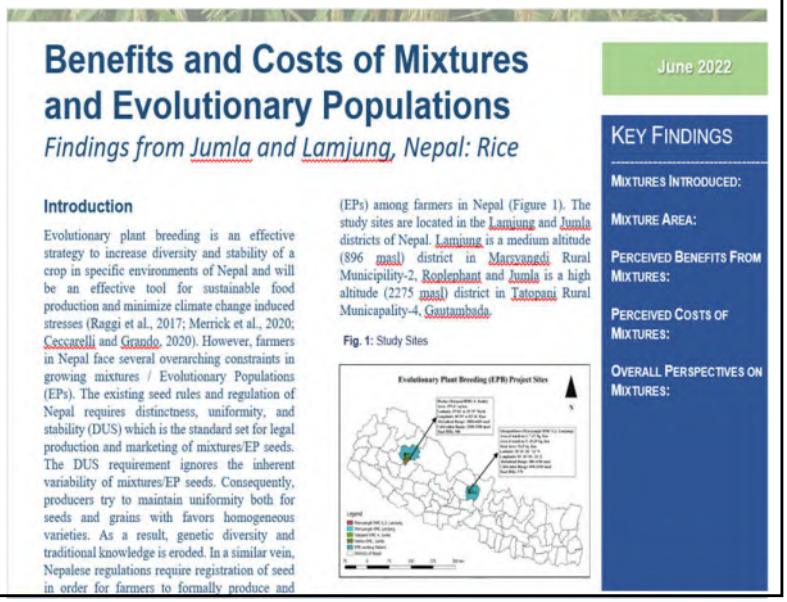
Field survey on comparative analysis of EP (2022)

Benefit-Cost Analysis of evolutionary population in Nepal

Location of survey: Lamjung and Jumla
Survey year: 2022
Survey HHs in Lamjung (RicEP): 22 HHs
Survey HHs in Jumla (BeEP): 19 HHs
Survey HHs in Jumla (RiceEP): 25 HHs


QUESTIONNAIRE FOR EP / MIXTURES BENEFIT-COST ANALYSIS (BCA)

I. General Information / Overview


Benefits and Costs of Mixtures and Evolutionary Populations

Findings from Jumla and Lamjung, Nepal: Rice

June 2022

KEY FINDINGS

MIXTURES INTRODUCED:

MIXTURE AREA:

PERCEIVED BENEFITS FROM MIXTURES:

PERCEIVED COSTS OF MIXTURES:

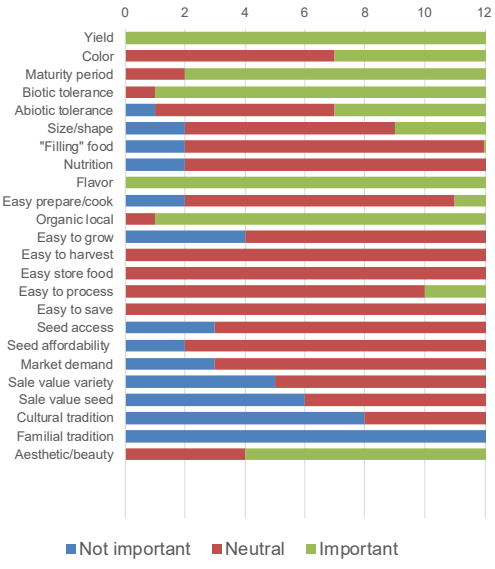
OVERALL PERSPECTIVES ON MIXTURES:

Introduction

Evolutionary plant breeding is an effective strategy to increase diversity and stability of a crop in specific environments of Nepal and will be an effective tool for sustainable food production and minimize climate change induced stresses (Raggi et al., 2017; Merrick et al., 2020; Ceccarelli and Grando, 2020). However, farmers in Nepal face several overarching constraints in growing mixtures / Evolutionary Populations (EPs). The existing seed rules and regulation of Nepal requires distinctness, uniformity, and stability (DUS) which is the standard set for legal production and marketing of mixtures/EP seeds. The DUS requirement ignores the inherent variability of mixtures/EP seeds. Consequently, producers try to maintain uniformity both for seeds and grains with favors homogeneous varieties. As a result, genetic diversity and traditional knowledge is eroded. In a similar vein, Nepalese regulations require registration of seed in order for farmers to formally produce and (EPs) among farmers in Nepal (Figure 1). The study sites are located in the Lamjung and Jumla districts of Nepal. Lamjung is a medium altitude (896 masl) district in Marsyangdi Rural Municipility-2, Rolephant and Jumla is a high altitude (2275 masl) district in Tatopani Rural Municapality-4, Gautambada.

Fig. 1: Study Sites

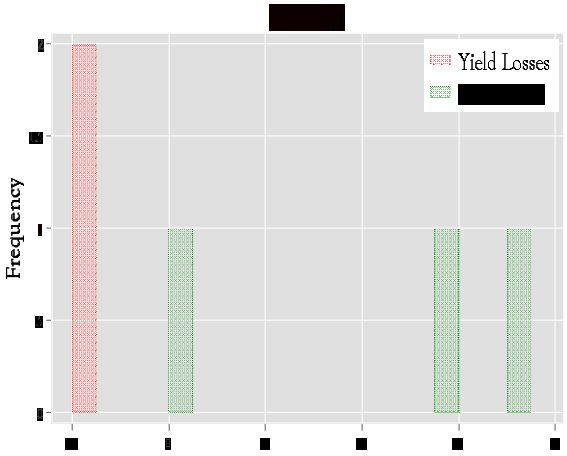
Farmers motives and priorities on varietal selection, survey results, EPB/RicEP, 2022



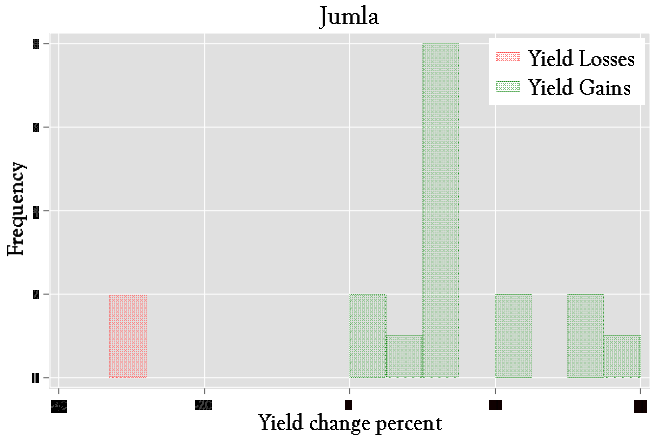
Bar graph summarizes the farmer motives and priorities in varietal selection drawing on original survey data on EPs/mixtures from the study sites (Lamjung and Jumla), 2022 (n=47)

Field survey results of evolutionary population (RicEP, 2022)

Field-Measured Change in Yield from EPs in Lamjung (n=22)



Field-Measured Change in Yield from EPs in Jumla (n=25)



Note: In Lamjung, 77% (17/22) and Jumla 36% (9/25) farmers reported the yield was unchanged from EP compared to TV or MV (neither a gain nor a loss).

EPB related policy dialogue and mainstreaming activities

National policy level workshop was held to facilitate the registration, varietal maintenance and marketing of EPB varieties and products

The policy interaction meeting was organized where national ITPGR focal person/joint secretory, VARCC member participated.

Publication and knowledge dissemination (2018-2022)

SN	Year	Title and link
1.	2019	उत्परिवर्तनशील बाली प्रजनन् (Evolutionary Plant Breeding) परियोजना (A flyer introducing EPB project in Nepal) Link: http://libird.org/app/publication/view.aspx?record_id=354&origin=results&QS=QS&f1_4417=dipendra&union=AND&top_parent=221
2.	2020	उत्परिवर्तनशील बाली प्रजनन् (Evolutionary Plant Breeding): के हो, किन र कसरी गरिन्छ (A booklet on EPB: what, why and How?s) Link: http://libird.org/app/publication/view.aspx?record_id=373&origin=results&QS=QS&f1_4417=dipendra&union=AND&top_parent=221
3.	2020	दिगो संरक्षण तथा उपयोगका लागि प्रवर्धन गरिएका असल अभ्यासहरू (An agriculture issue article on sustainable conservation and use of crop diversity as a good practices in agriculture) Link: http://libird.org/app/publication/view.aspx?record_id=396&origin=results&QS=QS&f1_4417=dipendra&union=AND&top_parent=221
4	2022	उत्परिवर्तनशील बाली प्रजनन् (Evolutionary Plant Breeding) परियोजना सम्बन्धि भिडीयो (A video introducing EPB project in Nepal)

Publication of knowledge product related to participatory tool kit (2022)

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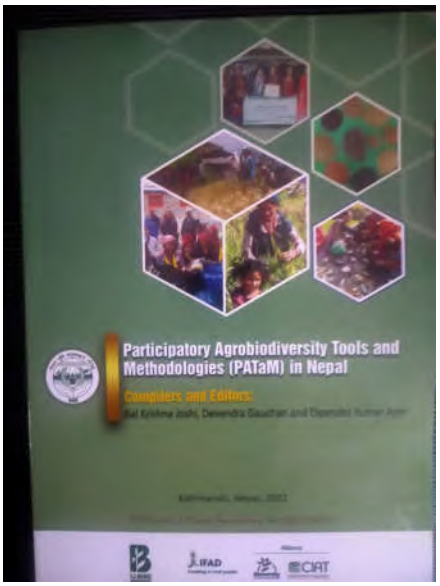
60 different participatory approaches documented for assessment of PGR



Mainstreaming evolutionary population, 2022 (University, national research and extension system)

District	Crop	IRD sets	PVS	Institutions engaged
Jumla	Rice	190	2	ARS Jumla, AKC Lamjung, RMs, Field Office LI-BIRD
Jumla	Bean	90	2	ARS Jumla, AKC, RMs, Field Office, LI-BIRD
Lamjung	Rice	162	2	TU/Lamjung Campus, CSB Ghanapokhara, AKC
Tanhun	Rice	92	1	CSB Purkot, RM
Kaski	Rice	121	1	CSB Sundaridanda, AKC Kaski
Lalitpur	Rice	-	1	National Gene Bank, Khumaltar

Field photo gallery, EPB






By D Gauchan

Overview of Project Goal, Objectives, Outcomes and Outputs

Overview of Project Goal, Objectives, Outcomes and Outputs

Use of genetic diversity and Evolutionary Plant Breeding for enhanced farmer resilience to climate change, sustainable crop productivity, and nutrition under rainfed conditions (EPB Project)

Devendra Gauchan, PhD
Bioversity International

Paper presented in Orientation and Planning Meeting of EPB Project, Besishahar (Hotel Gateway Himalaya), Lamjuhg, 27 December 2018

Project Goal and Objectives

Goal: To sustainably increase **crop productivity** and enhance the **resilience to climate change** of farming communities under **low-input**, **rainfed** and **less favoured** production conditions and **organic production** systems.

Specific objective : The of target low-input poor farmers in the project area is enhance **resilience** ced through developing **evolutionary populations (EP)** with higher and stable yields under the local farm agronomic and stress conditions, including drought, salinity, pest and diseases.

Project Outcomes

- A **gender- and age-sensitive participatory toolkit** is used jointly by farmers, researchers, breeders, development and extension workers **to design evolutionary crop populations** targeted towards improved production, income, nutrition and resilience for smallholder farmers under **changing climatic conditions**;
- **Women** and **men farmers** have the **capacity and receive** the necessary **institutional support, to access, maintain and increase their income from the use evolutionary crop population** that increase productive gains while at the same time maintaining yield stability and ecosystem resilience under changing climate conditions.
- **Cost-benefit and cost-efficiency analyses**, which include **nutritional** and **environmental value assessment**, are used by communities, gene banks, breeders, researchers, extension seed producers and market chain actors to promote, and benefit from the use of EP products.
- **Policy options** to **support** the **promotion, access** and **benefit sharing** of **evolutionary breeding populations** are identified and made available to local and national decision makers.

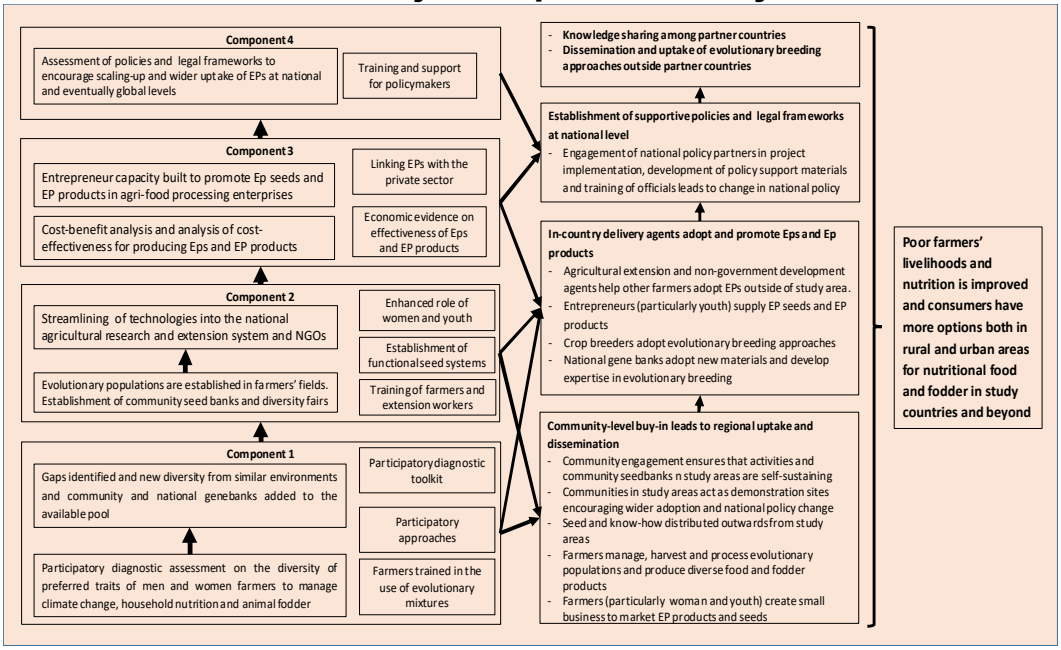
Project Outputs

- **A gender and age sensitive participatory toolkit** for **priority trait** setting with farmers for evolutionary breeding
- **Evolutionary populations** with a wide range of genetic resources from genebanks, community seed banks and on farm sources; these populations will remain as a permanent asset to farmers' communities after the end of the project.
- **Seed suppliers diversified** and farmers and farmers' groups integrated in seed value chains for the provision of evolutionary population seeds
- **Cost benefit analyses (CBA)** and **cost efficiency analyses (CEA)** with comparative studies on **EPB vs conventional breeding** and accompanying seed supply systems
- **Actions and recommendations** that support the adoption of **good practices** and **policies on access and benefit-sharing**

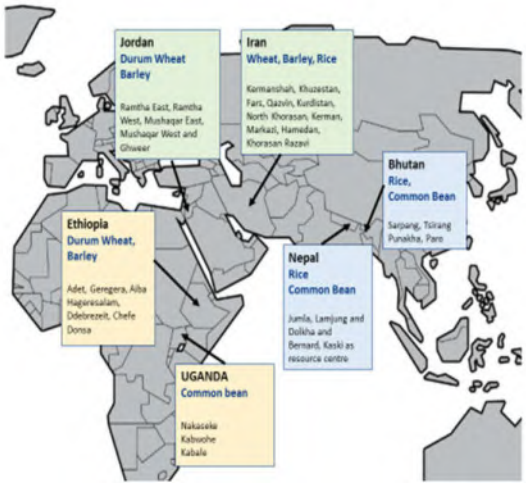
Components

1. **Participatory assessment of the role of plant genetic resources** in the resilience of smallholders to climate change;
2. **Establishment of evolutionary populations (EPs)** in farmers' fields and ensure sustainable seed supply;
3. **Economic** and **cost-benefit analysis of evolutionary plant populations** and supportive **seed supply**; and
4. **Enhancing the policy** and **regulatory frameworks** for use of plant genetic resources for food and agriculture (PGRFA) in the beneficiary countries.

