

## General Article

### ROLES AND CONTRIBUTION OF COMMUNITY SEED BANKS IN CLIMATE CHANGE ADAPTION

*M. R. Nayak<sup>1\*</sup>, H. K. Das<sup>1</sup>, H. Nayak<sup>1</sup>, D. P. Das<sup>1</sup>, N. Bhol<sup>1</sup> D. Swain<sup>1</sup> and S. C. Mohapatra<sup>2</sup>*

<sup>1</sup>College of Forestry, Odisha University of Agriculture and Technology, Bhubaneswar

<sup>2</sup>AICRP on Agroforestry, Odisha University of Agriculture and Technology, Bhubaneswar

Corresponding Email: [mrnayak.forestry@ouat.ac.in](mailto:mrnayak.forestry@ouat.ac.in)

Received: 19 May, 2025

Accepted: 19 August, 2025

#### Abstract

Community seed banks are repositories of local genetic diversity that is often adapted to prevailing climate conditions, including biotic stresses. They may be useful to contribute to community based strategies for adaptation to climate change. However, to date community seed banks have received little attention in the literature related to climate change adaptation. This comes as a surprise given that community-based seed-saving initiatives have been around for about 30 years. Different names are used for these initiatives: community gene bank, farmer seed house, seed hut, seed wealth centre, seed savers group, association, or network, community seed reserve, seed library, and community seed bank.

**Key words:** Community Seed Banks, Climate Change Adaptation, Agro-biodiversity, Seed Sovereignty, Traditional Varieties, Farmer Resilience

**Citation:** *Nayak, M. R., H. K. Das, H. Nayak, D. P. Das, N. Bhol, D. Swain and S. C. Mohapatra, Roles and Contribution of Community Seed Banks in Climate Change Adaption. The PLANTA Research Book Series, 6 (2), 1892-1902 [www.pgrindias.in](http://www.pgrindias.in)*

#### Introduction

Climate change is affecting agricultural productivity and food security globally. Global warming resulting in increased temperatures, erratic rainfall, and leading to severe droughts and floods could pose a serious threat to food production (IPCC 2014). One common strategy for adapting to climate change is to exploit genetic sources of resistance to the abiotic and biotic stresses that result from climate changes. Both inter- and intra-crop genetic diversity can be utilised for this strategy. Farmers can use inter-crop diversity by switching to crops that are more resilient. Or they can use better adapted varieties of the same crop developed through their own on-farm selection, a formal sector crop/tree improvement programme, or a collaborative effort such as participatory plant/tree breeding.

In recent years, scientists around the world have come up with concrete suggestions to strengthen the roles that plant genetic resources can play in coping with climate change. Jarvis et al. (2015) identify several of these concrete actions in the Food and Agricultural Organization of the United Nations (FAO) publication “Coping with climate change — the roles of genetic resources for food and agriculture”. They include diversification at species and variety levels; revalorization of plant species that have been or have become underutilized and neglected; broadening and intensifying the collection, characterization, and utilization of crop wild relatives; better targeted plant breeding; and forging better linkages between in situ and ex situ conservation activities. In addition, the authors argue for more policy support to improve access to improved seeds and to allow farmers to produce, save, exchange, and sell seeds (Yadav et al. 2011).

Linn (2011) elaborates on the multiple benefits of crop diversification practices such as using varietal diversity in monocultures, mixing crops with non-crop vegetation, crop rotations, polycultures (including wild varieties), agroforestry and mixed landscapes. Benefits derived from these strategies include pest and disease reduction, increased production, increased production stability, and climate stress buffering. Evidence from field trials underway in various countries offers strong support for the use of intraspecific crop diversity within the production system to reduce disease incidence and risks related to climate change (Jarvis et al. 2011a). Such practices will likely also reduce the vulnerability to pest and disease infestations in the future caused by changing climate conditions.

