

## REBUILDING LOCAL SEED SYSTEM AND SAFEGUARDING CONSERVATION OF AGROBIODIVERSITY IN THE AFTERMATH OF NEPAL 2015 EARTHQUAKE

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### ABSTRACT

*A study was conducted from July 2015 to December 2017 to rebuild local seed system and safeguard conservation of agrobiodiversity in the aftermath of earthquake through rescue collection, conservation and repatriation of endangered crop landraces from 10 earthquake affected districts. The process employed several methods, approaches and processes combining rescue missions with qualitative and quantitative assessments techniques and tools. The process helped to assess status of diversity of traditional crops, identify endangered, extinct and rare crop landraces, document and characterize their unique agronomic traits and develop and validate methodology for conservation of native crops by linking on-farm and ex-situ approaches. A total of 921 accessions of 61 crops were collected from 35 VDCs of 10 severally earthquake affected districts. The process has identified 104 lost crop landraces and rescued 284 rare and endangered ones and conserved them in national Genebank. Some of the farmer demanded crop landraces are repatriated back to local communities and also conserved in community seed banks in affected districts. The process therefore helped to restore lost diversity, revive and strengthen the local seed system and safeguard biodiversity of native crops to adapt to more extreme and changing climatic conditions.*

**Keywords:** *Adapted seeds, capacity building, conservation, rebuilding, rescue collection, repatriation*

### INTRODUCTION

The April 25 earthquake (with 7.6 Richter scale) and its subsequent aftershocks have had significant impact on people's livelihoods, agriculture and agrobiodiversity in Nepal. The major effect of disaster was in remote hills and mountains where production system was rainfed, risk-prone, subsistence and people's livelihoods depended on agriculture and biodiversity of traditional crops. According to the estimates of the Post Disaster Need Assessment (PDNA) of the Government of Nepal, the total value of direct and indirect impact of the earthquake to Nepalese economy was close to USD 7 billion, equivalent to one-third of country's GDP (NPC, 2015). The agriculture sector suffered total damage and loss of USD 255 million, with maximum losses (86%) in mountainous and hilly - affected areas (Rasul et al., 2015). The country's vulnerable areas had been most affected, leaving over 3.5 million people in need of food, water, shelter and medical assistance (FAO, 2015). Over 70% of the agricultural households have lost their more than 60% of their seed stock and crop genetic resources stored in their household stores from earthquake damage (FAO, 2015; NPC, 2015). The earthquake had also secondary effects, triggering human and nature induced landslides, land degradation, flooding, drying up of water sources, avalanches and disease epidemics. It also had long-term negative impact on agricultural and national development through the loss of productive labor force, infrastructure, forced outmigration and disruption in supply chains and earning potentials of people (NPC, 2015). The disaster had

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significant effect on the agriculture and agrobiodiversity due to destruction of storage structures, burial of stored seeds and damage of agricultural lands (Gauchan et al., 2017).

Seed is at the heart of restoring food security for farmers and their families in Nepal. Farmers in rural and remote hills and mountains have high dependence on food security by producing agricultural production from self-saved and locally exchanged seeds and biodiversity of traditional crops. Estimates show that over 90% of the farm households in rural hills and mountainous regions of earthquake affected regions of Nepal depend on self-saved and locally exchanged seeds of traditional crops in the communities (Gauchan et al., 2016). The majority of the affected families were smallholder farmers, with low capacity to respond and recover from shocks. Therefore, rescue collection of native and endangered seeds was important after disasters in order to revive local seed system, restore lost diversity and safeguard local crop biodiversity for future generation (Bioversity International, 2016; Gauchan et al; 2016).

Aftermath of the disaster, various national government and international relief agencies made efforts in Nepal to rescue human beings, livestock and valuable assets but no immediate initiatives were made to rescue endangered native crop seeds and varieties in the affected areas in Nepal (Gauchan et al 2016). Considering the critical role of local and native varieties in rebuilding local seed system, improving livelihoods of mountain communities and safeguarding biodiversity of globally important crops, Bioversity International jointly in partnership with National Genebank, NARC and LI-BIRD initiated a study from July 2015 to December 2017 on rescue seed collection, conservation and repatriation of local crop genetic resources that are endangered from earthquake areas. This paper deals with the role, process, methodologies and achievement made in rebuilding local seed system through rescue collection, conservation and repatriation in 10 earthquake affected areas.