EPB Project Impact Pathways



Project Countries and Target Crops



Six countries 3 Regions
Uganda, Ethiopia, Iran, Jordan, Nepal and Bhutan

Total Net Grant from IFAD	$ 3.5 Million
Co-financing Bioversity+ Partners	$2.09 Million
Total Project Fund US	$5.59 Million

Net Grant allocated for Nepal:
USD 0.3 Million

PROJECT IMPLEMENTATION ARRANGEMENTS

Bioversity is the main **executing agency** and **responsible** for reporting in I**FAD** for six project countries

- Implementing Organisation(s) in Nepal: NARC and LI-BIRD
- Project Management and Implementation Period
- Monitoring, Evaluation and Reporting
- Supervision and knowledge Management
- Scaling up and sustainability

Seed Systems and Evolutionary Plant Breeding: Where is the link with Other Bioversity Projects in Nepal

Seed Systems and Evolutionary Plant Breeding: Where is the link with Other Bioversity Projects in Nepal

Devendra Gauchan, PhD

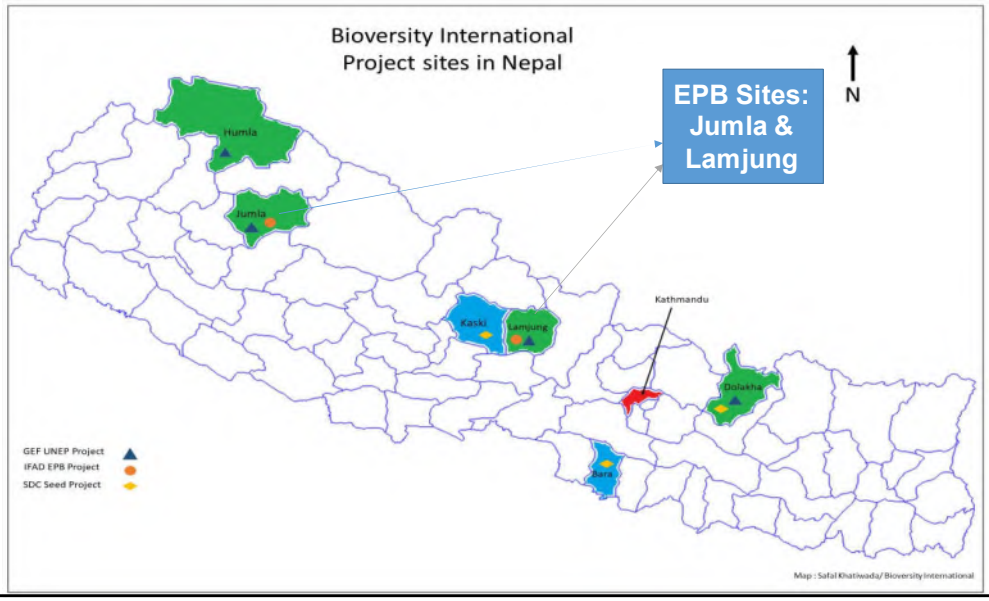
Bioversity International, Nepal

Presentation made in Uganda in Global Meeting for mainstreaming and up-scaling the ICRAF-IFAD- Bioversity project results, tools and methods of Community seed bank management and enhanced seed systems, into other countries programs, Uganda 25th October 2019

Recently Completed and On-going Bioversity Work in Nepal

1. **Genetic Resources Policy Initiative (GRPI) for** Agrobiodiversity and ITPGRFA Implementation Issues in Nepal-Completed in 2016
2. **Rebuilding Local Seed System through Emergency Seed Rescue and Relief** of **native landraces** after Earthquake (2015-17)
3. **Conservation** and **use of globally important traditional underutilized Crops** in Nepal Himalayas (**UNEP GEF)-(**2014-2019)
4. **Improving seed system** of smallholder by **diversifying seed sources, portfolio of varieties & seed value chains (**2017-2021)
5. **Evolutionary Plant Breeding Project** (IFAD) focusing on improving traditional varieties of rice and beans for **rainfed low input organic production system** (2018-2022)
6. **Strengthening Network of Community Seed Banks in Nepal (Bioversity International /New Field Foundation USA)-**2019-20

Bioversity Implemented Current Projects in Nepal

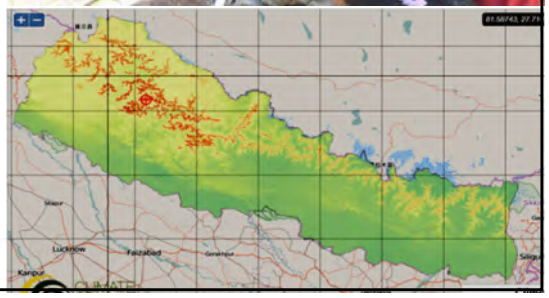


Partnership and Implementation of EPB Project

- **EPB Project** has been implemented with the strong **pre-existing partnership** of **Bioversity International** with **NARC and LI-BIRD**
- It is being implemented in **synergy** and close partnership with GEF UNEP, SDC Seed System & **Community Seed Bank Strengthening Projects** in Nepal
- GEF UNEP Local Crop Project provided the **ground infrastructure and working base** (e.g. project sites, community seed banks, Diversity Field Schools, Diversity Assessment tools & approaches, seed business activities-e.g. Market linkages & Local Product shops).
- The project's **strong focus is on linking** with existing Community Seed Banks, Mobilizing Farmers' Groups and **supplying and connecting seed activities** of GEF UNEP and SDC Seed system projects including

Linkages and Synergy of EPB with Other Projects

- **Baseline Information** for **Diversity Assessment** and **Participatory Tool Kit Development** from GEF UNEP, Seed Rescue and Global Insitu Projects
- **Rescue** and **Repatriation of rare indigenous landraces and Tools** in EPB Project Sites from earthquake affected Areas
- **Germplasm Gaps** and **Climate Suitability Analysis** in **Project Sites, Community Seed Banks and National Gene Banks** using **GIS-CAT tools** developed by GRPI-2 and Seed Rescue Projects in Nepal
- **Linking of Community Seed Banks of EPB project sites** with national Network of Community Seed Bank Association



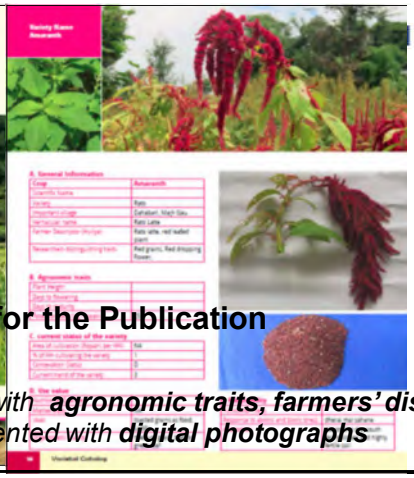
Linkages and Synergy of EPB with ……

- Establishing **Rice** and **Bean EPB Populations** and Strengthening **Seed Multiplication of Preferred Varieties** and their Seed value chain linking with **SDC Seed & GEF UNEP projects**
- **Training** to **farmers groups** (including CSBs) and stakeholders in **governance**, methodology **development**, d**ocumentation** and promotion
- **Gender research, Social Inclusion and Seed Value Chain** development of local crops
- **Policy reform and advocacy** for **Registration of diverse Farmers Varieties** and strengthening **seed value chain of Beans** and **Rice EPB Populations**

Community Seed Banks and CBM Fund Mobilization

Varietal Catalogue of Traditional Crops including Rice & Beans

- A **tool** for **documenting unique functional traits** and **traditional knowledge of farmers for strengthening Local Seed System,** enhancing **ABS** and **protecting** genetic resources from **biopiracy**



Sent in the Press for the Publication

Published in 2017 & shared widely

Farrmers' local** names with **agronomic traits, farmers' distinguishing characters, use value and **adaptability** documented with **digital photographs

Mainstreaming EPB Approaches, Genetic Resources, Products

- **Training** of **national and local Stakeholders** in EPB **Concepts** and **Approaches** linking of GEF UNEP Project
- Organizations of **Healthy Seed Production and Seed Processing Machines Training** to farmers and stakeholders by GEF UNEP and SDC Seed Projects in EPB Project Sites (Jumla and Lamjung)
- **Capacity building of men and women** farmers in Farmers **Variety Registration Proposals Development** supported by SDC Seed System & GEF UNEP Projects
- **Consultation Meeting on Agrobiodiversity Bills, ABS and Farmers Rights**" engaging men and women farmers linking with **GEF UNEP, SDC Seed & EPB Projects**

Knowledge Products, Publications and Dissemination of EPB Project


Research Protocol for Evolutionary Plant Breeding (EPB) in Nepal


उत्परिवर्तनशील बाली प्रजनन् (Evolutionary Plant Breeding) परियोजना


Concept and Rationale of Evolutionary Plant Breeding in Nepal

International and National Policies and Practices in supporting Farmers Rights and Enhancing ABS for Mainstreaming Evolutionary Populations


Devendra Gauchan, PhD

Alliance of Bioversity International & CIAT (CGIAR)

Paper presented in the "**Provincial Level Results Sharing Workshop of Evolutional Plant Breeding Project", Gandaki Province, Pokhara, Nepal. March 13, 2023**

Presentation Outlines

- **Features of International and National Policies** related to ABD, ABS, IPR, FRs
- **Concept** and **Role of Farmers' Rights, IPR** and **ABS**
- **Concept** and Importance of **Evolutionary Populations (EPs) and Crop Diversity**
- Current **Gaps** and **Issues** on promoting **EPs, agrobiodiversity** & **Farmers Rights**
- **Global Policies** and **Practices for EPs** and **Crop Diversity**
- **Mainstreaming** for **EPs** in national policies and Programs
- **Conclusions** and **Ways Forward**

International Policies, Conventions and Treaty, relevant to Agrobiodiversity, IPR, ABS & Farmers Rights

	International Policies	Special Features
1	Convention on Biological Diversity (CBD) 1992	***National Sovereignty*** on genetic resources/ biological resources; ownerships Provisions
2	International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) 2004	***Multilateral Systems*** (MLS) of **Access and Benefit Sharing**, Provision of **Farmers Rights**, and SMTA
3	Nagoya Protocol (2010)	***Access and Benefit Sharing*** (Bilateral means) as per the provision of CBD
4	World Trade Organization (WTO)	TRIPS; **Provision of *Suigeneris* system**
5	The Union for the Protection of New Varieties of Plants (UPOV)-1978;1991	Provisions of **IPR** focusing on **Plant Breeders Rights** and **Patents**
6	UN Declaration on the Rights of Peasants and other people working in rural areas (UNDROP)-2018	Provision of **Farmers Rights** as a **Human Rights**

Interrelationships and Differences between CBD, Nagoya Protocol and ITPGRFA

The **objectives** of **CBD/NP** and **ITPGRFA** are basically identical- as they aim to promote

- -the **conservation** of biological /genetic resources
- **-sustainable use** of the biological/ genetic diversity
- -the **equitable sharing of benefits** derived from its use

However they differ in access and benefit sharing (ABS)

ITPGRFA focus on **Multilateral System of Access and Benefit sharing** of genetic resources using **Standard Multilateral Transfer Agreement** (SMTA). Focus is on **facilitated access** from free and restricted access of PGRFA.

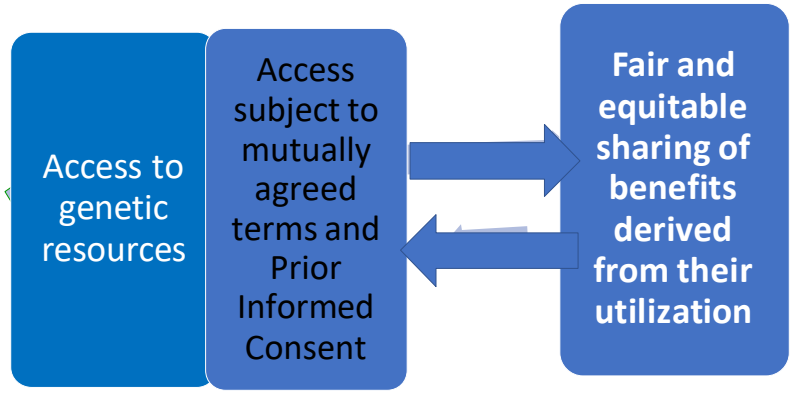
CBD/Nagoya Protocol: focus on **bilateral access** and **benefit sharing** subject to individually tailored access and benefit-sharing (ABS) agreements of PGRs

Model of Access and Benefit Sharing (ABS) Process

CBD (1992), ITPGRFA (2001) and Nagoya Protocol (2010) are guiding ABS Mechanisms Globally. Biodiversity Strategy/ACT and ABS Laws are guiding ABS process at National level

Access and benefits are inter-related

Prior Informed Consent (PIC), Mutually Agreed Terms (MAT) and Benefit Sharing (BS) agreement are three pillars of ABS



Easy and timely access of diverse seeds itself is a benefit to poor farmers in marginal farming systems

Access can be two directional ways

Gauchan (2017)

Distinguishing Features of International Policies

Intellectual property rights (IPRs)	Farmers Rights /Community Rights and Access and Benefit Sharing (ABS)
WTO/TRIPS: Rights over innovations (both products and processes): Suigeneris Laws	**CBD:** Commercial use of genetic resources and protection of the rights of local and indigenous communities (bilateral access regime)
UPOV: Patents and Plant Breeder Rights (no provision of Farmers Rights)	**ITPGRFA:** Commercial use of plant genetic resources for food and agriculture and Provision of Farmers' rights and Multilateral System of Access and Benefit Sharing (MLS)

Status of Farmers Rights, IPR & ABS in National Policy

SN	Policy, strategy, vision	Specific Contents and Gaps
1	National Intellectual Property Right Policy (2017)	Provisions of **IPR i**ncluding **GI rights** for holder of resources, not **clear provisions** on farmers rights
2	Agricultural Development Strategy (ADS), 2015	Mention of **General Farmers Rights**-not specific to agricultural genetic resources
3	National Biodiversity Strategy and Action Plan (2014)	Policy framework for ABS and **Ownership rights to all Genetic resources** (no legal framework)
4	National Seed Vision (2013-2025)	Recognizes the **role of indigenous** genetic resources, emphasize **simplification in release** and **registration** of farmers varieties
5	Agrobiodiversity Policy 2007 (revised 2014)	**Ownership rights** for local agri genetic resources, **farmers rights** but doenot provide legal framework
6	National Seed Policy (1999)	Seed security, mention **Breeder rights**, spell out **ownership rights to traditional varieties**

Status of National Legislation on IPR, FRs and ABS

SN	Legislation & Regulation	Specific Contents and Gaps
1	The Patent, Design and Trade-Mark Act, 2022. (1965)	Very old, IPR for products' no provision of breeders & farmer's rights to genetic resources
2	Seed Act 1988 (Amend 2008)	Mention of Breeder Rights not Farmers' Rights
3	Seed Regulation 2013	Relaxed provisions for farmers' varieties but not specific clarity on Farmers Rights
4	Community Seed Bank Guidelines (2008)	Focus on seed production not on the specific provisions of farmers rights and ABS
5	Local Government Operation Act (2017)	Recognize the local crop genetic resources and farmers roles on conservation but not specific provisions of farmers rights
6	The Rights to Food & Food Sovereignty Act (2018)	Focus on broader rights to food and food sovereignty with limited content on farmers rights to genetic resources

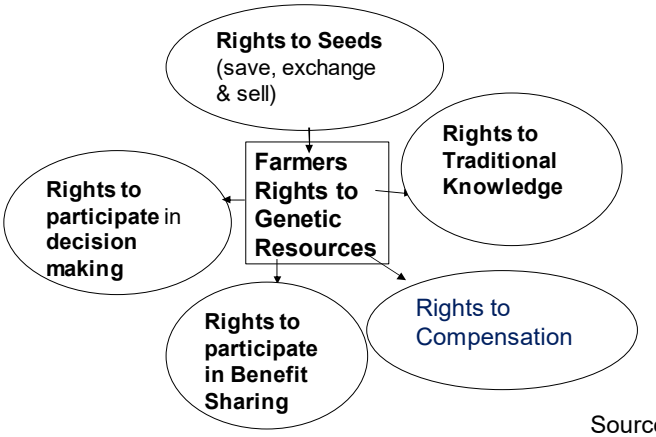
Draft National Legislation on ABS, IPR & Farmers Rights

SN	Legislation, Regulation	Provisions in the laws & Regulation
1	Access to Genetic Resources and Benefit Sharing (ABS) Bill 2018	Provision of prior informed consent (PIC) for ABS from local community
2	Plants Variety Protection and Farmers' Right bill 2005 (draft)	Provisions of both farmers' rights and plant breeders' rights
3	Agrobiodiversity Conservation and Utilization Bill (2018)	Focus on conservation and sustainable utilization of agro-genetic resources and provisions of farmers rights

Farmers Rights

- **Farmers** are not only **cultivators** but also **conservers** and **creators (breeders)** of agricultural genetic resources.
- **Farmers' Rights** consist of the **customary rights** of **farmers** to **save, use, exchange** and **sell farm-saved seeds**, their **rights** to **traditional knowledge, participate in decision making**, and **equitable sharing of benefits**
- **Article 9 of the ITPGRFA** has provision of **Farmers Rights** and makes provision for its **realization in the national legislation**

Concepts of Farmers' Rights



Adapted from ITPGRFA (2004)

Source: Gauchan (2011)

What are Evolutionary Populations (EPs)?

