International Journal of Ecology and Environmental Sciences 43 (3): 221-227, 2017
ISSN: 2320-5199 (Online)

Community Seed Banks in Nepal: Prospects and Challenges from the Perspective of Climate Change Adaptation

SHREE KUMAR MAHARJAN* AND KESHAV LALL MAHARJAN

Graduate School of International Development and Cooperation, Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima, Japan, 739-8529
* Corresponding author; Emails: *smilingsiri@gmail.com; mkeshav@hotmail.com

ABSTRACT

Conservation of quality seeds, their diversity and accessibility has always been vital for farmers. Community Seed Banks (CSBs) has emerged as a formalized and effective local-institution to conserve and maintain quality seeds. It also enhances farmers' accessibility, strengthens informal seed networks and improves agro-biodiversity and local food security. This paper aims to identify the prospects and challenges ofCSBs in climate-change contexts by review of literature. It is found that CSBs serve as sources of climate-resilient and stress-tolerant seeds that can withstand in local climate, thus, improve the community resilience. Additionally, CSBs provide landraces for participatory crop improvement to develop new resistant varieties for better quality and productivity. CSBs also strengthenparticipatory seed exchangeto cope with climate adversity. However, it's challenge to define specific and common goals, functions, approaches and governance of CSBs. The CSB guideline is developed by the Crop Development Directorate, but implementation remains still a challenge.

Key Words: Seed Bank; Landraces, Seed Networks; Community Adaptation; On-farm Conservation

INTRODUCTION

Agriculture is the mainsource of income and livelihood for poor and small holders in Nepal. It has drastically changed recently because of increased human pressures; agriculture intensification and aggravated climate change impacts and induced disasters (Maharjan, et al. 2011a). The latter one is intensified in recent days mainly due toincreased unpredictability and irregularity of climatic patterns such as erratic rainfall, floods etc. (MoE 2010). However, farmers still practice small-scale agriculture, mainlysustenance and rain-fed in nature. They are mostly patient and have managed to cope with the changing climatic contexts. They largely conserve, manage and use landraces and introduced seeds that are resistant to biotic and abiotic stresses;use family labor and labor exchange fortraditional and mixed farming based on traditional knowledge and experiences that is very important for better yields and climate change adaptation.

Farmers mainly conserve seeds at household and community levels (Worede, undated). Community seed banks (CSBs) are the community-based seed conservation and distribution to needy farmers in sustainable way as loan and payback system. The farmers need to return 50-100% more seeds than the seedthey borrowed as loans that will be re-distributed to the farmers or replicated in diversity blocks for seed viability maintenance (Vernooy et al. 2015). It's a community led and owned institution to maintain and manage local, introduced and improved seeds for ensuring seed, food and livelihood security (Sthapit 2013). It has emerged as a reliable rural institution to resolve seed and agro-biodiversity losses due to human and climate induced disasters. Crop diversity conserved in CSBs enables farmers to cope with the changing climates (Pokhrel et al. 2012). The forms, sizes, functions of CSBs are different across the communities (Sthapit 2013).

This paper aims to explore and study CSBs in Nepal from climate change adaptation perspectives based on

the existing literature relating to CSBs, on-farm conservation and community based adaptation in Nepal and abroad. It further identifies the prospects and challenges of CSBs in relation to climate change adaptation. It also reviews the factors influencing CSBs including seed and climate interaction for its viability in CSB. Based on the review and study of the literature, this paper is allotted into prospects of CSBs in addressing climatic risks; issues and challenges of CSBs and analysis of factors affecting successful implementation of CSB as climate change adaptation.

PROSPECTS OF CSBs IN ADDRESSING CLIMATE CHANGE

CSBs as Effective Mechanism for On-farm Conservation of Crop Varieties

Maintenance of crop diversity (both genetic and species) together with pool of genetic variability has significant role in sustainable and ecological agriculture that support farmers in adapting to the changing climatic patterns. On-farm conservation is the process of conserving plants and their wild relatives in the farm and the place of origin. CSBs have emerged as reliable option for maintaining that pool of resources and variability through on-farm conservation that provide seed and food security to the farmers against biotic and abiotic stresses such as diseases, pests, droughts, floods etc.(Worede, undated; Shrestha et al. 2012). The crop genetic resources conserved in CSBs enhance seed security and improve farmers' accessibility (Pokhrel 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 in managing crop diversity and processes (Subedi et al. 2006). The assessment of 6 CSBs in western terai shows an increase of 50 to 148% seed accessions conserved on-farm from 2007 to 2009. CSBs also included other on-farm practices such as diversity blocks, community biodiversity registers (CBRs), community based seed productions (CBSPs), community based management fund (CBM fund), participatory landrace enhancement such as participatory plant breeding among others (Sthapit et al. 2006).