## **OBJECTIVES**

The main objectives of the study were to (i) rebuild local seed system of native crop varieties in earthquake affected areas through rescue collection, conservation and repatriation and (ii) develop and validate methodology of rescue collection for seed recovery, livelihood improvement and safeguarding biodiversity of native crops.

## **METHODOLOGY**

The study employed several methods and approaches combining both qualitative and quantitative methods for rescue collection, conservation and repatriation of native crops seeds in affected areas. The process of rescue collections was initiated in 35 village development committees (VDC) of 10 severely affected districts covering 2-4 most severely affected VDCs of each district (Figure 1). Participatory rural appraisals focusing on key informant interviews, transect walks and focus group discussion (FGD) were carried out for identification of appropriate locations and communities for rescue collection, conservation and repatriation. FGD and 4-cell analysis were carried out in selected communities to identify rare native crops and landraces that need rescue collection, conservation and repatriation in local communities. Passport data filling with sample seed collection and survey of 837 farmers were carried out where seeds are collected and rescued for the documentation of rescued seed types, crop varieties and farmers' knowledge that are being collected and rescued.

After rescue mission and field survey, assessment was carried out to characterize and document diversity of traits of traditional crops, identify endangered, extinct and rare crop landraces and develop and validate methodology for conservation of native crops by linking on-farm and ex-situ approaches. Data were also captured by employing DIVA GIS software and CAT (Climate Analogue Tool) using rice germplasm from national and international genebanks. DIVA-GIS software was used to construct a collection map and use Climate Analogue Tool (CAT) to identify the analogue sites of earthquake affected areas. Seed samples that donot meet standard gene bank requirements and those

demanded by farmers were planted in the genebank fields for seed increase, characterization and evaluation. Some of the farmer preferred landraces seeds of 4 crops (rice, foxtail millet, lentil and naked barley) were re-introduced and repatriated back to local communities in affected districts of Dolakha, Kavre and east Lamjung for building local seed system, providing local access of seeds and conservation in community seedbanks and farmers fields. Monitoring and follow-up for feedback collections were carried out in repatriated locations and communities for their suitability and adaptability. Rescue collected seed sample data and information including methodology and findings were supplemented and validated through review of available national and international literature, field characterization and evaluation and consultation meetings and workshops with relevant stakeholders at the local and national level.

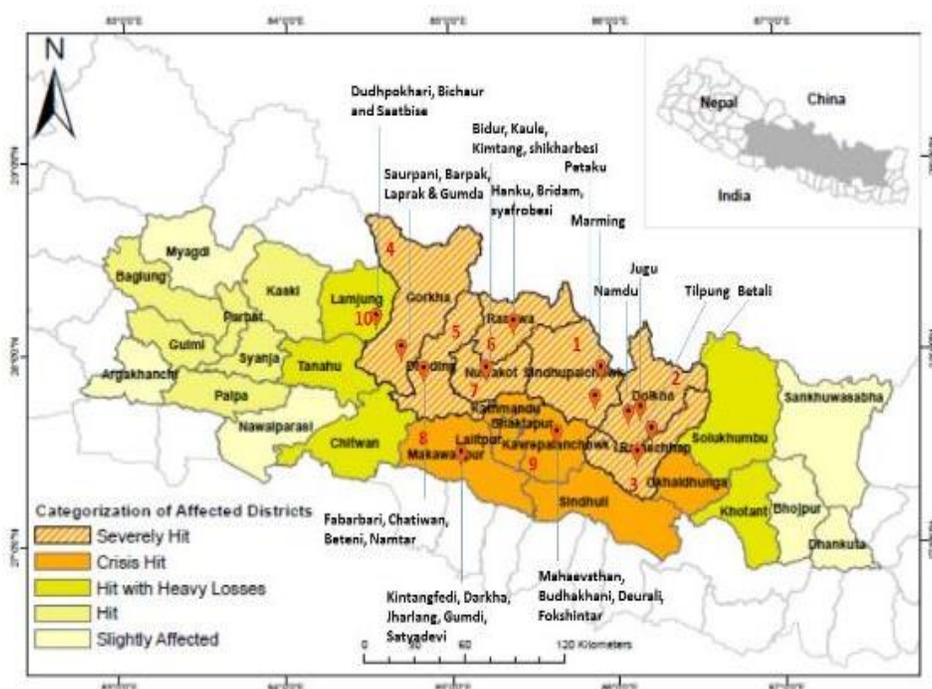
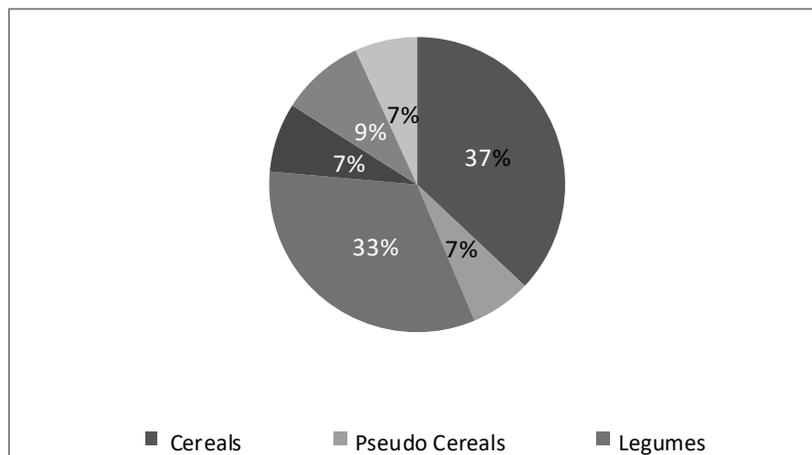