Bellon and van Etten (2014) identify other types of interventions that can support on-farm crop conservation as an effective way to respond to climate change. These interventions include the establishment of a global information system that reports changes in adaptation and evolution processes and enables the localisation of new crop genes and genotypes that can be used in adaptation efforts. They also make the practical suggestion to improve community-based seed saving and storage practices, with particular attention to safeguarding seeds of plants that survive under extreme weather conditions. Sthapit et.al (2010) reinforce these suggestions by highlighting the need for more policy support given to the various forms of in situ and on-farm conservation in which farmers and their local forms of organization should play key roles. The multiple suggestions put forward by all these authors have been brought together in a comprehensive decision-making frame work (Jarvis et al. 2011) that links constraints with action options. The framework also identifies which kind of farmer organization could be the most effective for implementing each action. A community seed bank is one of the organizational forms included.

Community seed banks are repositories of local genetic diversity that is often adapted to prevailing climate conditions, including biotic stresses. They may be useful to contribute to community based strategies for adaptation to climate change. However, to date community seed banks have received little attention in the literature related to climate change adaptation. This comes as a surprise given that community-based seed-saving initiatives have been around for about 30 years. Different names are used for these initiatives: community gene bank, farmer seed house, seed hut, seed wealth centre, seed savers group, association, or network, community seed reserve, seed library, and community seed bank (Vernooy et. al. 2015). The latter seems the most common. These article illustrate two important ways in which more effective management of plant genetic resources can strengthen farmers’ capacity to adapt to climate change: (1) securing improved access to, and availability of diverse, locally adapted crops and varieties through the use of multiple germplasm sources;

and (2) enhancement of related local knowledge and skills in plant management, including seed selection, treatment, storage, multiplication, and distribution. As such, community seed banks can enhance or revive traditional social seed networks that have existed for decades or centuries based on combinations of seed saving, seed exchanges, seed giving, seed bartering, and seed purchase. What is needed now is a growing recognition among policymakers that community seed banks can be a very effective form of farmer organization toward more climate smart agriculture.

### **What is Community Seed Banks (CSBs)?**

Community seed banks are collections of seeds of local landraces that are maintained and administered by the communities themselves, with the following criteria:

1. Community seed banks had birth from the necessity of local people, importance has assigned after that.
2. CSBs serve local farmers to form an informal seed distribution system prevailing in villages since ancient time at no or very low cost.
3. CSB system is maintained and promoted by farmers and conserves landraces; in addition to that it may also include improved varieties of farmers/farmers group interest, farmer selected varieties etc.
4. Seeds stored in CSBs in order ensure planting material for farmer himself or group in large quantities for the season or to ensure conservation genetic material of rare and endangered varieties for the posterity due to their importance.
5. Establishment and management community seed banks form an important part of informal seed distribution system in villages and they have no established guideline for the same.
6. Community seed banks serve as focal point in maintaining indigenous genetic diversity and associated traditional knowledge involving farmers' community.
7. The main aim of community seed conservation is to ensure/increase local seed security and to help prolonged utilization of locally important genetic diversity.
8. Community seed banks play a vital role in improving farmers' access to seeds, conserving agricultural biodiversity for seed security and the associated traditional knowledge, providing options for adapting to climate change, as well as can contribute to the realization of Farmers' Rights.
9. Farmers need relatively little skill to access the community seed banks and on-farm conservation efforts can be linked easily.
10. Specific objectives, include:
  - Maintain diversity and sustainable conservation of farmer landraces.
  - Link community seed banks and Farmers' Rights.
  - Link community seed banks with Farmers' Rights and sustainable agricultural production.
11. Motivation is necessary for the community farmers in order to participate in conservation and seed management programme for the posterity.
12. Assessing the quality and quantity of seed at the time of distribution and while taking it back from the farmers for storage.

13. Linking CSBs with FPOs and seed marketing companies in order to market for the surplus/extra seeds available with the seeds banks and extend the support to farmers as well as CSBs.
14. Conditions leading to success of CSBs
  - Willingness of farmers to participate in community seed bank interventions.
  - Large scale cultivation of local landraces as component of subsistence farming.