EPs are components of Crop Diversity /Agrobiodiversity

1. **Evolving populations** obtained **from crosses**
2. **Varietal mixtures** obtained from mixing seed varieties (e.g., mixed bean)

- Both are left **evolving in the target environments** and considered as **Evolutionary Populations**

Evolutionary Populations (Agrobiodiversity)
for Organic and Low Input Farming System

A fundamental difference between organic and conventional agriculture

- **Conventional Agri: Homogenous**

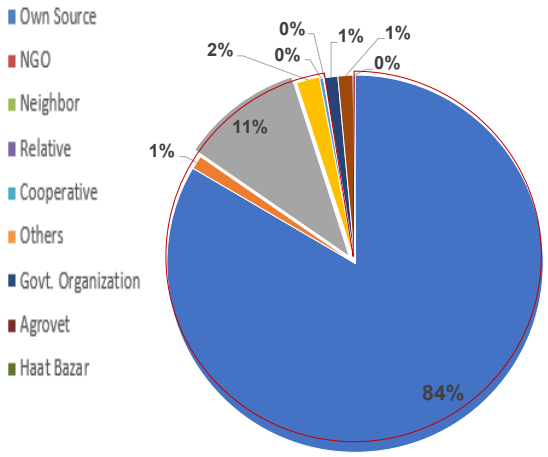
Organic Low Input Agri: Heterogenous

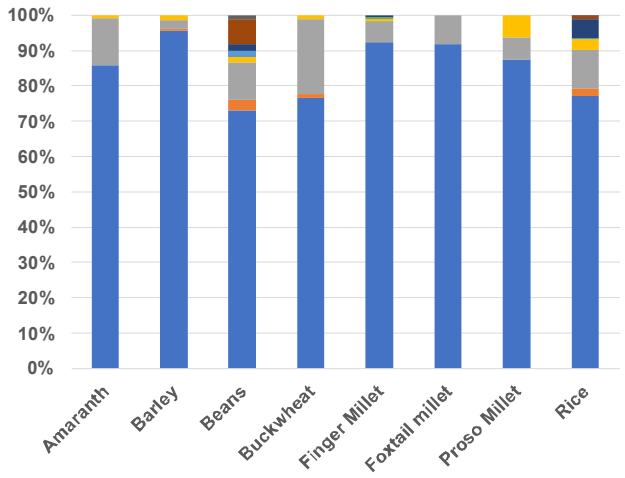
Why Evolutionary Plant Breeding Approach?

- **Conventional breeding** and **R &D system** and **commercialization** of **uniform varieties** has not benefitted **smallholder resource poor farmers** in marginal risk prone **mountain environments**
- **85% of households** in the mountain environment depend on **local farmers varieties** which are heterogenous population in mountain crops (LCP baseline report, 2016-17)
- **Over 90% of seed requirement** in traditional crops is fulfilled by the **informal or Farmers own seed system** (Gurung et al. 2020; Gauchan et al., 2017).
- **50% of traditional varieties** of crops already lost (Joshi et. al., 2017)

Dominance of Informal Seed Systems in the Mountains

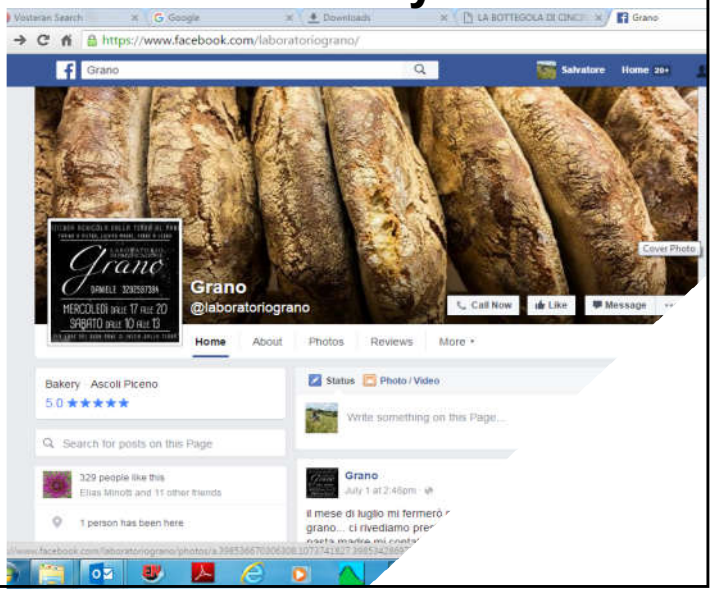
Informal seed sources: 97.4 (Gurung et al, 2016):





Food Products of Evolutionary Populations (EPs) are More Nutritious and Healthy

Bread from EPs wheat are more **tastier** and **nutritious** with higher **market demand** in **niche market in Europe** (Salvatore 2019)



Indigenous Crop Varieties & EPs are Rich in Nutrients

- **Anti-oxidants, Poly phenol** and **flavonoid** are higher in **Jumli Marshi rice** (Joshi et al, 2020)
- **Mean Nutritional Concentration** of most **EP**s of Bean and Rice are **highe**r than **pure stands**
- **Jumli rice**, **EP mixtures of rice** in Jumla and Lamjung have relative **higher micro-nutrient contetns (P, Fe)** including **Polyphenol** and **Antioxidants**
- Some **bean EPs have higher Fe content** (EP1, EP3, EP4, EP6) & **higher polyphenol** (EP5)

Gaps and Disincentives from Policy & Practices

- Currently **International (TRIPS,UPOV) instruments** in the form of **patents, PBRs** provide **incentives** to professional breeders, but limited mechanisms exists to provide **incentives** for informal **farmer breeders** (farming communities)
- The **notion** that "**economic benefits** can be derived only from the promotion of "**MVs" /"Modern technology"** is still the **guiding philosophy** in the policy formulation (e.g., **area coverage of MVs** and **productivity** as indicators of success)
- **National policies**, **legislation** and **programs** donot provide clear **definition of farmers rights** and **farmers varieties**, though some broader form of rights are indicated in the new Constitutions
- **Research, extension** and **education programs** are not directed towards **developing** and **disseminating agrobiodiversity based technologies** due to **lack of investment** and **incentives for professionals**

Key Constraints, Challenges and Issue

- Difficult **to release** and **register heterogenous landraces as Variety** in the **National Seed System** due to lack of **Distinct, Uniformity** and **Stability** (DUS) criteria
- **Seed Certification** is also a **problem due to lack of uniformity**
- **Policy** and **incentives such as subsidy** on seeds, inputs, and **market support** lacking for traditional heterogenous varieties /EPs.
- **Agricultural insurance** and **credit support** are also lacking as these facilities are only available if varieties are **released** and **registered**
- **Heterogenous Farmers varieties** are not the **priority focus** in the **national agri development-**though **overall 80% of** seed **requirements of major food crops and > 90% for indigenous crops** are met by **farmers local varieties**
- **Legal framework** for **farmers heterogenous varieties** and **Farmers Rights** including **Geographical Indication law** do not exist to **protect** and provide **legal pathways** for **commercialization**

Economic Issues and Challenges for Agrobiodiversity

- **Loss of agrobiodiversity (Genetic Erosion)** is increasing due to **undervaluation** of agrobiodiversity as result of market failures and policy failures
- Currently the **cost of agrobiodiversity conservation is very high** in the context of current **libera**l and **globalized economy** where **global food production** and distribution is **subsidized** that are derived from homogenous uniform industrial produced products
- Currently **cost of ABD is fully borne by small farmers** in traditional farming systems, who are **custodians of agrobiodiversity**. They donot receive any **incentives** and **subsidies** for the production of diverse ABD products.
- However, the **benefits of agrobiodiversity conservation (e.g., high yields, ecosystem restoration etc.)** are **received globally by every**one. There is high **inequity in cost** and **benefits.**

Global Implementation of Evolutionary Populations

- Research and promotion of Evolutionary Populations are taken by **national agricultural research** system in **Jordan for wheat and barley** (e.g., NARC) and **Iran for Barey, Wheat** and **rice**

- **Good initiatives** are going to promote EPs **in Ethiopia for Duram wheat**, and **Barley** and in **Uganda** for **Common Bean**

Global Evidence on Policy Change

- Reform in **European Seed regulation in 2018** to allow production and marketing of genetically **diverse materials (evolutionary populations)** that do not meet **definition of variety** (Distinct, Uniform and Stability) for **organic farming**

Evolutionary populations of wheat, maize, oats and barley can be marketed in Europe

AMENDMENTS BY THE EUROPEAN PARLIAMENT*

to the Commission proposal

REGULATION (EU) 2018/…

OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of …

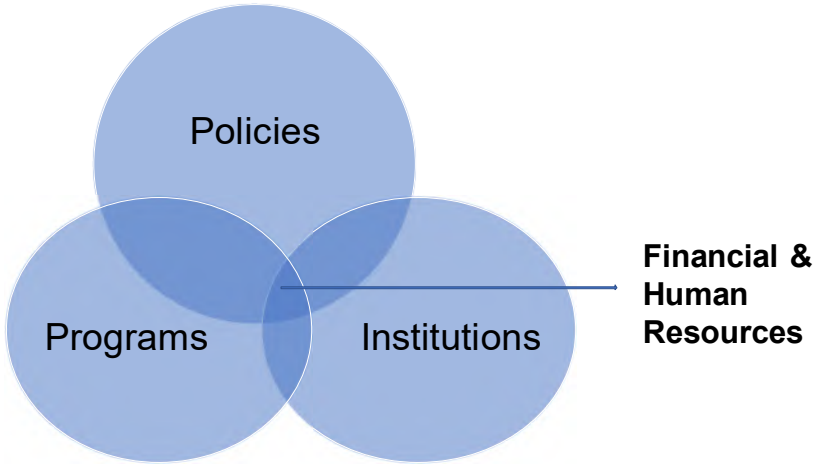
on organic production and labelling of organic products

and repealing Council Regulation (EC) No 834/2007

Salvatore (2019)

Strategies for Mainstreaming Evolutionary Populations/ Crop Diversity

- **Integration of EPs or crop diversity into policies, programs and institutions**



Policy Strategies for Mainstreaming Evolutionary Populations (EPs)/ Crop Diversity

- **Targeted market development** through **green, ecological or organic marketing and specialty product marketing** can promote commercialization of diverse varieties and **EPs**
- **Non-market methods** can also support in **marketing** and **commercialization** which includes;
  - -**Educational or promotional** programs (e.g. course curricula, biodiversity / food fairs, school nutrition)
  - -Increased use and farmers' **participation in EPB /PPB** and other crop improvement programs that increase **value of EPs**

- **Policy for Registration** and **certification of heterogenous** varieties
- **Geographic Indication (GIs)** for EPs and mixture (Julmli Rice and Mountain mixed Beans)

Policies and Practices for EPs/Crop Diversity

- **Decentralized participatory plant breeding** approach (site-specific, crops & context specific)
- **Relaxed seed regulations** for promotion of heterogenous seed varieties
- **Research, extension and education** to develop technologies and promote genetically diverse materials
- **Inputs and subsidy policy** to support low input and organic agriculture

- **Technologies for processing**, product development and value addition for diverse materials
- **Marketing policy** and **regulation** to trade diverse products from EPs (e.g., **GI)**

Suggested Wholistic Domains of Policy for Agrobiodiversity/Evolutionary Populations

A diversity of rules, incentives & Policy for:

- Varietal development and Dissemination
- Plant variety registration
- Seed quality certification
- Plant variety protection
- Access and benefit sharing
- Farmers rights on genetic resources
- Food safety, marketing, and labeling rules
- Credit (farmers) & insurance (market actors)

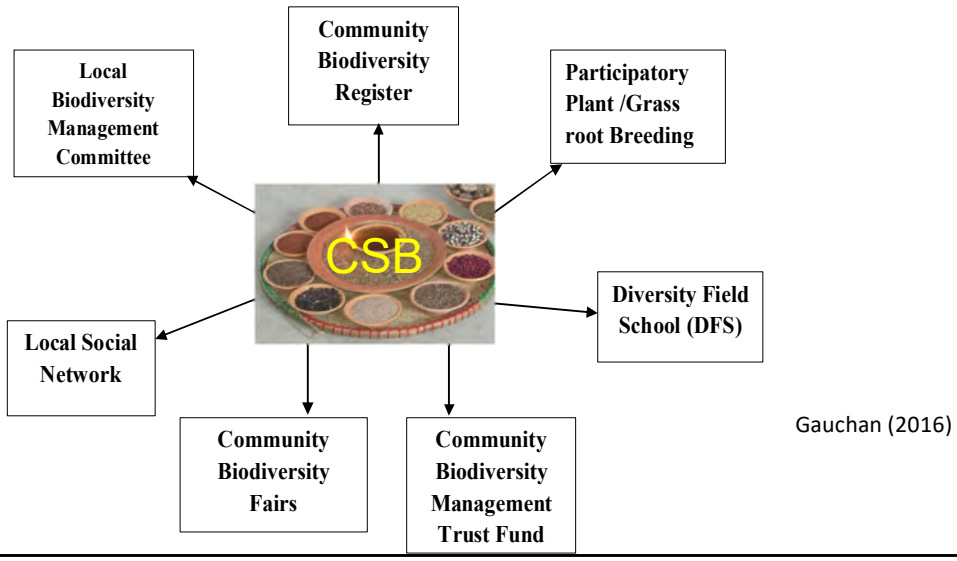
Need to include Provision for Inclusion of EPs in Existing Seed Regulation under " Schedule D"