Figure 1: Rescue collection of crop landraces from earthquake districts: Map source: NPC (2015).

## RESULTS AND DISCUSSION

### RESCUE COLLECTIONS, CONSERVATION AND PARTICIPATORY SEED EXCHANGE

A total of 921 accessions of 61 crops were collected from 35 VDCs of 10 severely earthquake affected districts. The germplasm rescue project implemented by the National Genebank (NAGRC) with the funding support of Global Crop Diversity Trust (GCdT) collected 513 crop landraces of 57 crops while Seed Rescue Project implemented by LI-BIRD with the funding of Genetic Resource Policy Initiative - Phase 2 (GRPI-2) project of Bioversity International collected 410 accessions of 46 crops. Out of those collected samples, the large proportion of the crop landraces collected and rescued were cereals (37%) followed by legumes (33%) and small proportion of pseudo cereals, oilseeds, vegetables and spices (Figure 2).



**Figure: 2 Proportion of sample collected by crop groups in earthquake affected areas**

These collected samples were processed (cleaning, germination testing, drying) for conservation in Genebank for future use in affected areas as well as for future crop improvement. Seed samples that did not meet standards and quality for safe storage in genebank are planted in the fields for their seed increase, regeneration and phenotypic evaluation. Part of the rescue collected endangered seeds of cereals, legumes and vegetables (20 landraces in Dolakha and 18 landraces in Lamjung) were also conserved in local community seed banks of earthquake affected areas such as in Jungu Dolakha and Rainash in east Lamjung. The rescue collected rare and endangered seeds from three earthquake affected districts of Dolakha, Ramechhap and Sindhuplanchowk were distributed back immediately to local communities by employing participatory seed exchange (PSE) method. The objectives were to provide immediate access of locally adapted seeds to disaster affected communities for their immediate food production and also the revival of their damaged local seed system. A total of 503 farm households received rescued rare and endangered seeds and participated in PSE (Gautam et al., 2017) which signifies importance of seed exchange to the affected communities for revival of the local seed system and ensuring local food security. Smallholder farmers and women were the key beneficiaries of the PSE.

#### ASSESSMENT OF CROP DIVERSITY

The rescue collected crop landraces were assessed, characterized and documented based on passport data information, visual seed observation and on-farm evaluation of selected ones. The process helped to identify crop landraces that are endangered, extinct, rare and abundance in surveyed 10 earthquake affected districts. The assessment revealed that a total of 104 crop landraces are lost, 26 of rare and unique and 258 seed types of different crops are at endangered state due to earthquake and other factors (Figure 3).