Majority of local landraces have an important incentive of fetching premium prices in markets after some add-value interventions particularly through processing or packaging.

### **Functions and Activities of Community Seed Banks that Contribute to Climate Change Adaptation**

A community seed bank is defined as a locally governed and managed, mostly informal, institution whose core function is to maintain seeds for local use (Development Fund 2011). Beyond this core conservation function, community seed banks have a broad range of additional purposes and vary significantly in scope, size, governance and management models, infrastructure and technical aspects. There is considerable variability in the performance of community seed banks in terms of technical and operational capacities (e.g. technical rigor in monitoring germination and ensuring viability of stored seed), governance, and operational management. Technical and operational challenges are often compounded by lack of legal recognition and scarce financial resources. Past experience has shown that community seed bank initiatives are usually quite effective during their initial years, but with withdrawal of external support, many cut back on activities or stop altogether. As in other organizational efforts, when community seed banks are established without proper foundations, long-term survival is difficult. Nonetheless, in many countries one can find well-functioning community seed banks (Vernooy et al. 2015). In recent years, the number of newly established community seed banks has been on the rise partly due to the growing support of national and state or provincial governments.

Based on a global review of the mostly grey literature about community seed banks (CSBs) and a collection of comparative case studies from various parts of the world published in 2015 (Vernooy et al. 2015), we developed a framework to identify and organise key functions and activities of community seed banks. The three key functions are: (i) conservation of plant genetic resources; (ii) access and availability of diverse seeds and planting materials according to farmers' needs and interests; and (iii) seed and food sovereignty (Vernooy et al. 2014). Some community seed banks are strictly focused on conservation of agricultural biodiversity including reviving lost local varieties, while others give priority to both conservation, and access and availability of diverse types of seeds and planting materials suitable to various agro-ecological domains. Very few community seed banks explicitly present their efforts as promoting seed and food sovereignty.

Here we expand this framework by identifying activities that are particularly relevant with regard to climate change adaptation. Under conservation these are: conservation of a portfolio of diverse seeds of crops and crop varieties; conservation of seeds from plants that have high capacity to survive under extreme weather conditions; restoration of "lost" varieties, particularly those with good adaption potential. Under access and availability, they are: platform for multiple channels of access and availability of seeds at the community level;

accessing novel diversity not conserved locally; accessing seeds from areas where plants have adapted to extreme weather conditions; pro vision of adapted seed to marginal communities not served by commercial seed dissemination efforts. Under seed and food sovereignty there are no activities that deal explicitly with climate change adaptation. However, the approach known as community based biodiversity management (de Boef et al. 2013) encourages the search for, use of and control over portfolios of locally adapted germplasm that could be sourced from diverse sources and locations. In the next sections we present a number of community seed banks that put one or more of these climate change adaptation activities in practice.

### Roles of CSBs in Addressing Climate Change

Many researchers have emphasized the importance of crops and seed diversity for climate change adaptation. Over-reliance on limited crop species has increased global food insecurity (Sthapit 2013). There are many common strategies being practised by communities with or without the support of development agencies. One common strategy is to exploit and effectively use resistant and diverse seeds to adapt to climate change (Vernooy et al. 2017). Furthermore, CSBs improve the accessibility and availability of diverse and Indigenous tree, locally adapted crops, seeds, and varieties and also enhance the adaptive capacities, development, and exchange of tolerant and resistant varieties and crops. Livelihood diversification through onsite or on-farm conservation of crops is an additional strategy that has been practiced by farmers (Table 1).