- Development of Guidelines for inclusion of existing EPs/ Mixtures in the Variety Registration, maintenance and Seed Production Guidelines

Policy and Practices to Support Farmers Rights and ABS of Diverse EPs

- **Economic Incentives** (subsidies, support) to **farmers** to use & promote **diverse EPs/varieties**
- **Policy support** to promote **crop diversity: Organic** & **ecological** production**, GI branding, Value chain** & **Marketing** of **agrobio-diverse** products
- **Rewards, recognition & incentives to** farmers to **maintain** and **supply portfolio of varieties** & **breeds** with **portfolio of functional traits**
- Ensure **Farmers' Rights** in **seed, traditional knowledge, equitable access & benefit sharing** & **participate** in **policy** decision making

Community Seed Banks as Local Institutions for Implementing ABS and Farmers Rights



Gauchan (2016)

Conclusions and Ways Forward

- **Policy for Registration** and **certification of heterogenous** varieties /EPs
- **Mainstream Economic Incentives: Subsidy on inputs, credits, insurance, tax relief** for native diverse **varieties**
- **Market support** and **biodiversity-based value chain** of diverse crop varieties for nutrition sensitive agriculture
- **Incentives** in **R &D** and **education** to linking **traditional Knowledge** with **Science** & **Business Innovation**
- **Policy support** to link **agriculture** with **Eco-Tourism** using **organic, ecological** farming**, certification, branding** & **geographic indication**

By S Shrestha
Participatory Toolkit for Documentation in EPB Project

Participatory Toolkit for Documentation in EPB Project

Orientation and Planning Meeting of EPB Project

Santosh Shrestha, PhD
Team Leader, Nepal Seed System Project, LI-BIRD

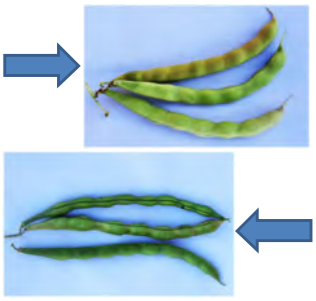
27 December, Hotel Gateway Himalaya, Besishahar, Lamjung

Local Initiatives for Biodiversity, Research and Development (LI-BIRD)
www.libird.org • info@libird.org

Participatory tools – Compiled/Listed

- Participatory Research Appraisal (PRA) tools
  - Key informant interview
  - Focus Group Discussion
  - Wealth Ranking
  - Transect Walk
  - Preference analysis- Matrix ranking
- Survey/secondary data collection
- Participatory Four-Cell Analysis (FCA)
- Modified FCA- Red Listing
- Participatory Seed Exchange
- Seed Network Analysis
- Portfolio Approach
- DFS/FFS/CBM
- Diversity fairs
- PPB/PVS
- Participatory disease diagnostic
- Community Biodiversity Register/Local inventory/varietal catalogue
- CSB
- Diversity KIT/IRD/Minikit/
- IRD

Example from Jungu Dolakha- Common bean

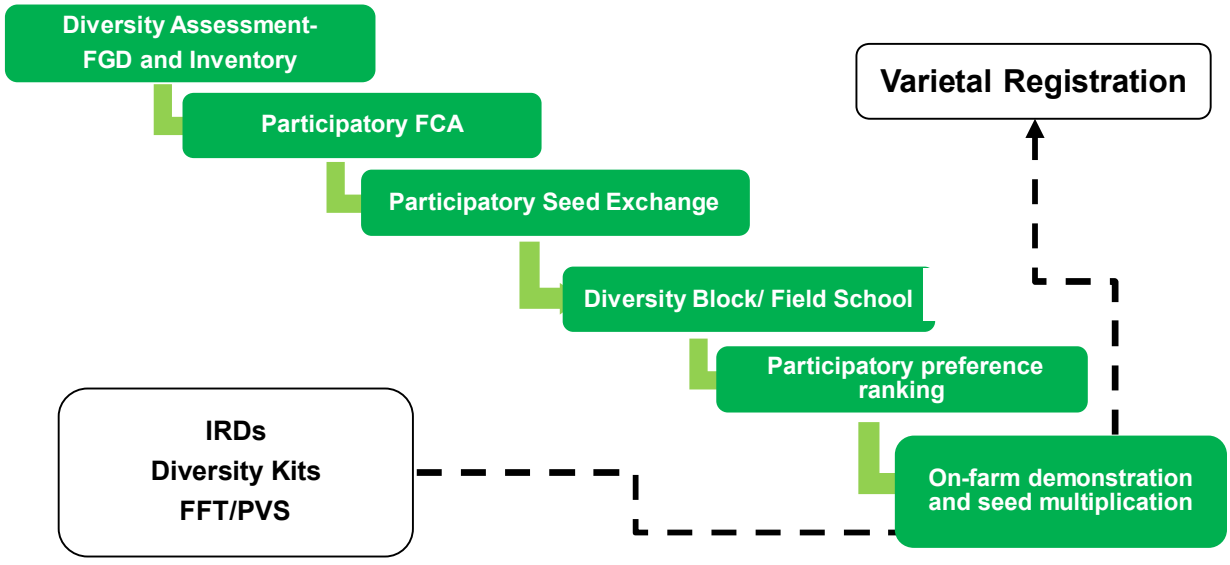


Pahenlo Simi

Variety Name	Winter Season Planting**		Summer Season Planting**	
	Green Pod (kg/Rop)*	Dry Grain (kg/Rop)*	Green Pod (kg/Rop)*	Dry Grain (kg/Rop)*
Pahenlo Simi	**1020.9 ± 77.5**	**163.7 ± 5.9**	**712.5 ± 92.3**	**201.8 ± 27.5**
Khairo Ghiu Simi	**930.9 ± 67.5**	**134.8 ± 9.1**	**722.5 ± 76.7**	**179.2 ± 13**
Trishuli Simi	727.6 ± 65.7	80.6 ± 6.8	449.9 ± 73.6	85.6 ± 8.5
Jayanti Simi	302.7 ± 30.3	78.3 ± 5.9	139.1 ± 24.7	74.9 ± 6.2

Khairo Ghiu Simi

Example from Jungu Dolakha- Common bean

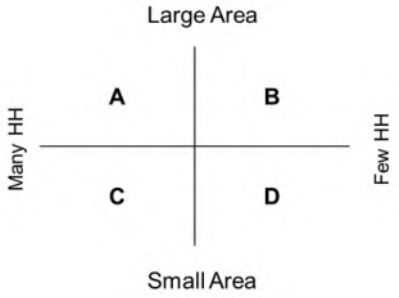


Participatory Four Cell Analysis

- Developed by in-situ project team/Nepal
- Assess the Risk Of Genetic Diversity Loss
- Distribution and population size analysis
- Trait distribution analysis

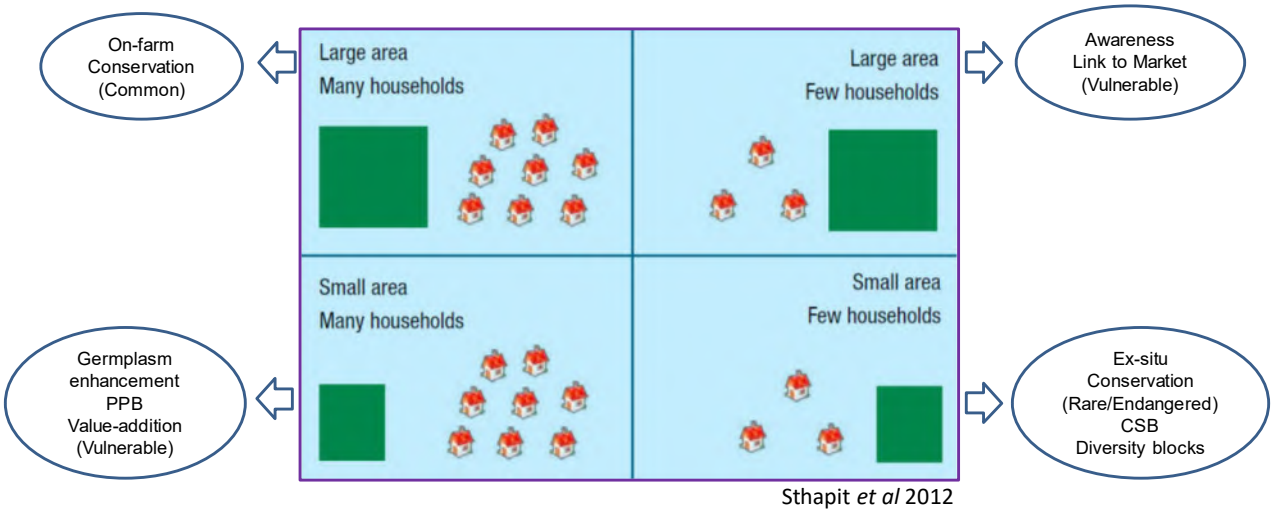
OBJECTIVES

- To identify common, unique and rare crop varieties
- To document/understand dynamics of existing local crops
- To identify the level and type of interventions needed for conservation of a crop in a community



Four cell analysis of extent and distribution of local crop diversity

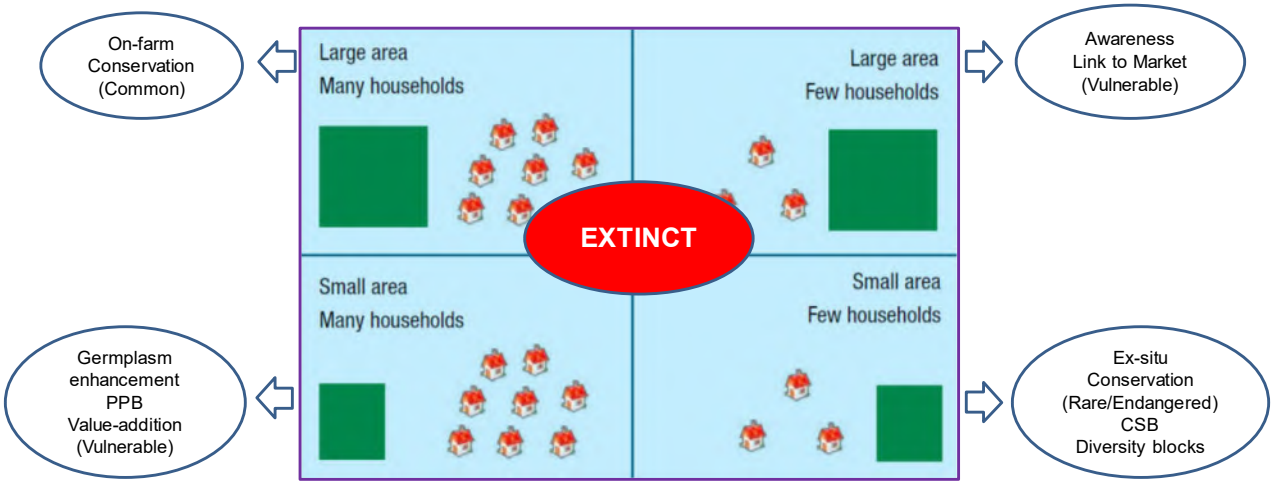
Participatory Four Cell Analysis



Sthapit *et al* 2012

Participatory Four Cell Analysis- Modified

Red List Status reflects on the trend of genetic erosion



Joshi and Gauchan, 2017

Participatory Seed Exchange

An informal process in which local farmers DISPLAY and EXCHANGE seeds and KNOWLEDGE of local landraces

- ❑ Seed registration and display
- ❑ Seed Observation
- ❑ Discussion and knowledge sharing
- ❑ Seed demand collection and exchange
- ❑ Evaluation

Pros/Cons

- ➢ Suitable for vegetable seeds than cereals crops
- ➢ Identification of custodian farmer
- ➢ Sensitize local people to realize the available agro diversity
- ➢ May lead economic loss to particular farmers
- ➢ Appropriate to organize just before planting season

Photo- Niranjan

Diversity Field School

A platform of social learning for the use of crop genetic diversity for the management of pests, diseases and other abiotic stresses and adversities.

Evolved from learning of FFS, PPB and CBM. *(LCP-DFS-Field Guide)*

Common bean in Dolakha: To orient and train farmers for their good quality seed production and diversity deployment at local scale

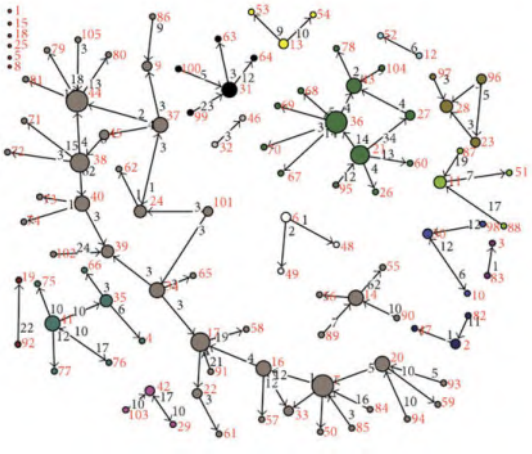
Assess on-farm genetic crop diversity	Increase community engagement and access to diverse sets of crops	Improve use of genetic resources, management tactics and information	Promote use of local crop diversity
Understand existing Diversity, Knowledge, and Past Interventions Tools: Diversity fairs, FCA Diversity blocks, disease damage assessment	Link with CSB, National Genebank and local information sources Tools: FGD and coordination with local stake holders	Disseminate agricultural knowledge Involve youth Tools: PVS, Pest mgmt. PPB, diversity kits	Diversity blocks, diversity fairs and community based seed production

Participatory Seed Network Analysis

- To identify nodal/custodian farmers who play major roles in the informal flow of genetic materials and associated knowledge within and outside the farming community
- Project interventions- fragmented seed network- CSB approach and complex SN (may be look beyond CSB)

Pros/Cons

- ➢ Based on memory & perceptions- may be false and misleading information
- ➢ Single crop SN appropriate,
- ➢ Multiple crops SN – may be misleading and hard to analyze



Social seed networks of Begnas area; Node size degree of centrality, Node color differentiates the network, arrow indicates direction of seed flow (Poudel et al 2015),

Portfolio Approach

- An approach of managing biodiversity at different level in a way to fulfill/achieve/maximize need of farming community and maintaining ecosystem health
- Fulfilling diverse need (diverse agro-ecological farming zone, diverse use value- ethnicity, culture, regional)
- Deal against unpredictable environmental changes – Biotic and abiotic stresses, climate change
- Management of Biodiversity by promoting its wise use
- Diversity is needed for evolution
- More diversified portfolios tend to produce more stable system

Mixture Cultivation : It has set of varieties which best fit in mixture system to produce better result
less invasion of pest and disease
Better yield
Better test

Portfolio Approach

Assess biodiversity status at different level
(Baseline Study and Documentation)

Context Analysis (Farming system, **production constraints- biotic and abiotic stresses, socio-economic context**)
- Diversity Assessment (Richness, evenness) and identifying sources
- Documentation (CBR, varietal catalogue,)

Tools: PRA, diversity fair, custodian farmer identification

Portfolio Preparation
(Characterization and Evaluation)

Test and identify set of materials for preparing best portfolio to address need of farming community
- Diversity Block
- Characterization and evaluation at research station
- Participatory plant breeding
- Profile preparation of different variety
- Ecosystem Services approach

Dissemination

Make available the set of diverse material to farming community
- Seed Multiplication
- Diversity kit distribution
- Feedback Collection

EPB protocol

Research Protocol for Evolutionary Plant Breeding (EPB) in Nepal

Introduction

Developing evolutionary populations (EPs) in rice and bean

Concept of evolutionary plant breeding (EPB) is to develop a population which is more adaptable, stable and higher yielding than the existing single varieties released either through formal plant breeding or through participatory plant breeding. Principally, all the genes and allelic frequencies in a population are under natural selection pressure and evolve naturally maintaining higher frequencies of adaptable traits or genes or alleles establishing their fitness with the nature. Those individuals of a population which survive in the natural selection pressure are generally considered naturally fit and increase their frequencies in the subsequent generations without artificial selection pressure. We will be developing evolutionary populations (EPs) for rice and beans in two project sites, Jumla and Lamjung. Regarding the numbers of treatments or entries and replications per site, it is better to design the experiment in such a way that we can have sufficient data regarding the precision of the results and publication of the experimental outputs from each site individually. It is considerate because each site will have different types of EPs which can't be common in multilocation trials and the degrees of freedom will meet the reliable statistical analysis. With this view in consideration, each site should have sufficient numbers of entries and replications for the statistical analysis to be valid, which is also an important part of the experiment for obtaining reliable results and making quality publications.