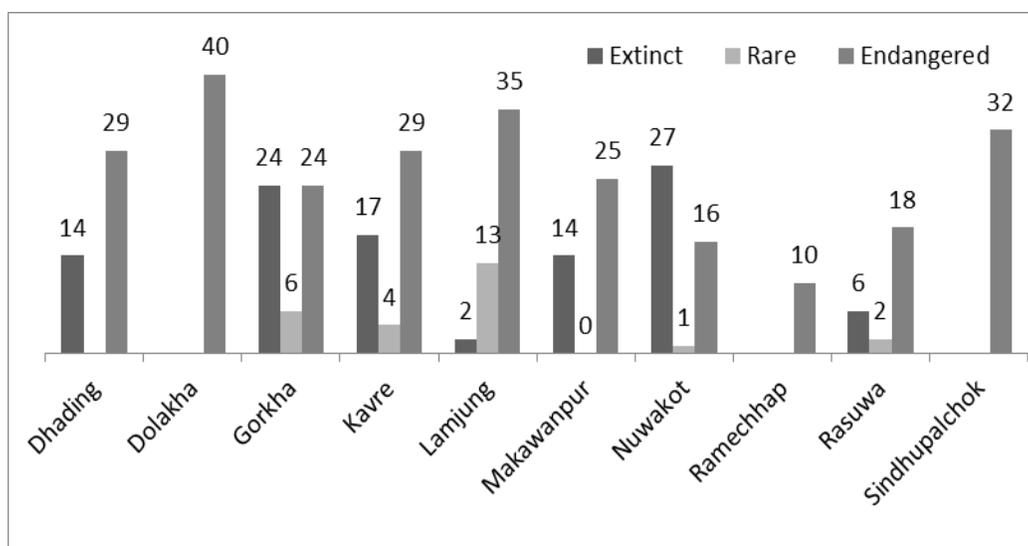


Figure 3. Status of endangered, rare and extinct crop landraces in earthquake affected areas

Endangered native landraces in affected areas were observed for various food crops in most parts of mid hills and high hills/mountains of the affected areas due to direct and indirect consequences of earthquake and other subsequent effects of disaster. Furthermore, we carried out supplementary survey of 131 households in 17 VDCs of severely affected four districts of Gorkha, Nuwakot, Kavre and Rasuwa to assess farm level richness and evenness of dominant rescue collected crops. The findings showed the declining community and farm level richness and evenness of crop biodiversity of rice, maize and finger millet in most of the surveyed households. The major perceived causes of genetic erosion occurring in the surveyed areas and germplasm at risk are the *ad hoc* distribution of large amounts of improved, untested seeds as relief materials from external agencies, the sudden migration of farmers after the disaster and attraction of rural farm households towards other alternative income generating options (Gauchan et al., 2016; Sapkota et al., 2017).

#### DEVELOPING AND VALIDATING METHODOLOGY

The study has played important role in developing, testing and validating available methods for post-disaster revival of seed system and safeguarding biodiversity of traditional underutilized crops. The study has developed methods for analogue sites identification (Poudyal et al., 2017); and red listing of crop genetic resources similar to forest and broader plant and animal biodiversity (Joshi et al., 2017) and helped in identifying gaps in collections in Genebank and methods for repatriation methods (Dongol et al., 2017). Mapping of the existing genebank collection was carried out to identify gaps in collections in earthquake affected districts to initiate the rescue collection in those locations where previous collections are missing and endangered crop seeds need to be rescued (Ghimire et al., 2017). The process has helped in validating 4-cell analysis to identify endangered and rare crop genetic resources for rescue collection and conservation in Genebanks (Sapkota et al., 2017). The work also supported validation of methodology for participatory seed exchange (PSE) for rescue collection and revival of local seed system after disaster (Sthapit and Gautam, 2016; Gauchan et al., 2016) and testing and validation of climate analogue tools (CAT) for the suitability of rescue collected germplasm for repatriation in similar affected areas (Poudyal et al., 2017).

## **DOCUMENTATION AND CHARACTERIZING VALUABLE AND UNIQUE LANDRACES**

Documentation and characterization of rescued collected samples are essential for their protection, immediate use in cultivation and future use in crop improvement. The collected seeds were assessed to the processing (germination, drying) and regeneration through data captured. The collected samples which did not meet adequate Genebank standards (e.g. adequate quantity, germination percent) were used for seed increase and further processing. Some of them are in the cleaning and drying process in Genebank for long-term safe storage. Most of the collected samples were further evaluated, characterized and regenerated for their evaluation, multiplication and documentation of unique and rare traits. A total of 173 samples (accessions) of 11 crops were characterized in the fields for their agronomic traits. The study has supported national genebank of Nepal for characterization and documentation of unique and rare germplasm and traits from earthquake affected districts for future use in crop improvement.