**Table 1.** The climate adaptation-related functions of CSBs

Climate adaptation-related functions	Main functions of CSBs
On-farm management of crop diversity to address climate adversity	Conservation of diverse seeds and crop genetic resources
Enhance climate resilience and stress-tolerant seeds	Restoration of rare and lost seeds and varieties
Maintenance of locally adapted seeds at low cost	Enhance farmers’ accessibility and availability of diverse seeds and crop genetic resources
Provision of adapted seeds to poor and marginalized communities	Maintenance of local control over seed conservation, community based management of seed
Enhance capacity of farmers to respond to local crisis, disasters, and shortages	Income generation through conservation and sales of seeds
Sources of resources for participatory crop enhancement and seed exchange	Contribution to ecological agriculture and food sovereignty Linkage between in-situ and ex-situ conservation and sharing of knowledge through farmers’ seed network

Source: Sthapit (2013)

*(1) On-farm management of crops for addressing climate adversity:*

Maintenance of crop diversity and pool of genetic resources and variability has a significant role in sustainable agricultural practices and also support farmers in adapting to changes in weather and climatic patterns. However, modern agriculture has shrunk that pool of crop genetic resources and increased the dependency of farmers towards external sources. Although traditional and local landraces are resistant to both biotic and abiotic stresses, farmers have to depend on the modern and hybrid varieties because of lack of access to local landraces and also easily available hybrid seeds in the markets. That has led to dependency on external sources of seeds and loss of traditional landraces, and loss of agrobiodiversity, associated knowledge, practices, and the whole evolutionary process of farming (Shrestha et al. 2006).

CSBs have emerged as a reliable option for maintaining the pool of resources and variability through on-farm conservation that provides seed and food security to farmers against biotic and abiotic stresses such as diseases, pests, droughts, and floods (Shrestha et al. 2012). Vernooy et al. (2014) further confirmed CSBs as on-farm management of local crop diversity for natural and human selection in agricultural production systems, in which farmers are the custodians and managers in handling the crop diversity and processes (Subedi et al. 2006). CSBs have also empowered farmers in managing and continuing on-farm practices such as diversity blocks, community biodiversity registers (CBRs), community-based seed productions (CBSPs), community-based management fund (CBM fund), and participatory landrace enhancement such as participatory plant breeding, among others (Sthapit et al. 2006). All of these on-farm practices have strengthened socio-economic, cultural, and environmental relationships and benefits among the community.

*(2) Farmers' accessibility and adaptive capacities enhancement:*

CSBs have enhanced seed availability and accessibility to the poor and needy farmers based on a cash or loan basis. Borrowers need to return 50 to 100% more seeds than they borrowed as seed loans, which will be stored and distributed to other farmers or replicated in diversity blocks to maintain viability (Vernooy et al. 2015). Thus, CSBs have become a successful and reliable local institution that enhances the farmers' accessibility and capacities to locally adaptable and improved seeds through the process of collection, conservation, distribution and sustainable use of seeds and its diversity, to ultimately support on local food security.

CSBs have mostly conserved and distributed rare and tolerant seeds to the farmers that have made them more common, ensuring seed and food security in the local context (Maharjan et al. 2011b). The availability of quality seeds is very important for the production of enough food (Progressio 2009). Shrestha et al. (2012) also reported that the CSBs have increased abundance and accessibility of landraces and overall diversity. Maharjan et al. 2011a and Pokhrel et al. 2012 further confirmed that CSBs have enhanced the easy availability of seeds, conservation of landraces, and associated knowledge and livelihood security.

Furthermore, Progressio (2009) claimed that conservation of diverse seeds has enhanced the adaptive capacities of farmers to adapt to climate change. Farmers' capacities on seed conservation, distribution, multiplication, marketing, seed/diversity fairs, and diversity blocks become more sustainable due to CSBs, which also strengthened the seed networks

among farmers. Likewise, farmers have gained skills in conservation farming, home gardens, sloping agriculture land technologies (SALT), and participatory seed exchange to address seed shortages and climate change issues. Some CSBs have also focused on empowering farmers, promoting ecological agriculture, establishing farmers' rights over seeds, and developing mechanisms for fair and equitable benefits (Vernooy et al. 2015).