Evolutionary populations (EPs) establishment for Rice and Bean

Rice Evolutionary Populations (RicEPs) establishment

We will have 4 evolutionary populations, one improved variety and one local landrace (6 entries) in a replicated trial with 2 replications for the first year. Randomized Complete or Incomplete Blocks will be used in each site based on the land availability. Number of components may vary according to the availability of germplasm sources, and mutual agreement of the plant breeders and farmers.

Entry No	Entry	Field Code	Evolutionary Population (EP) component	Component feature	Components * (Jumla - Appendix 1)	Components* (Lamjung - Appendix 2)
1	RicEP1	REP1	Local landraces	Mixture of local landraces of the sites	4 local landraces	21 local landraces
2	RicEP2	REP2	Local landraces 1	Mixture of local landraces of similar agroecological domains across Nepal	37 landraces from similar agroecological domains	25 landraces from similar agroecological domains
3	RicEP3	REP3	Improved varieties	Mixture of improved varieties of similar agroecological domains across Nepal	6 improved cultivars	5 improved cultivars
4	RicEP4	REP4	Landraces + Improved varieties + Breeding lines	Mixture of local landraces, improved varieties, and breeding lines of similar agroecological domains across Nepal	41 landraces, 6 improved cultivars and 19 advanced breeding lines	46 landraces, 5 improved cultivars and 5 advanced breeding lines
5	RicEP5	Check1	Local Landrace	Single popular local landrace as a check	Jumli Marshi	Gaure
6	RicEP6	Check2	Improved	Single popular improved	Chandannath	Khumal 4

Entry No	Entry	Field Code	Evolutionary Population (EP) component	Component feature	Components* (Jumla - Appendix 1)	Components* (Lamjung - Appendix 2)
			Variety	released variety as a check	-3	
Evo Master Pop (EMP)	RicSEP	RSEP	Landraces + Improved varieties + Breeding lines	Separate bigger plot of the mixture for selection by male and female farmers and researchers. Three sub EPs will be developed for next year's trial: RicSEP1 (selected by male farmers), RicSEP2 (selected by female farmers), and RicSEP3 (selected by researchers) (Fig 1)	Same as RicEP4 for Jumla	Same as RicEP4 for Lamjung
Components*: each component will comprise of equal number of grains from each landraces, improved cultivars and breeding lines. The mixture obtained will be defined as an evolutionary population entry (EP). Involved components will also be maintained, if possible, by community seed banks (CSB) either in diversity blocks or in farmer's field *in situ*. Details of components in each entry is given in Appendix 1 (for Jumla) and Appendix 2 (for Lamjung).						

Note: The selection plot (EMP) will be divided into four equal sub-plots and used for selection by men farmers, women farmers and researchers. This will give three new selected EPs for next year. Which, in theory, will be selected EPs because of imposed selection for desired traits. Identity of the components from this entry after selection may or may not be possible. Further, we can't make selections from the 6 entries in the trials because selection from those entries and advancement to next generation will reduce the number of components of those EPs in the population. However, depending upon the appropriate time of maturity of the population as preferred by farmers, late maturing plants will not be harvested from these six entries because agroclimate in those sites may have impact on maturity of some plants or components in the population. Thus, from first six entries, we will take different observations from three random samples within replicates per entry (by using 1m² blocks at three random places within each plot) and finally harvest the plot in bulk in such a way that all the desirable genes or alleles present in the population are harvested which were subjected to natural selection pressure. We may impose selection in those population from next season if we intend to. Next year EPs will be a random sample from those bulks rather than selected ones of those entries. With this in consideration, it is more appropriate to include one separate bigger plot of all the components for selection and advancement to the next generation. For the next year's trial, we will have total of 9 entries (the 4 RicEPs from first year, the three selected EPs, the same local landrace and the same improved variety).

Bean Evolutionary Populations (BeEPs) establishment

We will have 4 evolutionary populations, one improved variety and one local landrace (6 entries) in a replicated trial with 2 replications for the first year. Randomized Complete or Incomplete Blocks will be used in each site based on the land availability. Number of components may vary according to the availability of germplasm sources, and mutual agreement of the plant breeders and farmers.

Entry	Entry Abbreviation	Field Codes	Evolutionary Populations (EPs)	Mixtures	Components* (Jumla)	Components* (Lamjung)
1	BeEP1	BEP1	Local landraces	Mixture of local landraces of the sites	21 local landraces	-
2	BeEP2	BEP2	Local landraces 1	Mixture of local landraces of similar agroecological domains across	21 landraces from similar domains	-

				Nepal		
3	BeEP3	BEP3	Breeding lines*	Mixture of advanced breeding lines of similar agroecological domains across Nepal	6 breeding lines from Jumla	-
4	BeEP4	BEP4	Landraces + Improved varieties + Breeding lines	Mixture of local landraces, improved varieties, and breeding lines of similar agroecological domains across Nepal	42 landraces and 6 breeding lines	-
5	BeEP5	Check1	Local Landrace	Single popular local landrace as a check	Kalo Male	-
6	BeEP6	Check2	Improved Variety or advanced breeding line	Single popular improved released variety or an advanced breeding line as a check	Trishuli	-
Evol Master Pop	BeSEP	BSEP	Landraces + Improved varieties + Breeding lines	Separate bigger plot of the mixture for selection by male and female farmers as well as researchers. Three sub EPs will be developed for next year's trial: BeSEP1 (selected by male farmers), BeSEP2 (selected by female farmers), and BeSEP3 (selected by researchers). (Figure 1)	Same as BeEP4	-

Components*: each component will comprise of equal number of grains from each landraces, improved cultivars and breeding lines. The mixture obtained will be defined as an evolutionary population entry (EP). Involved components will also be maintained, if possible, by community seed banks (CSB) either in diversity blocks or in farmer's field *in situ*. Details of the components in each entry is given in Appendix 3 (for Jumla) and bean trial will be conducted only in Jumla.

Breeding lines*: We have only one released variety for high hills but many recommended advanced breeding lines from similar agroecological domains across Nepal. Thus, a mixture of breeding lines will be used as a separate entry in bean which differs than rice entries.

Note: The selection plot will be divided into four equal sub-plots and used for selection by men farmers, women farmers and researchers. This will give three new selected EPs for next year. Which, in theory, will be selected EPs because of imposed selection for desired traits. Identity of the components from this entry after selection may or may not be possible. Further, we can't make selections from the 6 entries in the trials because selection from those entries and advancement to next generation will reduce the number of components of those EPs in the population. However, depending upon the appropriate time of maturity of the population as preferred by farmers, late maturing plants will not be harvested from these six entries because agroclimate in those sites may have impact on maturity of some plants or components in the population. Thus, from first six entries, we will take different observations from three random samples within replicates per entry (by using 4m² blocks at three random places within each plot) and finally harvest the plot in bulk in such a way that all the desirable genes or alleles present in the population are harvested which were subjected to natural selection pressure. We may impose selection in those population from next season if we intend to. Next year EPs will be a random sample from those bulks rather than selected ones of those entries. With this in consideration, it is more appropriate to include one separate bigger plot of all the components for selection and advancement to the next generation. For the next year's trial, we will have total of 9 entries (the 4 BeEPs from first year, the three selected EPs, the same local landrace and the same improved variety).

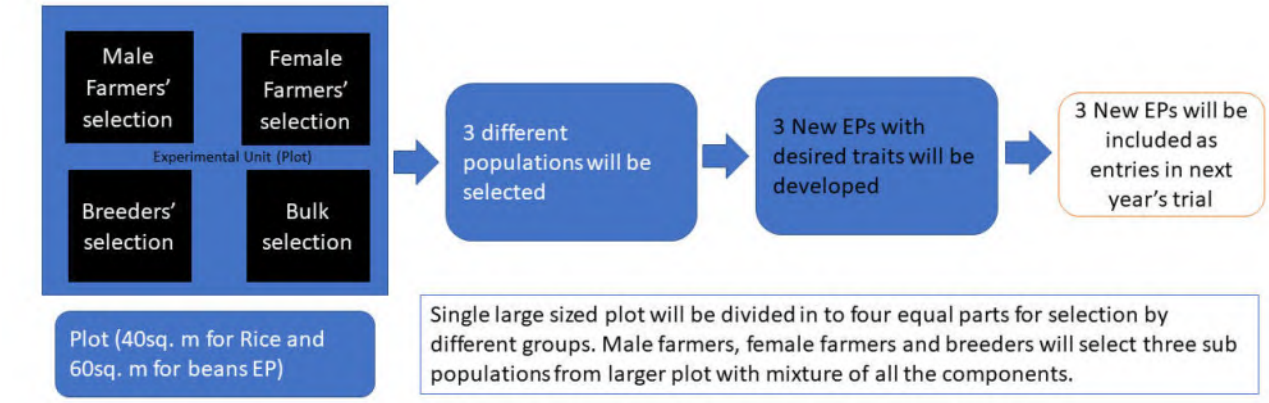


Figure 1 Evolutionary population for selection

Note: Each group will select at least 100 plants in case of rice and 50 plants in case of beans depending upon the number of plants with desirable traits and harvest as separate bulks. Separately harvested bulks in rice after selection will be denoted as RicSEP1 for male farmer's selection, RicSEP2 for female farmer's selection and RicSEP3 for researcher's selection. While in case of bean, selected bulks will be denoted as BeSEP1 for male farmer's selection, BeSEP2 for female farmer's selection and BeSEP3 for researcher's selection. Fourth bulk selection population in rice and bean selection plot will be the same as RicEP4 and BeEP4 respectively because same components are involved.

Available germplasm sources with LIBIRD from different sites

Different local landraces in each site and some landraces from similar agroecological domain available in the Local Crop Project (LCP) sites will be collected by Local Initiatives for Biodiversity, Research and Development (LIBIRD) in coordination and collaboration with Nepal Agricultural Research Council (NARC). Germplasm sources are given in Appendix 4.

Available germplasm sources with NAGRC, NARC from different sites

Different improved released varieties, breeding lines and local landraces of target sites and from similar agroecological domains across Nepal as that of Jumla and Lamjung will be collected by National Gene Bank or Nepal Agriculture Genetic Resource Centre (NAGRC), Nepal Agricultural Research Council (NARC) in coordination and collaboration with Local Initiatives for Biodiversity, Research and Development (LIBIRD). Germplasm sources are given in Appendix 5.

Experimental design and plantation

Randomized complete block design (RCBD) will be used as far as possible but if land availability is a problem, in case of beans, incomplete blocks will be designed. Plot size will be of 20 m² (5 m X 4 m) for rice and 30 m² (6 m X 5 m) for bean with 0.5 m spacing between plots. Six entries (four EPs, one local landrace and one improved variety) with two replications will be used. One separate bigger plot of 40 m² for rice

and 60 m^2 for bean will be maintained as a selection plot for male farmers, female farmers and breeders (Figure 1) where complete mixture of all the components will be planted for imposing selection in both the crops separately. For each component in each crop, equal number of grains will be used and mixed together by using seed mixing tools or by hand. Nursery bed will be prepared for each entry separately in case of rice after mixture. If dryland is preferred seed mixture will be broadcasted, in case of beans. Fertilizers and cultural management will be the farmers' usual practices. In addition to the EPs, diversity blocks of each component variety of rice and bean will also be maintained for field observation as well as to support CSBs in each site. Experimental layouts are given in Appendix 6 for rice and Bean EP establishment in both sites using RCBD.

Based on the plot size and plant spacing, it will be possible to roughly estimate number of grains required per component in each entry for making a mixture but counting number of grains individually is tedious and laborious job for too many components. Hence, we will use hundred grain weight of each component of rice and beans separately for estimating equivalent weight required for estimated number of grains per component to be used in each entry separately. Which will reduce the bias during making mixture.

Data observation and selection

Each plot will be observed for different agronomic and morphological traits with 3 samples per plot. Data will be recorded from three randomly selected blocks of 1 m^2 area for rice and 4 m^2 area for bean EPs respectively within each entry in each replication with the help of square frame (Figure 2) generating a total of 3 (samples) x 2 (replications) x 6 (entries) = 36 data points, hence 35 degrees of freedom. No plants will further be selected for data recording within each sample i.e. all plants within a sample is taken as a single unit for data observation, and if applicable, averaged (in case of plant height, grains, spikes, pods etc). Observations will be recorded in metric units from each selected sample within replication separately for each entry. At the end of crop season, bulk harvested seeds from each entry will be taken as a first generation of evolutionary population in each crop.

From selection plots, male farmers', female farmers' and breeders' group will select at least 100 individual plants in case of rice and 50 individual plants in case of bean depending upon the number of desirable plants for selection to constitute a diversified evolutionary population having higher frequencies of desirable traits or genes or alleles. Individual plant selection will be done once during flowering and once before harvest stage using different marking threads for identity of selected plants in rice and bean respectively.

Data will also be observed in the selection plot with at least ten (10) plants per evolutionary population selected by male farmer, female farmer and breeders in rice and bean respectively. Those selected plants will also be harvested in bulk at the end of crop season along with other entries in the experiment. Data recording sheets will be prepared in excel format for data analysis. At the end of second year's trial, we can have a linear visualization of evolutionary responses of different EPs. Parameters for observations are (spikes in case of rice and pods in case of bean) as follows:

1) Date of planting (date) – separately for each plot
2) Plant height (cm) – separately for each sample within a plot
3) Number of plants – separately for each sample within a plot
4) Number of tillers per plant – separately for each sample within a plot
5) Spike length or pod length (cm) – separately for each sample within a plot
6) Disease and pest infestation – separately for each plot (standard scoring procedure will be used)
7) Ambient temperature (degree Celsius or Fahrenheit) and rainfall intensity (mm) in each site
8) Number of panicles in rice and number of pods in bean– separately for each sample within a plot
9) Thousand grain weight (g) – separately for each sample within a plot
10) Bulk harvest yield per plot (g or kg) – separately for each sample within a plot and bulks per plot
11) Grain colors and population structure – high definition images will be documented for each entry separately during different stages of experiment starting from making mixtures.
12) Days to 50% flowering (date) – separately for each sample within a plot
13) Days to 80% maturity (date) – separately for each sample within a plot
14) Days to harvest (date) – separately for each sample within a plot

15) Cooking quality and taste – bulk harvest from each entry will be used for sensory tests
16) Participatory selection during flowering and harvest (preference ranking)

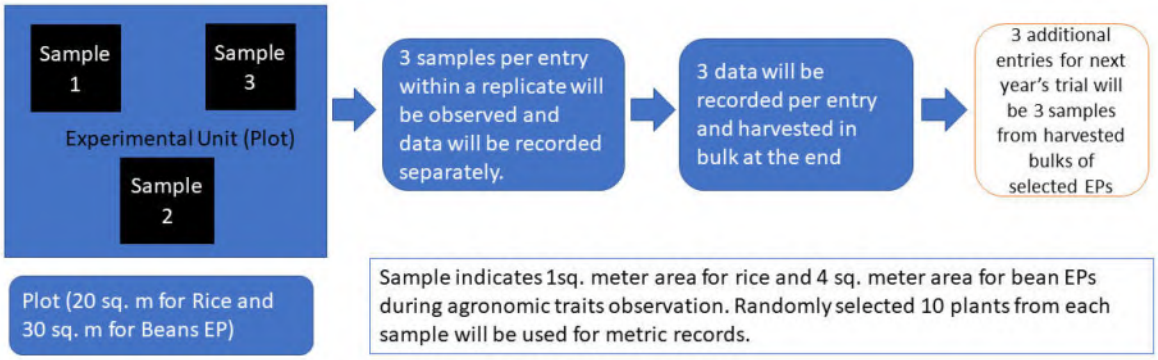


Figure 2 Data observation in evolutionary population

Statistical Analysis

Regression and correlation studies can be used for visualization of the experimental results. Results of first year will be used to compare results of second year's trial. Subsequent generations/years data will be used to study the evolution pattern and selection direction of the nature (directional changes in the frequencies of traits or alleles in a population). Statistical analysis can be performed in R studio or other statistical analysis packages for analysis of variance.