## **STRENGTHENING LINKAGE BETWEEN ON-FARM AND EX-SITU APPROACHES**

The process has rescued 284 rare and endangered crop landraces (26 rare and 258 endangered) from on-farm (farm households and fields). They are processed and conserved in both National Genebank and partly in Community Seed banks located in earthquake affected areas of east Lamjung (Rainash) and Dolakha (Jungu village). Farmer's preferred ones are multiplied and shared with disaster affected local communities through diversity kits distribution and organizing participatory seed exchange (PSE) with local communities. Over 90% of the collected and shared seeds in the earthquake affected local communities were not in the official national notified list of crop varieties (Sthapit and Gautam, 2016) and of the lists of national genebank collections (Gauchan et al., 2016). The process has helped linking national Genebank with community seed banks and farming communities in risk prone mountain areas for holistic conservation. During the rescue collection and study process, training and orientation were provided to farmers and members of Community Seed Bank in east Lamjung for safe storage, conservation and methods of cultivation for their use.

## **LINKAGES AND SYNERGIES WITH ON-GOING INITIATIVES**

The study made significant efforts to link with on-going initiatives and develop synergies with on-going programmes and project of NARC, LI-BIRD and Bioversity International in Nepal for rebuilding local seed system in the aftermath of disaster. The rescue collection work carried out in the first phase in three districts (Ramechhap, Dolakha and Sindhupalchowk) was linked with LI-BIRD's Rebuilding Family Farm (RFF) programme (Sthapit and Gautam, 2015). The study was also linked with an existing Global Environment Facility (GEF) and United National Environment Programme (UNEP) funded local crop project in the affected districts (Dolakha and Lamjung), which is being implemented jointly by Bioversity International, NARC, LI-BIRD and Department of Agriculture (DoA) in Nepal. GEF UNEP Nepal project has organized a Diversity (Seed) Fair in Jugu VDC (now Gaurishankar Rural Municipality) of Dolakha district on 2 April 2016 as part of on-going project activities, in which this activity was linked to generate supplemental information and validate the type of rescue collected materials. The work has also supported to on-going activities in other GEF project sites such as Lamjung, Jumla and Humla districts through on-farm testing of rescue collected seeds and also linked to Bioversity implemented "Smallholders seed security for food security project" funded by Swiss Agency for Development Cooperation (SDC) and implemented by NARC and LI-BIRD. The work has also been linked with on-going programmes and projects of the National Genebank and those of NARC Research Programmes and Stations for collection, conservation and use of native crop landraces in crop breeding and research programme. In addition, the rescue collection was linked with the local NGO, COPPADES (Community

for the Promotion of Public Awareness & Development Studies) that had initiated relief work and community seed bank activities in Rainash, eastern Lamjung, linking with its activities in earthquake affected areas. Collaboration with local stakeholders and district agricultural offices (DADOs) also provided visibility and applicability of work to rescue endangered seeds and develop plan for repatriation to real target group of farmers.

### **SENSITIZING STAKEHOLDERS ON RESCUE COLLECTION, CONSERVATION AND REPATRIATION**

Sensitization of local stakeholders and communities was key component of the process of rescue collection. This was carried out both for seeking local support in rescue collection and creating awareness for conservation of rare and endangered traditional crop seeds and safeguarding genetic diversity for food security. In addition, two major district level interaction workshops were carried out during the study process. The study made significant efforts to organise district level interaction and awareness programme on Rescue Collection in Charikot, Dolakha in 22 Feb 2016 and in Dhunche, Rasuwa on 7 Dec 2016 by involving local district government offices, relevant district stakeholders and communities. The events were special not only sensitizing local stakeholders for rescue collection and conservation but also provided venue for official handover of rescue collected seeds particularly in Charikot (Dolakha) for conservation in National Genebank of Nepal. There was a very good response from district level stakeholders and local communities on the role of rescue collection, repatriation and conservation of native seeds for future generation. The work on revival of local seed system after disaster was also communicated widely to relevant stakeholders through organizing national sharing workshop and participating in international workshops (eg International Agrobiodiversity Workshop New Delhi, 6-9 November 2016 and International Mountain in Changing World Conference, Kathmandu 2-3 October 2016) in addition to sharing through news media (FM Radio, TV), social media (facebook), research papers and news blogs in the Bioversity International and GEF UNEP Prokject websites (eg [www.bioversityinternational.org](http://www.bioversityinternational.org); [www.himalayancrops.org](http://www.himalayancrops.org)).