*(3) Increased access to climate resilient and stress-tolerant seeds:*

Climate change and climate-induced disasters such as flood and drought have further intensified the vulnerability of poor and marginalised farmers in India. Many crop genetic resources are extinct because of rapid erosion due to climate change and induced disasters. CSBs have played a crucial role in preserving and reviving such important genetic resources through a collection of resources and associated knowledge, storage, regeneration, multiplication, and distribution of resilient seeds to farmers and their networks, fulfilling their seed demands (Maharjan et al. 2011a; Vernooy et al. 2015). CSBs have developed a healthy and stable seed system since seeds are distributed to the wider communities and rare seeds become more common. Some drought- and flood-resistant varieties have become more broadly available to the public through CSBs, therefore enhancing the resilience of the community and agroecosystems (Maharjan et al. 2011b; Shrestha et al. 2012) that support farmers to prepare for erratic weather events (Zofeen 2014). FAO (2010) revealed that conservation and use of crop diversity help farmers to respond to climate change issues. Therefore, CSBs have enhanced farmers' resilience both at the household and the community levels through securing improved access to diverse and locally adapted crops and enhancement of related knowledge and skills (Maharjan et al. 2011b; Vernooy et al. 2015).

Shrestha et al. (2012) claimed that CSBs are a viable and reliable opportunity for farmers living in marginal and disaster-prone areas. Vernooy et al. (2017) emphasized that the establishment of CSBs in climate vulnerable communities help them to respond quickly to environmental stresses and contribute to the restoration of local food security.

Progressio (2009) also found CSB as "safe deposits" of farmers' valued seeds, especially during total crop failure caused by drought, floods, or fire. In such crises, CSBs have provided seeds saved by the farmers. Furthermore, farmers have diverse options to utilise the full range of highly varied microclimates and diverse seeds since they saved seeds by themselves in CSBs, which is suitable for different soil types, temperature, altitude, slopes, water availability, and overall fertility. In these areas, CSBs have provided viable traditional landraces, which are better adapted to such stressful conditions. Both farmers and geneticists preferred and valued traditional landraces because of its diversity and heterogeneity, unique traits and adaptability to the local and harsh climate (Gyawali et al. 2006). Diverse seeds in the field and CSBs act as insurance against losing seeds and crops under adverse climatic conditions, and some of these seeds can withstand extreme climatic conditions (Regmi et al. 2009).

*(4) Participatory landrace enhancement and participatory plant breeding (PPB):*

Local landraces are important bio-resources for sustainable production and livelihood improvement of the community, providing the foundation for the development of new varieties (Gyawali et al. 2006) through participatory crop improvement to conserve genetically pure, healthy, and quality seeds at the grassroots level (Vernooy et al. 2014). Farmers have been selecting varieties that would perform better under the changing climate

conditions, which has triggered discussion among researchers about the participatory variety selection to select good quality seeds for upcoming growing seasons (Vernooy et al. 2017). One important focus of CSBs and participatory crop improvement is to train farmers on the procedures and requirements of participatory breeding (Sthapit et al. 2006). Participatory crop improvement and PPB, selection of farmers' preferred seeds, and community-based seed production are ways to improve the access and availability of improved seeds (Vernooy et al. 2015).

*(5) Participatory seed exchange among farmers during climate hardships:*

For generations, farmers have been managing the local crop diversities and maintaining informal seed networks and seed systems through bartering or exchanging with their neighbours, relatives, and friends within and outside the community, which is crucial for the maintenance of local crop diversity (Maharjan et al. 2011a; Subedi et al. 2006). It is estimated that globally 80% of seeds are farm-saved through informal networks and exchange (Vernooy et al. 2015). Informal networks and systems include CSBs as they have been playing significant roles in maintenance and seed exchange. They also enhance social cohesion and inclusion among farmers since it is a collective effort of farmers to manage landraces and exchange (Subedi et al. 2006).