First year ANOVA (for both crops: rice and beans) in the case of 3 samples/plot

Source of variation	Degrees of freedom
Entries	5
Replication	1
Entries x Replications	5
Error	24*
Total	35

*If Entries x Replications is not significant, we can combine its Sum of Square with the Sum of Squares of the error thus obtaining a new Error with 29 degrees of freedom.

Appendix 1. Rice evolutionary population establishment in Jumla: Details of the entries for rice evolutionary population (RicEP) establishment in Jumla

SN	RicEP1	RicEP2	RicEP3	RicEP4	RicEP5	RicEP6	RicSEP
1	Darime	Bageri	Chandannath-1	Bageri	Jumli Marsi	Chandannath-3	Bageri
2	Jumli Marsi	Bharnang	Chandannath-3	Bharnang			Bharnang
3	Kalimarsi	Bhirtalo dhan	Chhomrong	Bhirtalo dhan			Bhirtalo dhan
4	Melte	Borang	Lekali-1	Borang			Borang
5		Chimathe	Lekali-3	Chandannath-1			Chandannath-1
6		Dhaudo	Machhapuchhre-3	Chandannath-3			Chandannath-3
7		Dhokr		Chhomrong			Chhomrong
8		Gumki Dotelo		Chimathe			Chimathe
9		Kale dhan		Churena Cross_Churena Jasto			Churena Cross_Churena Jasto
10		Kalimarsi-1(Humla)		Churena Cross_Jaudhan Jasto			Churena Cross_Jaudhan Jasto
11		Kalo Dhan		Churena Cross_Khetalo Jasto			Churena Cross_Khetalo Jasto
12		Ladamate		Churena Cross_Lumsero Jasto			Churena Cross_Lumsero Jasto
13		Lahare Sali		Darime			Darime
14		Lekali		Dhaudo			Dhaudo
15		Lotan sarau		Dhokro			Dhokro
16		NGRC01795		Gumki Dotelo			Gumki Dotelo
17		NGRC01797		Jumli Marsi			Jumli Marsi
18		NGRC01801		Kale dhan			Kale dhan
19		NGRC01802		Kalimarsi			Kalimarsi
20		NGRC01829		Kalimarsi-1(Humla)			Kalimarsi-1(Humla)
21		NGRC01973		Kalo Dhan			Kalo Dhan
22		NGRC01974		Khachche Cross_Dhilo Pakne			Khachche Cross_Dhilo Pakne
23		NGRC03156		Khachche Cross_JauDhan jasto			Khachche Cross_JauDhan jasto
24		NGRC03157		Khachche Cross_Khetalo Jasto			Khachche Cross_Khetalo Jasto
25		NGRC03164		Khachche Cross_Lumsero Jasto			Khachche Cross_Lumsero Jasto
26		NGRC03165		Ladamate			Ladamate
27		NGRC03262		Lahare Sali			Lahare Sali
28		Pakhe Ghaiya		Lekali			Lekali
29		Palsale Dhan		Lekali-1			Lekali-1
30		Patala		Lekali-3			Lekali-3
31		Ratanpuro Dhan		LHAR-130005			LHAR-130005
32		Sali		LHAR-130006			LHAR-130006

SN	RicEP1	RicEP2	RicEP3	RicEP4	RicEP5	RicEP6	RicSEP
33		Setomarsi (Genebank)		LHAR-130009			LHAR-130009
34		Shitali		Lotan sarau			Lotan sarau
35		Sunakhuri		Lumle-2			Lumle-2
36		Sunaulo		Lumle-2 (Humla)			Lumle-2 (Humla)
37		Suwa dhan		Machhapuchhre-3			Machhapuchhre-3
38				Melte			Melte
39				NGRC01795			NGRC01795
40				NGRC01797			NGRC01797
41				NGRC01801			NGRC01801
42				NGRC01802			NGRC01802
43				NGRC01829			NGRC01829
44				NGRC01973			NGRC01973
45				NGRC01974			NGRC01974
46				NGRC03156			NGRC03156
47				NGRC03157			NGRC03157
48				NGRC03164			NGRC03164
49				NGRC03165			NGRC03165
50				NGRC03262			NGRC03262
51				NR10682-B-B-B-3			NR10682-B-B-B-3
52				NR10682-B-B-B-B-4			NR10682-B-B-B-B-4
53				NR10695-B-B-B-5-1			NR10695-B-B-B-5-1
54				NR10859-1-7-2-1			NR10859-1-7-2-1
55				NR11121-B-B-17-5-7-3			NR11121-B-B-17-5-7-3
56				Pakhe Ghaiya			Pakhe Ghaiya
57				Palsale Dhan			Palsale Dhan
58				Patala			Patala
59				Ratanpuro Dhan			Ratanpuro Dhan
60				Sali			Sali
61				Setomarsi (Genebank)			Setomarsi (Genebank)
62				Setomarsi (Jumla)			Setomarsi (Jumla)
63				Shitali			Shitali

SN	RicEP1	RicEP2	RicEP3	RicEP4	RicEP5	RicEP6	RicSEP
64				Sunakhuri			Sunakhuri
65				Sunaulo			Sunaulo
66				Suwa dhan			Suwa dhan

Appendix 2. Rice evolutionary population establishment in Lamjung: Details of the entries for rice evolutionary population (RicEP) establishment in Lamjung

SN	RicEP1	RicEP2	RicEP3	RicEP4	RicEP5	RicEP6	RicSEP
1	Aanga	Anadi_Dolakha	Khumal 2	Aanga	Gaure	Khumal 4	Aanga
2	Aanpjhutte	Gudgude Marshi	Khumal 4	Aanpjhutte			Aanpjhutte
3	Belbhute	Koili	Khumal 6	Belbhute			Belbhute
4	Biramphul	Maldunge Marshi	Khumal 8	Biramphul			Biramphul
5	Dalle	Rambilas	Khumal 10	Dalle			Dalle
6	Darmali	Sigare Marshi		Darmali			Darmali
7	Ekle	Somara Marshi		Ekle			Ekle
8	Gaure	Bhui Pokhreli		Gaure			Gaure
9	Jarneli	Chainpure		Jarneli			Jarneli
10	Junge Jhare	Gurdi		Junge Jhare			Junge Jhare
11	Junge_Kanchhi	Hansraaj		Junge_Kanchhi			Junge_Kanchhi
12	Junge_Khotang	Jarneli_Rasuwa		Junge_Khotang			Junge_Khotang
13	Kalo Jhinuwa	Jhini		Kalo Jhinuwa			Kalo Jhinuwa
14	Kalo Patle	Jirmani Jaudhan		Kalo Patle			Kalo Patle
15	Pathijhare	Kaalo Kathe		Pathijhare			Pathijhare
16	Piyale	Kamal		Piyale			Piyale
17	Pomali	Krishnabeli		Pomali			Pomali
18	Rato Anadi	Mansara		Rato Anadi			Rato Anadi
19	Sailyan	Paakhe		Sailyan			Sailyan
20	Seto	Pahenlo		Seto			Seto
21	Seto Dalle	Raajmati		Seto Dalle			Seto Dalle
22		Saalo		Anadi_Dolakha			Anadi_Dolakha
23		Samundra Fini		Gudgude Marshi			Gudgude Marshi
24		Seto Marshi		Koili			Koili
25		Tauli Satara		Maldunge Marshi			Maldunge Marshi
26				Rambilas			Rambilas
27				Sigare Marshi			Sigare Marshi
28				Somara Marshi			Somara Marshi
29				Bhui Pokhreli			Bhui Pokhreli
30				Chainpure			Chainpure
31				Gurdi			Gurdi
32				Hansraaj			Hansraaj
33				Jarneli_Rasuwa			Jarneli_Rasuwa
34				Jhini			Jhini
35				Jirmani Jaudhan			Jirmani Jaudhan
36				Kaalo Kathe			Kaalo Kathe
37				Kamal			Kamal
38				Krishnabeli			Krishnabeli
39				Mansara			Mansara
40				Paakhe			Paakhe
41				Pahenlo			Pahenlo
42				Raajmati			Raajmati
43				Saalo			Saalo
44				Samundra Fini			Samundra Fini
45				Seto Marshi			Seto Marshi
46				Tauli Satara			Tauli Satara
47				Khumal 2			Khumal 2
48				Khumal 4			Khumal 4

SN	RicEP1	RicEP2	RicEP3	RicEP4	RicEP5	RicEP6	RicSEP
49				Khumal 6			Khumal 6
50				Khumal 8			Khumal 8
51				Khumal 10			Khumal 10
52				NR 11115-B-B-31-3			NR 11115-B-B-31-3
53				NR 10676-B-5-3			NR 10676-B-5-3
54				NR-11011-B-B-B-B-29			NR-11011-B-B-B-B-29
55				NR 11105-B-B-27			NR 11105-B-B-27
56				08FAN10			08FAN10

Appendix 3. Bean evolutionary population establishment in Jumla: Details of the entries for bean evolutionary population (BeEP) establishment in Jumla

SN	BeEP1	BeEP2	BeEP3	BeEP4	BeEP5	BeEP6	BeSEP
1	Kalo Male	Dalle Simi	PB-0001	Kalo Male	Kalo Male	Trishuli	Kalo Male
2	Rato Male	Rato Maale	PB-0002	Rato Male			Rato Male
3	Kalo Sano	Dange Simi	PB-0048	Kalo Sano			Kalo Sano
4	Rato Sano	Lahare Kalo Simi	KBL-1	Rato Sano			Rato Sano
5	Besare Pahenlo	Kalo Maale	KBL-2	Besare Pahenlo			Besare Pahenlo
6	Khairo Sada	Pahelo Simi	KBL-3	Khairo Sada			Khairo Sada
7	Kalo Lamo	Seto Maale		Kalo Lamo			Kalo Lamo
8	Fusro Chhirkey	Seto Sano		Fusro Chhirkey			Fusro Chhirkey
9	Rato Sano Chhirkey	Kaleji Simi		Rato Sano Chhirkey			Rato Sano Chhirkey
10	Rato Lamo	Gahate Simi		Rato Lamo			Rato Lamo
11	C 2008	Humla-557		C 2008			C 2008
12	EP-15-02 FB	Humla-372		EP-15-02 FB			EP-15-02 FB
13	EP-15-04 FB	Humla-553		EP-15-04 FB			EP-15-04 FB
14	DS-018-03FB	Humla-41		DS-018-03FB			DS-018-03FB
15	KA-17-04 FB	C 2009		KA-17-04 FB			KA-17-04 FB
16	NGRC07447	C1783		NGRC07447			NGRC07447
17	NGRC07993	NGRC07720		NGRC07993			NGRC07993
18	NGRC07995	NGRC07943		NGRC07995			NGRC07995
19	NGRC07997	NGRC07990		NGRC07997			NGRC07997
20	NGRC08238	NGRC08240		NGRC08238			NGRC08238
21	NGRC08239	NGRC08241		NGRC08239			NGRC08239
22				Dalle Simi			Dalle Simi
23				Rato Maale			Rato Maale
24				Dange Simi			Dange Simi
25				Lahare Kalo Simi			Lahare Kalo Simi
26				Kalo Maale			Kalo Maale
27				Pahelo Simi			Pahelo Simi
28				Seto Maale			Seto Maale
29				Seto Sano			Seto Sano
30				Kaleji Simi			Kaleji Simi
31				Gahate Simi			Gahate Simi
32				Humla-557			Humla-557
33				Humla-372			Humla-372
34				Humla-553			Humla-553
35				Humla-41			Humla-41
36				C 2009			C 2009
37				C1783			C1783
38				NGRC07720			NGRC07720
39				NGRC07943			NGRC07943
40				NGRC07990			NGRC07990
41				NGRC08240			NGRC08240
42				NGRC08241			NGRC08241
43				PB-0001			PB-0001
44				PB-0002			PB-0002
45				PB-0048			PB-0048

SN	BeEP1	BeEP2	BeEP3	BeEP4	BeEP5	BeEP6	BeSEP
46				KBL-1			KBL-1
47				KBL-2			KBL-2
48				KBL-3			KBL-3

Appendix 4. Germplasm sources of rice and bean collected from farmers and community seed banks by LIBIRD

NR	Source	Crop Name	Crop Variety	Type of material [1]	Origin (region or area)	Agroecology	Trait/ Crop
Humla_R1	Humla CSB	Rice	Churena Cross_Khetalo Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R2	Humla CSB	Rice	Churena Cross_Churena Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R3	Humla CSB	Rice	Churena Cross_Jaudhan Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R4	Humla CSB	Rice	Khachche Cross	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R5	Humla CSB	Rice	Khachche Cross_Khetalo Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R6	Humla CSB	Rice	Khachche Cross_Lumsero Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R7	Humla CSB	Rice	Khachche Cross_Dhilo Pakne	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R8	Humla CSB	Rice	Churena Cross_Lumsero Jasto	Segregating/breeding line	Humla	1100-1600 masl	Rice
Humla_R9	Humla CSB	Rice	Sunakhuri	Landrace currently grown	Humla	1100-1600 masl	Beaten rice and rice
Humla_R10	Humla CSB	Rice	Kali Marshi	Landrace currently grown	Humla	1100-1600 masl	Rice
Humla_R11	Humla CSB	Rice	Chhomrong	Landrace currently grown	Humla	1100-1600 masl	Rice
Humla_R12	Humla CSB	Rice	Palsale Dhan	Landrace currently grown	Humla	1100-1600 masl	Rice
Humla_R13	Humla CSB	Rice	Ratanpuro Dhan	Landrace currently grown	Humla	1100-1600 masl	Rice
Humla_R14	Humla CSB	Rice	Kalo Dhan	Landrace currently grown	Humla	1100-1600 masl	Rice
Humla_R15	Humla CSB	Rice	Chandannath-1	Improved cultivar	Humla	1100-1600 masl	Rice
Humla_R16	Humla CSB	Rice	Chandannath-3	Improved cultivar	Humla	1100-1600 masl	Rice
Humla_R17	Humla CSB	Rice	Lumle-2	Improved cultivar	Humla	1100-1600 masl	Rice
Humla_R18	Humla CSB	Rice	Lekali-1	Improved cultivar	Humla	1100-1600 masl	Rice
Humla_R19	Humla CSB	Rice	Lekali-3	Improved cultivar	Humla	1100-1600 masl	Rice
Humla_B1	Humla CSB	Bean	Dalle Simi	Landrace currently grown	Humla	1100-3200 masl	Fresh pods,pulses
Humla_B2	Humla CSB	Bean	Rato Maale	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B3	Humla CSB	Bean	Dange Simi	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B4	Humla CSB	Bean	Lahare Kalo Simi	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B5	Humla CSB	Bean	Kalo Maale	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B6	Humla CSB	Bean	Pahelo Simi	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B7	Humla CSB	Bean	Seto Maale	Landrace currently grown	Humla	1100-3200 masl	Pulses