### **STRENGTHENING LOCAL AND NATIONAL CAPACITY ON RESCUE COLLECTION & CONSERVATION**

The work has helped in building national capacity for rebuilding local seed system after disaster through rescue collection, conservation, seed multiplication and repatriation and laying a foundation for community seed bank in Jungu Dolakha. The study was linked in building the capacity of researchers, local field staff and interns for collection missions with GEF UNEP project of NARC, DoA and LI-BIRD and “Rebuilding Family Farm (RFF)” project of the LI-BIRD. During the process, the capacity of researchers of NARC National Genebank, DADO and LI-BIRD that were engaged in GEF UNEP and RFF projects respectively were enhanced. In addition, it also provided opportunity for building capacity of two young graduate students (interns) in carrying out research, where one of them accomplished MS thesis on the topic related to rescue collection and conservation of native crop seeds. The study also collaborated with COPPADES in eastern Lamjung to train local staff and farmers involved in community seed banks for rescue collection and safe conservation in community seed banks and use of collected seeds for ensuring local food security. The collaboration with the District Agriculture Development Offices (DADOs) and key informant farmers in earthquake affected districts provided opportunity to sensitize and enhance capacity of district agricultural staff and local knowledgeable farmers of the affected districts in rescue collection and conservation. The work of rescue collection supported by GRPI-2 project of Bioversity International provided seed money of US \$ 8,000 to earthquake affected Jungu Community in Dolakha district for laying foundation of Community Seed Bank establishment (Sthapit and Gautam 2016), which is being further supported and strengthened through on-going activities of GEF UNEP project.

## CONCLUSIONS AND WAYS FORWARD

Rescue collection, conservation and repatriation of native and endangered seeds are important after disasters in order to restore lost diversity, revive local seed system and safeguard local crop biodiversity for future generation. During rescue collection, a large proportion of native crop varieties were found in endangered state and some had already extinct in the study areas. The loss of diversity was not only from the impact of earthquake damage but also from the emergency relief of *ad hoc* distribution of large amounts of improved, hybrids and untested seeds as relief material from external agencies, the sudden migration of farmers after the disaster and attraction of rural farm households towards other alternative income generating options. The main outcome of the study was to rebuild local seed system and promote conservation through rescue seed collection missions, seed multiplication and repatriation in severely earthquake affected villages. It was possible to rescue 284 rare and endangered crop landraces and conserved in Genebank, out of which some of the rare, endangered and farmer demanded ones are repatriated back to local communities for reviving local seed system. The study has helped to assess status of diversity of traditional crops, identify endangered, extinct and rare crop landraces, document and characterize their unique agronomic traits and develop and validate methodology for conservation and rebuilding local seed system of native crops in disaster-prone areas. The process has helped to store part of the collected seed samples in community seed banks for local access, availability and use. This strategy was useful to promote both ex-situ and on-farm agrobiodiversity conservation, rebuild local seed system affected by disaster and help to safeguard native crop biodiversity for future generation to adapt to more extreme and changing climatic conditions. The process has also helped building national capacity and resilience to cope with future disasters and laying a foundation for community seed banks by linking national gene banks with community seed banks and farming communities in risk-prone mountain areas.

Future priority in relief and rebuilding agriculture therefore should be given to rescue collection, conservation and repatriation in disaster prone areas. Focus should be on access and availability of locally adapted varieties and quality seeds of the local crops, that perform well in farmers' existing management systems and changing climate conditions, since locally adapted seeds are the heart of agriculture and food security of vulnerable people in fragile affected areas. Regular monitoring, collection and repatriation program will be more effective to conserve the underutilized and other crop landraces diversity in marginal areas. Promotion of traditional crops and their adapted seeds enhance not only sustainability of local agricultural system but also promote conservation and safeguard biodiversity of traditional crops. Finally, there is a need to rebuild human resource, institutional capacity and governance in agrobiodiversity conservation and building local seed system linked to disaster risk reduction through massive training and capacity building of youth in agriculture and agrobiodiversity conservation.

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