Furthermore, CSBs have prioritised seed access to women, poor and marginalised farmers, who are facing seed shortages since they cannot save and purchase seeds in the market (Shrestha et al. 2006). It is also found that women have played key roles in farmers' seed systems and active participation in participatory seed exchange by sharing seeds and associated knowledge with their neighbours, relatives, and other farmers in CSBs, although their roles are often ignored by research and development actors, policies, and programmes (Maharjan et al. 2011b; Vernooy et al. 2015).

CSBs have enhanced farmers' seed systems and strengthened social networks for seed exchange, which also help in coping with climate change adversity and impacts. Social seed networks among farmers are a secure source of seeds that are locally adapted to the local climate (Subedi et al. 2006). CSBs have developed a mechanism of participatory seed exchange among farmers within and outside to expand seed exchange and farmers' networks (Maharjan et al. 2011a).

### **Issues and Key Challenges of CSBs**

Despite agriculture intensification and other human pressures, local crop genetic resources are still conserved and maintained by farmers in India, both at household and community levels, to fulfil seed demands and also address local climatic conditions. However, these resources and landraces are significantly disappearing over the years at both levels, although landraces have been developed and adapted to the local environment for generations (Shrestha et al. 2006). The reasons behind mainly the inaccessibility of resource-poor farmers and their control over on these landraces, lack of quality seeds leading to increased farmers' preference on high yielding modern/hybrid varieties, lack of policy and incentives to farmers on conservation and maintenance of landraces, and increased climatic risks and vulnerabilities.

Despite the lack of any incentives to farmers for conservation and management of diversity, CSBs have been conserving and maintaining the landraces. It is difficult to conserve all landraces. Similarly, not all farmers may be interested in conserving the

landraces, as it requires resources and commitment of the farmers. Therefore, incentives and motivation play a role in conserving and maintaining such important landraces in the CSBs (Gyawali et al. 2006). Incentives could be created through linking to the market for conservation and exchange of landraces; creating an enabling environment to cultivate and exchange seeds at the local and national levels; and linking CSBs to the private sector for income generation, and/or national gene bank, and government agencies for the expansion of seed exchanges. Incentives can also be created through policy support and reform for the conservation of agro-biodiversity and also for commercialization of high-value products (Gyawali et al. 2006a).

Additional climate change pressures have been observed recently on farmers' seed and food production systems. The roles of CSBs in addressing climate change impacts are often neglected. It is estimated that climatic impacts will be more severe in future, meaning additional challenges to adapt to new weather dynamics. Very few scientific publications are available on CSBs, their history, evolution, experiences, successes, challenges, and prospects, and their importance in maintaining agrobiodiversity and in addressing climate change impacts are continuously ignored. Additionally, the roles and contributions of women in CSBs are often neglected in CSB-related programmes and policies, even though they have played significant roles in seed saving and farmers' seed networks (Vernooy et al. 2015). The main challenge is the commodification and commercialization of seeds by companies and corporate industries. Farmers are aggressively running after agro-vets for improved seeds and agricultural inputs rather than CSBs.

## Conclusion

CSBs have multiple functions in farmers' livelihoods and welfare, and have gained considerable recognition in India, with a long history in conservation, distribution, regeneration, and multiplication of seeds, fulfilling farmers' seed demands. CSBs have made rare seeds more widely available, and enhanced social cohesion and relationships among farmers through different on-farm activities. Additionally, both farmers and researchers have realized that landraces are more tolerant to both biotic and abiotic stresses. However, farmers still prefer improved and hybrid seeds found in the agro-vets and markets because of their easy accessibility. CSBs have played crucial roles in increasing awareness among farmers on the importance of landraces, indigenous species and enhancing the accessibility of quality seeds to farmers to improve their livelihood and social relationships. They have further strengthened skills and capacities around on-farm conservation and development activities, including adaptive capacities to climatic risks and stresses. However, there are still many issues and challenges for CSBs' sustainability in India due demographic, socio-economic, political, institutional, biophysical, and environmental factors associated with overall development and sustainability.