NR	Source	Crop Name	Crop Variety	Type of material [1]	Origin (region or area)	Agroecology	Trait/ Crop
Humla_B8	Humla CSB	Bean	Seto Sano	Landrace currently grown	Humla	1100-3200 masl	Pulses
Humla_B9	Humla CSB	Bean	Kaleji Simi	Landrace currently grown	Humla	1100-3200 masl	Pulses
Jumla_R1	Jumla CSB	Rice	Jumli Marsi	Landrace currently grown	Jumla		Rice
Jumla_R2	Jumla CSB	Rice	Kalimarsi	Landrace currently grown	Jumla		Rice
Jumla_R3	Jumla CSB	Rice	Darime	Landrace currently grown	Jumla		Rice
Jumla_R4	Jumla CSB	Rice	Melte	Landrace currently grown	Jumla		Rice
Jumla_B1	Jumla CSB	Bean	Besare Pahelo	Landrace currently grown	Jumla		Pulses
Jumla_B2	Jumla CSB	Bean	Cheelo Kalo Sano	Landrace currently grown	Jumla		Pulses
Jumla_B3	Jumla CSB	Bean	Coffee Rang	Landrace currently grown	Jumla		Pulses
Jumla_B4	Jumla CSB	Bean	Fusro Chherkey	Landrace currently grown	Jumla		Pulses
Jumla_B5	Jumla CSB	Bean	Gajaley Sada	Landrace currently grown	Jumla		Pulses
Jumla_B6	Jumla CSB	Bean	Gheu Rang	Landrace currently grown	Jumla		Pulses
Jumla_B7	Jumla CSB	Bean	Gheu Rang Lamo	Landrace currently grown	Jumla		Pulses
Jumla_B8	Jumla CSB	Bean	Kailo Seto Sano	Landrace currently grown	Jumla		Pulses
Jumla_B9	Jumla CSB	Bean	Kalegi Chherkey Sano	Landrace currently grown	Jumla		Pulses
Jumla_B10	Jumla CSB	Bean	Kalegi Chherkey Thulo	Landrace currently grown	Jumla		Pulses
Jumla_B11	Jumla CSB	Bean	Kalegi Sada	Landrace currently grown	Jumla		Pulses
Jumla_B12	Jumla CSB	Bean	Kalo Lamo	Landrace currently grown	Jumla		Pulses
Jumla_B13	Jumla CSB	Bean	Kalo Maley	Landrace currently grown	Jumla		Pulses
Jumla_B14	Jumla CSB	Bean	Kalo Sano	Landrace currently grown	Jumla		Pulses
Jumla_B15	Jumla CSB	Bean	Khairo Chherkey	Landrace currently grown	Jumla		Pulses
Jumla_B16	Jumla CSB	Bean	Khairo Lamo	Landrace currently grown	Jumla		Pulses
Jumla_B17	Jumla CSB	Bean	Khairo Thulo Chherkey	Landrace currently grown	Jumla		Pulses
Jumla_B18	Jumla CSB	Bean	Kharani Sada	Landrace currently grown	Jumla		Pulses
Jumla_B19	Jumla CSB	Bean	Pahelo Chherkey	Landrace currently grown	Jumla		Pulses
Jumla_B20	Jumla CSB	Bean	Pahelo Golo	Landrace currently grown	Jumla		Pulses
Jumla_B21	Jumla CSB	Bean	Rato Lamo	Landrace currently grown	Jumla		Pulses
Jumla_B22	Jumla CSB	Bean	Rato Maley	Landrace currently grown	Jumla		Pulses
Jumla_B23	Jumla CSB	Bean	Rato Sano	Landrace currently grown	Jumla		Pulses
Jumla_B24	Jumla CSB	Bean	Rato Sano Chhirke	Landrace currently grown	Jumla		Pulses

NR	Source	Crop Name	Crop Variety	Type of material [1]	Origin (region or area)	Agroecology	Trait/ Crop
Jumla_B25	Jumla CSB	Bean	Seto Chherkey	Landrace currently grown	Jumla		Pulses
Jumla_B26	Jumla CSB	Bean	Seto Chherkey Thulo	Landrace currently grown	Jumla		Pulses
Jumla_B27	Jumla CSB	Bean	Seto Dallo Sano	Landrace currently grown	Jumla		Pulses
Jumla_B28	Jumla CSB	Bean	Seto Lamo	Landrace currently grown	Jumla		Pulses
Jumla_B29	Jumla CSB	Bean	Sindure	Landrace currently grown	Jumla		Pulses
Jumla_B30	Jumla CSB	Bean	Sindure Chherkey	Landrace currently grown	Jumla		Pulses
Jungu_R1	Tilak Pandey	Rice	Sigare Marshi	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice
Jungu_R2	Tilak Pandey	Rice	Kohile	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice
Jungu_R3	Tilak Pandey	Rice	Rambilas	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice
Jungu_R4	Tilak Pandey	Rice	Gudgude Marshi	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice
Jungu_R5	Tilak Pandey	Rice	Anadi	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice, Beaten Rice
Jungu_R6	Tilak Pandey	Rice	Somara Marshi	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Dryland farming, lodging resistance
Jungu_R7	Tilak Pandey	Rice	Maldunge Marshi	Landrace currently grown	Jungu, Dolakha	800-1300 masl	Rice
Lamjung_R1	Ghanpokhara CSB	Rice	Aanpjhutte	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R2	Ghanpokhara CSB	Rice	Aanga	Landrace currently grown	Lamjung	800-1300 masl	Rice, Jhaid (Local recipe)
Lamjung_R3	Ghanpokhara CSB	Rice	Anadi	Landrace currently grown	Lamjung	800-1300 masl	Rice, Latta (local recipe)
Lamjung_R4	Ghanpokhara CSB	Rice	Belbhute	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R5	Ghanpokhara CSB	Rice	Biramful	Improved cultivar	Lamjung	800-1300 masl	Rice
Lamjung_R6	Ghanpokhara CSB	Rice	Borang	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R7	Ghanpokhara CSB	Rice	Chemong	Landrace currently grown	Lamjung	1610m	Rice
Lamjung_R8	Ghanpokhara CSB	Rice	Dalle	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R9	Ghanpokhara CSB	Rice	Darmali	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R10	Ghanpokhara CSB	Rice	Ekle	Landrace currently grown	Lamjung	1000m	Rice, Selroti (Rice Doughnut)
Lamjung_R11	Ghanpokhara CSB	Rice	Gaure	Landrace currently grown	Lamjung	800-1300 masl	Rice, Siraula (desert)
Lamjung_R12	Ghanpokhara CSB	Rice	Gurdi	Landrace currently grown	Lamjung	1115m	Rice
Lamjung_R13	Ghanpokhara CSB	Rice	Himali	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R14	Ghanpokhara CSB	Rice	Indrabeli	Landrace currently grown	Lamjung	975m	Rice
Lamjung_R15	Ghanpokhara CSB	Rice	Jarneli	Landrace currently grown	Lamjung	800-1300 masl	Rice

NR	Source	Crop Name	Crop Variety	Type of material [1]	Origin (region or area)	Agroecology	Trait/ Crop
Lamjung_R16	Ghanpokhara CSB	Rice	Jawali	Landrace currently grown	Lamjung	985m	Rice
Lamjung_R17	Ghanpokhara CSB	Rice	Jhai Rice	Landrace currently grown	Lamjung	995m	Rice, Desert
Lamjung_R18	Ghanpokhara CSB	Rice	Jumli Marshi	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R19	Ghanpokhara CSB	Rice	Junge	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R20	Ghanpokhara CSB	Rice	Junge Jhare	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R21	Ghanpokhara CSB	Rice	Jurdung	Landrace currently grown	Lamjung	1231m	Rice
Lamjung_R22	Ghanpokhara CSB	Rice	Kaalo Jhinuwa	Landrace currently grown	Lamjung	1100m	Rice, Selroti (Rice Doughnut)
Lamjung_R23	Ghanpokhara CSB	Rice	Kagheri	Landrace currently grown	Lamjung	1115m	Rice
Lamjung_R24	Ghanpokhara CSB	Rice	Kalo Dhan	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R25	Ghanpokhara CSB	Rice	Kalo Jhinuwa	Landrace currently grown	Lamjung	800-1300 masl	Rice, Selroti (Rice Doughnut)
Lamjung_R26	Ghanpokhara CSB	Rice	Kalo Patle	Landrace currently grown	Lamjung	1530m	Rice
Lamjung_R27	Ghanpokhara CSB	Rice	Kanka Jeera	Landrace currently grown	Lamjung	968m	Rice
Lamjung_R28	Ghanpokhara CSB	Rice	Kartike	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R29	Ghanpokhara CSB	Rice	Khaire	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R30	Ghanpokhara CSB	Rice	Lama Gaun Rice	Landrace currently grown	Lamjung	980m	Rice
Lamjung_R31	Ghanpokhara CSB	Rice	Lekali Basmati	Landrace currently grown	Lamjung	1546m	Rice
Lamjung_R32	Ghanpokhara CSB	Rice	Lekali Rato	Landrace currently grown	Lamjung	1580m	Rice
Lamjung_R33	Ghanpokhara CSB	Rice	Mansara	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R34	Ghanpokhara CSB	Rice	Mayalu	Landrace currently grown	Lamjung	1257m	Rice
Lamjung_R35	Ghanpokhara CSB	Rice	More Marsi	Landrace currently grown	Lamjung	1000m	Rice,Selroti
Lamjung_R36	Ghanpokhara CSB	Rice	Naule	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R37	Ghanpokhara CSB	Rice	Pamali	Landrace currently grown	Lamjung	1160m	Rice
Lamjung_R38	Ghanpokhara CSB	Rice	Pathibhara	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R39	Ghanpokhara CSB	Rice	Piyale	Landrace currently grown	Lamjung	800-1300 masl	Rice, Selroti (Rice Doughnut)
Lamjung_R40	Ghanpokhara CSB	Rice	Pokh Marshi	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R41	Ghanpokhara CSB	Rice	Pokhreli	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R42	Ghanpokhara CSB	Rice	Rato Anadi	Landrace currently grown	Lamjung	1100m	Rice, Latta (local recipe)
Lamjung_R43	Ghanpokhara CSB	Rice	Saali	Landrace currently grown	Lamjung	800-1300 masl	Rice

NR	Source	Crop Name	Crop Variety	Type of material [1]	Origin (region or area)	Agroecology	Trait/ Crop
Lamjung_R44	Ghanpokhara CSB	Rice	Sano Masino	Landrace currently grown	Lamjung	1015m	Rice
Lamjung_R45	Ghanpokhara CSB	Rice	Seto	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R46	Ghanpokhara CSB	Rice	Seto Kaalo	Landrace currently grown	Lamjung	1669m	Rice
Lamjung_R47	Ghanpokhara CSB	Rice	Seto Kartike	Landrace currently grown	Lamjung	800-1300 masl	Rice
Lamjung_R48	Ghanpokhara CSB	Rice	Tamare	Landrace currently grown	Lamjung	1600m	Rice, Jhaid (Local recipe)
Lamjung_R49	Ghanpokhara CSB	Rice	Tulsi Rice	Landrace currently grown	Lamjung	971m	Rice
Maramche_B1	Govind Prasad Paudel	Bean	Gahate Simi	Landrace currently grown	Maramche, Kaski	Mid Hill, Upper Belt	Vegetable, Daal
Maramche_R1	Govind Prasad Paudel	Rice	Kalo Patle	Landrace currently grown	Maramche, Kaski	Mid Hill, Upper Belt	Rice, Rice Pudding
Maramche_R2	Govind Prasad Paudel	Rice	Juwari	Landrace currently grown	Maramche, Kaski	Mid Hill, Lower belt	Rice Pudding
Maramche_R3	Krishna Adhikari	Rice	Lumle-2	Improved cultivar	Maramche, Kaski	Mid Hill, Upper Belt	Beaten Rice
Maramche_R4	Krishna Adhikari	Rice	Machhapuchchhre-3	Improved cultivar	Maramche, Kaski	Mid Hill, Upper Belt	Rice
Maramche_R5	Krishna Adhikari	Rice	Chhomrong	Landrace currently grown	Maramche, Kaski	Mid Hill, Upper Belt	Beaten Rice

Appendix 5. Germplasm sources collected from different agroecological regions by NAGRC, NARC

NR	Source/Accession	Crop Name	Crop Variety/Collection Number	Type of material [1]	Origin (region or area)	Agroecology
NAGRC_R1	NGRC02138	Rice	Bharnang	Landrace/accessions from Genebank	Panchthar	1840
NAGRC_R2	NGRC01975	Rice	Chimathe	Landrace/accessions from Genebank	Kalikot	1792
NAGRC_R3	NGRC03227	Rice	Patala	Landrace/accessions from Genebank	Rasuwa	2033
NAGRC_R4	NGRC01728	Rice	Lekali	Landrace/accessions from Genebank	Myagdi	1800
NAGRC_R5	NGRC01799	Rice	Dhokro	Landrace/accessions from Genebank	Mugu	2350
NAGRC_R6	NGRC03234	Rice	Borang	Landrace/accessions from Genebank	Rasuwa	1947
NAGRC_R7	NGRC01674	Rice	Lahare Sali	Landrace/accessions from Genebank	Gorkha	2012
NAGRC_R8	NGRC01803	Rice	Dhaudo	Landrace/accessions from Genebank	Mugu	1780
NAGRC_R9	NGRC01979	Rice	Gumki Detole	Landrace/accessions from Genebank	Kalikot	1768
NAGRC_R10	NGRC01671	Rice	Sali	Landrace/accessions from Genebank	Gorkha	2347
NAGRC_R11	NGRC01836	Rice	Bageri	Landrace/accessions from Genebank	Solukhumbu	1707
NAGRC_R12	NGRC02062	Rice	Kale dhan	Landrace/accessions from Genebank	Bajhang	1737
NAGRC_R13	NGRC01800	Rice	Lotan sarau	Landrace/accessions from Genebank	Mugu	2080
NAGRC_R14	NGRC01782	Rice	Seto Marsi	Landrace/accessions from Genebank	Humla	2100

