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Good Practices for Agrobiodiversity Management

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

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A. Introduction

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

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

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

B. Objectives

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

C. Methods and Process

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

Climate Analogue Tool (CAT) for sourcing diversity

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

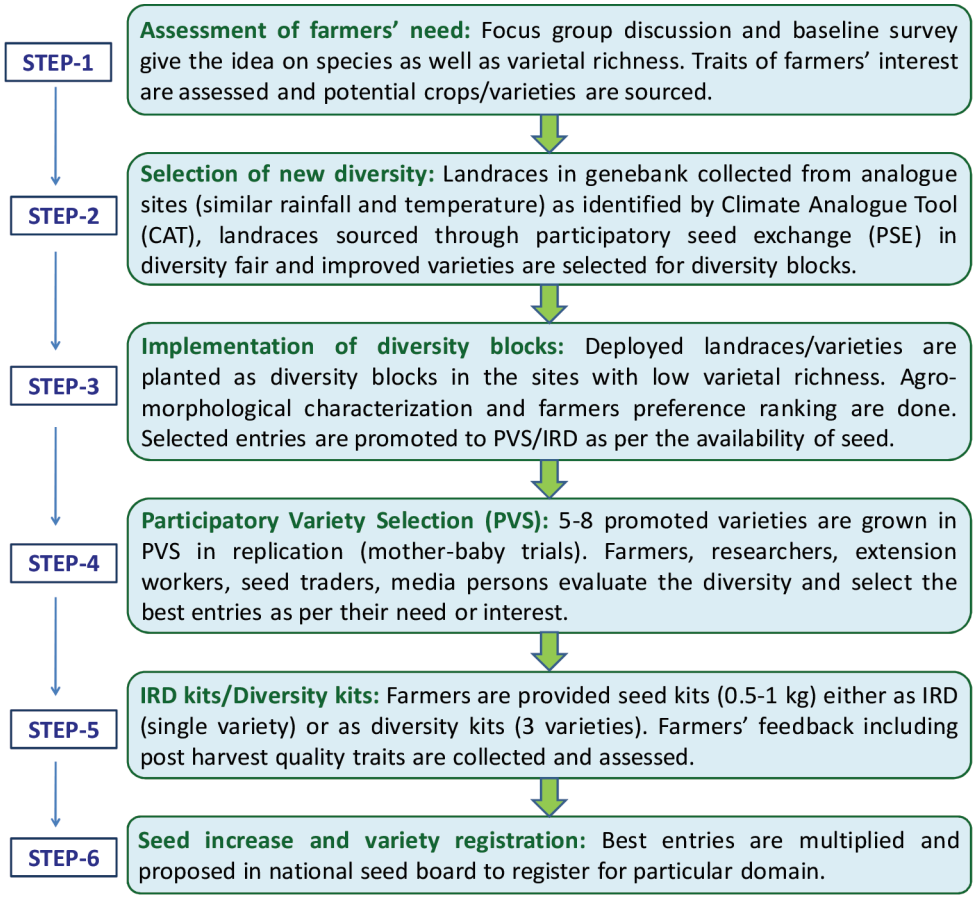

Figure 1. Steps for sourcing and deploying new crop diversity.

Participatory seed exchange (PSE)

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

Diversity blocks

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

Participatory varietal selection (PVS)

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

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

Informal research and development (IRD)

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

Diversity kit

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

D. Advantages and Disadvantages

Advantages

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

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

Disadvantages

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

E. Success Cases

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

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

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