## References

- Bellon, M. R., and van Etten, J. (2014). "Climate Change and on-Farm Conservation of Crop Landraces in Centres of Diversity." In *Plant Genetic Resources and Climate Change*, edited by M. Jackson, B. Ford-Lloyd, and M. Parry, 137-150. Wallingford: CAB International.

- Bhatta, M. R., Joshi, B. K. and Gauchan, D. (2013). “The National Gene Bank, the Multilateral System and Community Seed Banks for the Conservation and Utilization of Agricultural Genetic Resources in Nepal.” In *Community Seed Banks in Nepal: The Past, Present, and Future*, edited by P. Shrestha, R. Vernooy, and P. Chaudhary, 120–129. Proceedings of a National Workshop, LI-BIRD, USC-Canada/Asia, Oxfam, Development Fund, IFAD, Bioversity International.
- Chaudhary, P., Devkota, R. Upadhyay, H. and Khadka, K. (2015). “Nepal: Government Policies and Laws Related to Community Seed Banks.” In *Community Seed Banks: Origins, Evolution, and Prospects*, edited by R. Vernooy, P. Shrestha, and B. Sthapit, 243–247.
- deBoef, W.S., Subedi, A. Peroni, N. Thijssen, M. and O’Keeffe, E. eds. (2013). *Community Biodiversity Management: Promoting Resilience and the Conservation of Plant Genetic Resources*. Development Fund. (2011). *Banking for the Future: Savings, Security and Seeds*. Oslo: Development Fund.
- FAO. (2010). “The Second Report on the State of the World’s Plant Genetic Resources for Food and Agriculture: Synthetic Report.” Commission on Genetic Resources for Food and Agriculture.
- Gyawali, S., Sthapit, B. Bhandari, B. Gauchan, D. Joshi, B. K. Tripathi, M. Shrestha, P. K. Joshi, K. D. and A. Mudwari. (2006). “Participatory Landrace Enhancement: An Economic Incentive to Support On-Farm Management of Agrobiodiversity.” In *On-farm Management of Agricultural Biodiversity in Nepal: Good Practices*, edited by B. R. Sthapit, P. Shrestha, and M. P. Upadhyay. 53–56.
- Gyawali, S., Sthapit, B. Joshi, B. K. Mudwari, A. and Bajracharya, J. (2006a). “Participatory Plant Breeding: A Strategy of OnFarm Conservation and Improvement of Landraces.” In *On-farm Management of Agricultural Biodiversity in Nepal: Good Practices*, edited by B. R. Sthapit, P. Shrestha, and M. P. Upadhyay. 49–52.
- IPCC [Intergovernmental Panel on Climate Change]. (2014). “IPCC Fifth Assessment Report.” Geneva: IPCC.
- Jarvis, A., Upadhyaya, H. Gowda, C.L.L. Aggarwal, P.K. Fujisaka, S. and Anderson, B. (2015). “Plant Genetic Resources for Food and Agriculture and Climate Change.” In *Coping with Climate Change —the Roles of Genetic Resources for Food and Agriculture*, edited by Food and Agriculture Organization of the United Nations. 9-22.
- Jarvis, D. I., Fadda, C. De Santis, P. and Thompson, J. eds. (2011a). *Damage, Diversity and Genetic Vulnerability: The Role of Crop Genetic Diversity in the Agricultural Production System to Reduce Pest and Disease Damage*.
- Jarvis, D. I., Hodgkin, T. Sthapit, B. Fadda, C. and López-Noriega. I. (2011). “An Heuristic Framework for Identifying Multiple Ways of Supporting the Conservation and use of Traditional Crop Varieties Within the Agricultural Production System.” *Critical Reviews in Plant Sciences* 30 (1-2): 125–176.
- Linn, B. B. (2011). “Resilience in Agriculture Through Crop Diversification: Adaptive Management for Environmental Change.” *BioScience* 61 (3): 183–193.
- Maharjan, S. K., Gurung, A. R. and Sthapit, B. (2011a). “Enhancing On-Farm Conservation of Agrobiodiversity Through Community Seed Bank: An Experience of Western Nepal.” *Journal of Agriculture and Environment* 12: 132–139.