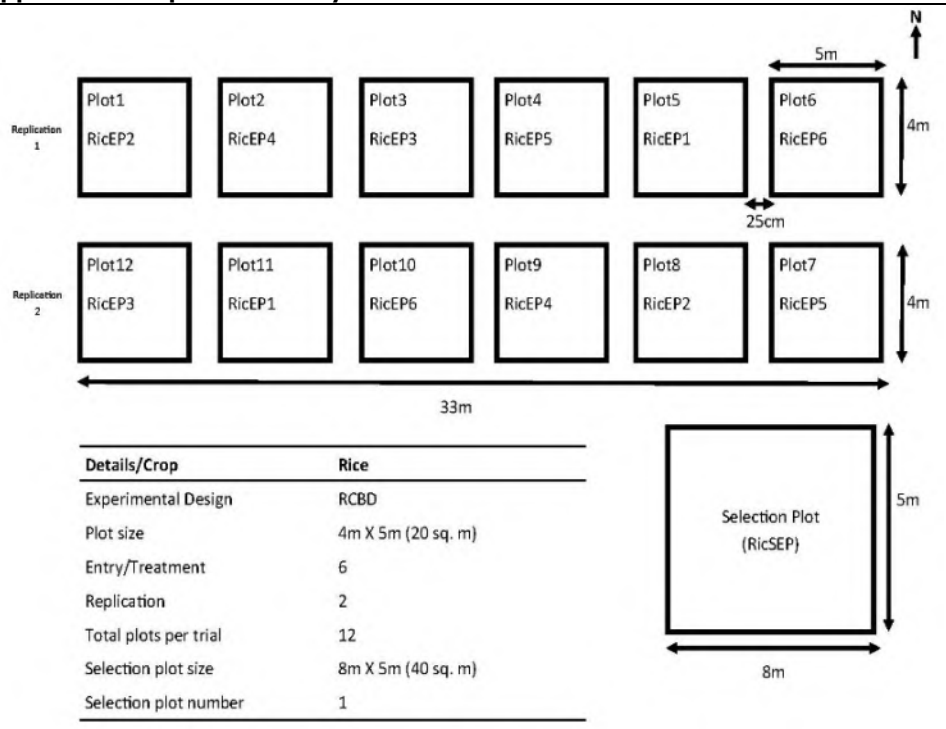
NR	Source/Accession	Crop Name	Crop Variety/Collection Number	Type of material [1]	Origin (region or area)	Agroecology
NAGRC_R15	NGRC02068	Rice	Shitali	Landrace/accessions from Genebank	Bajhang	1829
NAGRC_R16	NGRC01790	Rice	Bhirtalo dhan	Landrace/accessions from Genebank	Humla	1850
NAGRC_R17	NGRC02036	Rice	Sunaulo	Landrace/accessions from Genebank	Bajura	2700
NAGRC_R18	NGRC02069	Rice	Ladamate	Landrace/accessions from Genebank	Bajhang	1829
NAGRC_R19	NGRC01772	Rice	Suwa dhan	Landrace/accessions from Genebank	Sindhupalchok	2400
NAGRC_R20	NGRC01972	Rice	Pakhe Ghaiya	Landrace/accessions from Genebank	Mugu	1960
NAGRC_B1	Pahelosimi	Bean	Pahelosimi	Landrace/accessions from Genebank	Dolkha	1843
NAGRC_B2	DS-018-03FB	Bean	DS-018-03FB	Landrace/accessions from Genebank	Jumla	2968.15
NAGRC_B3	Humla-557	Bean	Humla-557	Landrace/accessions from Genebank	Humla	
NAGRC_B4	Humla-372	Bean	Humla-372	Landrace/accessions from Genebank	Humla	
NAGRC_B5	Humla-553	Bean	Humla-553	Landrace/accessions from Genebank	Humla	
NAGRC_B6	Humla-187	Bean	Humla-187	Landrace/accessions from Genebank	Humla	
NAGRC_B7	Humla-41	Bean	Humla-41	Landrace/accessions from Genebank	Humla	
NAGRC_B8	C 2002	Bean	C 2002	Landrace/accessions from Genebank	Mugu	2200
NAGRC_B9	C 2008	Bean	C 2008	Landrace/accessions from Genebank	Jumla	2350
NAGRC_B10	C 4531	Bean	C 4531	Landrace/accessions from Genebank		
NAGRC_B11	C 2009	Bean	C 2009	Landrace/accessions from Genebank	Kalikot	2160
NAGRC_B12	Ghiusimi	Bean	Ghiusimi	Landrace/accessions from Genebank	Jugu, Dolkha	1843
NAGRC_B13	EP-15-09 FB	Bean	EP-15-09 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B14	EP-15-02 FB	Bean	EP-15-02 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B15	EP-15-01 FB	Bean	EP-15-01 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B16	EP-15-04 FB	Bean	EP-15-04 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B17	EP-15-03 FB	Bean	EP-15-03 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B18	KA-17-01 FB	Bean	KA-17-01 FB	Landrace/accessions from Genebank	Khar, Kalikot	2146
NAGRC_B19	KA-17-03 FB	Bean	KA-17-03 FB	Landrace/accessions from Genebank	Khar, Kalikot	1536
NAGRC_B20	KA-17-02 FB	Bean	KA-17-02 FB	Landrace/accessions from Genebank	Khar, Kalikot	1536
NAGRC_B21	KA-17-06 FB	Bean	KA-17-06 FB	Landrace/accessions from Genebank	Khar , Kalikot	2146
NAGRC_B22	KA-17-04 FB	Bean	KA-17-04 FB	Landrace/accessions from Genebank	Talium, Jumla	1536
NAGRC_B23	EP-15-17 FB	Bean	EP-15-17 FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B24	NGRC 05054	Bean	NGRC 05054	Introduced modern variety	ARS, Jumla	

NR	Source/Accession	Crop Name	Crop Variety/Collection Number	Type of material [1]	Origin (region or area)	Agroecology
NAGRC_B25	NAGRC 5970	Bean	NAGRC 5970	Landrace/accessions from Genebank	Rasuwa	
NAGRC_B26	C 1753	Bean	C 1753	Landrace/accessions from Genebank	Babiyachour, Myagdi	971
NAGRC_B27	C1783	Bean	C1783	Landrace/accessions from Genebank	Myagdi	1512
NAGRC_B28	C 1788	Bean	C 1788	Landrace/accessions from Genebank	Rakhu, Myagdi	1543
NAGRC_B29	DS-018-07FB	Bean	DS-018-07FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B30	DS-018-06FB	Bean	DS-018-06FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B31	DS-018-01FB	Bean	DS-018-01FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B32	DS-018-02FB	Bean	DS-018-02FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B33	DS-018-05FB	Bean	DS-018-05FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B34	DS-018-04FB	Bean	DS-018-04FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B35	DS-018-03FB	Bean	DS-018-03FB	Landrace/accessions from Genebank	Talium, Jumla	2968.15
NAGRC_B1	NGRC05054	Bean	PB-0001	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B2	NGRC05055	Bean	PB-0002	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B3	NGRC05056	Bean	PB-0048	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B4	NGRC05057	Bean	KBL-1	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B5	NGRC05058	Bean	KBL-2	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B6	NGRC05059	Bean	KBL-3	Breeding Line/ARS, Jumla	Jumla	
NAGRC_B7	NGRC05060	Bean	KBL-4	Breeding Line	Jumla	
NAGRC_B8	NGRC05061	Bean	KBL-5	Breeding Line	Jumla	
NAGRC_B9	NGRC05062	Bean	KBL-6	Breeding Line	Jumla	
NAGRC_B10	NGRC05063	Bean	KBL-7	Breeding Line	Jumla	
NAGRC_B11	NGRC05064	Bean	KBL-8	Breeding Line	Jumla	
NAGRC_B12	NGRC05065	Bean	KBL-9	Breeding Line	Jumla	
NAGRC_B13	NGRC07447	Bean	C4531	Landrace/accessions from Genebank	Jumla	2609
NAGRC_B14	NGRC07720	Bean	Hallude Simi Kalo	Landrace/accessions from Genebank	Myagdi	971
NAGRC_B15	NGRC07943	Bean	Kalo Simi	Landrace/accessions from Genebank	Mugu	2200
NAGRC_B16	NGRC07990	Bean	Kalo Simi	Landrace/accessions from Genebank	Darchula	2146
NAGRC_B17	NGRC07993	Bean	Kalo Masino	Landrace/accessions from Genebank	Jumla	2968.15
NAGRC_B18	NGRC07995	Bean	Gulabi Sano	Landrace/accessions from Genebank	Jumla	
NAGRC_B19	NGRC07997	Bean	Kalo Thulo Maale	Landrace/accessions from Genebank	Jumla	29 68.15

NR	Source/Accession	Crop Name	Crop Variety/Collection Number	Type of material [1]	Origin (region or area)	Agroecology
NAGRC_B20	NGRC08238	Bean	Gulabi Thulo Maale	Landrace/accessions from Genebank	Jumla	3071
NAGRC_B21	NGRC08239	Bean	Kalo Masino	Landrace/accessions from Genebank	Jumla	3051
NAGRC_B22	NGRC08240	Bean	Kaleji Chhirbire	Landrace/accessions from Genebank	Darchula	1536
NAGRC_B23	NGRC08241	Bean	Batulo Simi	Landrace/accessions from Genebank	Darchula	2146
NAGRC_B24	Trishuli	Bean	Trishuli	Released variety		
NAGRC_R1	NGRC02956	Rice	Gurdi	Landrace/accessions from Genebank	Syangja	
NAGRC_R2	NGRC03093	Rice	Mansara	Landrace/accessions from Genebank	Gorkha	
NAGRC_R3	NGRC03097	Rice	Pahenlo	Landrace/accessions from Genebank	Gorkha	
NAGRC_R4	Nuwakot-65	Rice	Krishnabeli	Landrace/accessions from Genebank	Nuwakot	1125
NAGRC_R5	Nuwakot-66	Rice	Kaalo Kathe	Landrace/accessions from Genebank	Nuwakot	1125
NAGRC_R6	Nuwakot-56	Rice	Samundra Fini	Landrace/accessions from Genebank	Nuwakot	
NAGRC_R7	NGRC 02075	Rice	Paakhe	Landrace/accessions from Genebank	Jajarkot	762
NAGRC_R8	NGRC01720	Rice	Tauli Satara	Landrace/accessions from Genebank	Dhankuta	744
NAGRC_R9	NGRC 02090	Rice	Saalo	Landrace/accessions from Genebank	Dadeldhura	1158
NAGRC_R10	NGRC03069	Rice	Chainpure	Landrace/accessions from Genebank	Dadeldhura	1,140
NAGRC_R11	NGRC03118	Rice	Jirmani Jaudhan	Landrace/accessions from Genebank	Myagdi	968
NAGRC_R12	NGRC03218	Rice	Raajmati	Landrace/accessions from Genebank	Darchula	
NAGRC_R13	NGRC03241	Rice	Bhui Pokhreli	Landrace/accessions from Genebank	Rasuwa	1253
NAGRC_R14	NGRC02987	Rice	Kamal	Landrace/accessions from Genebank	Rukum	823
NAGRC_R15	NGRC03223	Rice	Jhini	Landrace/accessions from Genebank	Darchula	
NAGRC_R16	NGRC02998	Rice	Seto Marshi	Landrace/accessions from Genebank	Kaski	1075
NAGRC_R17	NGRC03238	Rice	Jarneli	Landrace/accessions from Genebank	Rasuwa	1253
NAGRC_R18	Hansaraj Dhan	Rice	Hansraaj	Landrace/accessions from Genebank		
NAGRC_R1	NR 11115-B-B-31-3	Rice	NR 11115-B-B-31-3	Breeding Line/Botany Division		
NAGRC_R2	NR 10676-B-5-3	Rice	NR 10676-B-5-3	Breeding Line/Botany Division		
NAGRC_R3	NR-11011-B-B-B-B-29	Rice	NR-11011-B-B-B-B-29	Breeding Line/Botany Division		
NAGRC_R4	NR 11105-B-B-27	Rice	NR 11105-B-B-27	Breeding Line/Botany Division		
NAGRC_R5	08FAN10	Rice	08FAN10	Breeding Line/Botany Division		
NAGRC_R1	Khumal 2	Rice	Khumal 2	Improved variety		
NAGRC_R2	Khumal 4	Rice	Khumal 4	Improved variety		

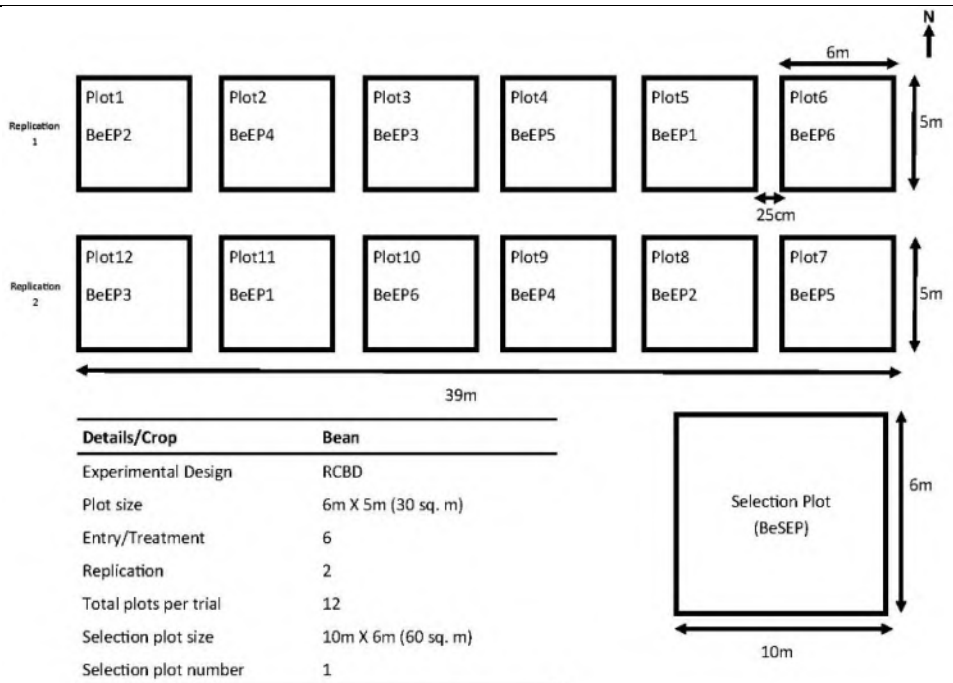
NR	Source/Accession	Crop Name	Crop Variety/Collection Number	Type of material [1]	Origin (region or area)	Agroecology
NAGRC_R3	Khumal 6	Rice	Khumal 6	Improved variety		
NAGRC_R4	Khumal 8	Rice	Khumal 8	Improved variety		
NAGRC_R5	Khumal 10	Rice	Khumal 10	Improved variety		

Appendix 6. Experimental layout for rice and bean EP establishment in RCBD



Details/Crop	Rice
Experimental Design	RCBD
Plot size	4m X 5m (20 sq. m)
Entry/Treatment	6
Replication	2
Total plots per trial	12
Selection plot size	8m X 5m (40 sq. m)
Selection plot number	1

Figure 1. Experimental layout for Rice Evolutionary Population (RicEP) establishment



Details/Crop	Bean
Experimental Design	RCBD
Plot size	6m X 5m (30 sq. m)
Entry/Treatment	6
Replication	2
Total plots per trial	12
Selection plot size	10m X 6m (60 sq. m)
Selection plot number	1

Figure 2. Experimental layout for Bean Evolutionary Population (BeEP) establishment

Training contents

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- Trend and impact of crop improvement
- Classification and features of plant breeding
  - Conventional, Molecular, Participatory, Evolutionary
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- History, Concept and Rationale of EPB
- Relevance of EPB in Nepal
- Challenges and Limitations of EPB
- EPB methodology
- Steps of evolutionary plant breeding
- Types and development of evolutionary populations
- Important traits in evolutionary populations
- Statistical analysis of EPB data (data types and recommended analysis methods)
- Cultivar mixtures and Evolutionary Populations (EPs)
- Policy dimension for adopting evolutionary population

Chapter II. Implementation of EPB

- EPB in Nepal
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- On-station EPB
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- Randomization and layout
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- Seeding and transplanting
- Caring and monitoring
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- Data collection, participatory monitoring and evaluation
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- Seed production and maintenance

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Chapter IV. Economics and policy analysis

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Policy recommendations and future look
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Chapter V. EPB Supplement

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Annex I. Training evaluation
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