CSB has Increased Farmers' Accessibility and Capacities

The CSBs mainly enhance seed availability and accessibility to the poor and needy farmers based on cash or loan basis with its own system. The study shows that about 25 to 30% of resource poor farmers are getting benefits from CSBs in western Nepal (Maharjan et al. 2011a). Thus, CSBs have become successful and reliable local institutions to enhance the farmers' capacities and accessibility through conservation, distribution and sustainable use of seeddiversity to ultimately support on local food security. CSBs made the rare seeds common by ensuring seed and food security in local context (Maharjan et al. 2011c).Production of enough food in changing environment depends on the availability of quality seeds (Progressio 2009). Shrestha et al. (2012) also reported that CSBs have increased abundance and accessibility of landraces and overall diversity. Maharjan et al. (2011a) and Pokhrel et al. (2012)further confirmed that CSBs enhanced easy availability of seeds, conserved landraces, associated knowledge and strengthened livelihood security over the years. Similarly, a study in Kachorwa, Bara showed that increased accessibility of farmers to quality seedshas reduced farmers' dependency to the external sources. In addition, it has increased the control over the seeds, since local community manages it by themselves (Shrestha et al. 2012).

Progressio (2009) also found that conservation of diverse seeds has enhanced the adaptive capacities of farmers in Africa. Moreover, farmers' capacities on seed conservation, distribution, multiplication, marketing, seed/diversity fairs, and diversity blocks are enhanced for sustainability of CSBs, which also strengthened the seed networks among farmers. Likewise, farmers have gainedskills in conservation farming, home gardens, sloping agriculture land technologies (SALT), 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).

CSB as a Source of 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 marginalized farmers in Nepal. Many

crop genetic resources are extinct because of rapid erosion of crop genetic resources due to climate change and induced disasters. CSBs have played crucial role in preserving and reviving such importantgenetic resources through collection of resources and associated knowledge, regeneration, multiplication and distribution to the farmers and their networks fulfilling their seed demands (Maharjan, et al. 2011a, Vernooy et al. 2015). CSB has developed a healthy and stable seed system and resilience of the community agro-ecosystems (Shrestha et al. 2012, Maharjan et al. 2011c) 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. Maharjan et al. (2011a) and Regmi et al. (2009) reported that CSBs played crucial role in conservation and distribution of resistant farmers' varieties of rice such as *Tilki* (flood tolerant) and *Mansara* (drought resistant) among farmers. Thus, CSBs have enhanced farmers' resilience both at household and community levels through securing improved access to diverse and locally adapted crops and enhancement of related knowledge and skills (Vernooy et al. 2015, Maharjan et al. 2011c). Pionetti (2006) also claimed conservation of tolerant landraces in CSBs enhances diverse options to the farmers in South India.

Shrestha et al. (2012) also claimed that CSBs is viable and reliable opportunity for farmers living in marginal and disaster prone areas. 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 crisis, CSB has provided seeds saved by the farmers. Furthermore,farmers have diverse options to utilize the full range of highly varied micro-climates 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 as well (Worebe, ND). In these areas, CSB can provide viable traditional landraces, which are better adapted in the stressful conditions (FAO 2014). Both farmers and breeders preferred and valued traditional landraces because of its diversity and heterogeneity, unique traits and adaptability to the local and harsh climate (Gyawali et al. 2006a). Diverse seeds in the field and CSBs act as insurance against the losing seeds and crops under adverse climatic conditions and some of these seeds can withstand extreme climatic conditions (Regmi et al. 2009).

CSB as the Basis for Participatory Landrace Enhancement and Participatory Plant Breeding

Local landraces are important bio-resources for sustainable production and livelihood improvement of the community. It's a foundation for development of new varieties through participatory crop improvement to conserve genetically pure, healthy and quality seeds at grassroot level (Gyawali et al. 2006b, Vernooy et al. 2014). One important focus of CSB and participatory crop improvement is to train farmers on the procedures and requirements of participatory plant breeding (Sthapit et al. 2006). Participatory plant breeding (PPB) is a concept of farmers' involvement in selection of varieties, management of local crop populations and seed supply systems through informal and formal seed networks. Participatory crop improvement and PPB, selection of farmers preferred seeds (i. e., grass root breeding), and community based seed production are the ways to improve access and availability of improved seeds (Vernooy et al. 2015). In western terai of Nepal, the farmers are trained on management of CSBs, community biodiversity register, PPB, seed collections and viability tests such as diversity blocks, community based seed production systems (Pokhrel et al. 2012). Regmi et al. (2009) claimed that PPB can reduce vulnerability of farmers to climate change and variability.