- Maharjan, S. K., Subedi, A. Shrestha, P. Gurung, A. R. Sthapit, S. Rana, R. Sigdel, E. K. Karki, D. and Sthapit, B. (2011b). “Community Seed Bank: Reaching to Poor Farmers and Building Climate Resiliency in Western Nepal.” In *Leveraging the Landscapes: Conservation Beyond the Boundaries*, edited by K. P. Acharya, D. M. Tripathi, J. Joshi, and U. M. Gurung, 54–67.
- Pokhrel, C. P., Bhandari, V. Lakhe, P. and Yadav, R. K. P. (2012). “Agrobiodiversity Conservation through Seed Banking: A Case Study from Mid-Western and Far-Western Nepal.” *Ecoprint* 19: 39–47.
- Progressio. 2009. *Seed Saving and Climate Change in Zimbabwe*. Zimbabwe: Progressio.
- Regmi, B. R., Thapa, L. Suwal, R. Khadka, S. Sharma, G. B. and Tamang, B. (2009). “Agrobiodiversity: An Opportunity for Mainstreaming Community-Based Adaptation to Climate Change.” *Journal of Forest and Livelihood* 8 (1): 111–119.
- Shrestha, P., Subedi, A. Sthapit, S. Rijal, D. Gupta, S. and Sthapit, B. (2006). “Community Seed Bank: A Reliable and Effective Option for Agricultural Biodiversity Conservation.” In *On-farm Management of Agricultural Biodiversity in Nepal: Good Practices*, edited by B. R. Sthapit, P. Shrestha, and M. P. Upadhyay. 41–44.
- Shrestha, P., Sthapit, S. Devkota, R. and Vernooy, R. (2012). *National Workshop on Community Seed Banks: Workshop Summary Report*.
- Sthapit, B. R., Shrestha, P. and Upadhyay, M. P. eds. (2006). *On-farm Management of Agricultural Biodiversity in Nepal: Good Practices*.
- Sthapit, B. R., Padulosi, S. and Bhag Mal. (2010). “Role of In Situ Conservation and Underutilized Crops in the Wake of Climate Change.” *Indian Journal of Plant Genetic Resources* 23 (2): 145–156.
- Subedi, A., Sthapit, B. Rana, R. Baniya, B. Paudel, D. Singh, D. and Shrestha, P. (2006). “Social Seed Network: Good Practice for Ensuring Maintenance of Local Crop Diversity.” In *On-farm Management of Agricultural Biodiversity in Nepal: Good Practices*, edited by B. R. Sthapit, P. Shrestha, and M. P. Upadhyay. 17–20.
- Vernooy, R., Sthapit, B. Galluzzi, G. and Shrestha, P. (2014). “The Multiple Functions and Services of Community Seed Banks.” *Resources* 3: 636–656.
- Vernooy, R., Sthapit, B. Otieno, G. Shrestha, P. and Gupta, A. (2017). “The Roles of Community Seed Banks in Climate Change Adaptation.” *Development in Practice* 27 (3): 316–327.
- Vernooy, R., Shrestha, P. and Sthapit, B. eds. (2015). *Community Seed Banks: Origins, Evolution and Prospects*. Oxford: Routledge.
- Yadav, S. S., Redden, R. Hatfield, J. L. Lotze-Campen, H. and Hall, A. eds. (2011). *Crop Adaptation to Climate Change*. Oxford: Wiley and Sons.
- Zofeen, T. E. (2014). “Seed Banks Help Communities Adapt to Climate Change.” Accessed September 16, 2017.