For successful PPB and crop improvement,farmers themselves assessed and selected 8 varieties out of 69 varieties of rice collected in CSB based on their preferred traits and knowledge (Regmi, et al. 2009). They further emphasized on importance of PPB in maintaining local agro-biodiversity. Sthapit et al. 1996 (cited in Gyawali et al. 2006a) also emphasized on importance on farmers' knowledge and value of local diversity in PPB process to enhance desirable and adaptive traits such as chilling tolerance, blast resistance, drought and flood tolerance etc. There are many successful cases of participatory crop enhancement and PPB utilizing local landraces conserved in CSBs. Vernooy et al. (2015) reported that CSB in Kacharwa, Bara has developed new rice variety named 'Kacharwa-4' in collaboration with local research organization through PPB.These days,CSB produces and sells 5 to 10 tons of seeds of Kacharwa-4 every year that provide regular source of income for the CSB.

CSB as Platform for Participatory Seed Exchange Among the Farmers

Farmers have managed the local crop diversity and maintained the informal seed networks and seed systems through bartering or exchanging it with neighbors, relatives, and friends within and outside the communities that is very crucial for the maintenance of local crop diversity (Maharjan et al. 2011a, Subedi et al. 2006).It is estimated that globally 80% of the seeds that smallholders in developing countries depended are conserved on-farm through informal networks and exchange (Vernooy et al. 2015). Subedi et al. 2006 further revealed that farmers in Nepal conserved and exchanged about 20-50% of seeds through informal networks and systems that show farmers still rely on these networks and systems in Nepal. CSB plays crucial role in maintenance and seed exchange among and between farmers, which enhances social cohesion and inclusion among farmers since it's a collective effort to manage landraces and exchange among themselves (Subedi et al. 2006).

Furthermore, it has prioritized the seed access to women, poor and marginalized farmers, whoface seed shortages since they cannot save and purchase the seeds in the market (Shrestha et al. 2006). It is also found that women have played key role in farmers' seed systems and actively participated in participatory seed exchange by sharing seeds and associated knowledge with their neighbors, relatives and other farmers in CSBs though their roles are often ignored by the research and development actors, policies and programmes (Vernooy et al. 2015, Maharjan et al. 2011c).

The enhanced farmers' seed systems and seed networks havehelped in coping with the climate change adversity and impacts. Informal seed networks among farmers are found as secure source of seeds that are locally adapted to the local climate (Subedi et al. 2006). CSBs have developed mechanism of participatory seed exchange among farmers within and outside to expand seed exchange and farmers' network (Maharjan et al. 2011a). Pokhrel et al. (2012) also found that CSBs also contributed in sustainable conservation and participatory seed exchange of traditional and improved seeds among farmers in western terai landscapes of Nepal.

ISSUES AND KEY CHALLENGES OF CSBs

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

The biggest challenge faced by CSBs is intensification, commodification and commercialization of seeds by the companies and corporate industries. Likewise, farmers' landraces haven't received wider public support and control over for its conservation and use (Khanal and Maharjan 2015). Farmers are still running after agro-vets and nearby markets for improved seeds and agricultural inputs rather than CSBs, though it has played crucial role in conservation and maintenance of landraces. However, there is no incentive to the farmers for maintaining the diversity. It's not possible to conserve all landraces and all farmers are not interested to conserve the landraces, as it needs cost and commitment of the farmers. Therefore, incentives and motivation are crucial for farmers to conserve and maintain such important landraces in their farms and CSBs (Gyawali et al. 2006a). The incentives could be either linking to the market or creating enabling environment to cultivate and exchange of seeds at local and national levels or linking CSBs to the private sectors for income generation and also national gene bank and government line agencies for expansion of seed exchanges. It can also be created through policy support and reform for conservation of agro-biodiversity and also for commercialization of high value products (Gyawali et al. 2006b). Recently, Department of Agriculture in Nepal has recognized the importance of CSBs, however official linkages with national gene bank and formal seed system is very crucial. Development of CSB guideline is important initiatives taken by the government for its sustainability, however, its implementation still remain challenge. Additionally, the seeds that farmers are not interested to conserve or that are in the endangered status need to be conserved in ex-situ. Thus, linkage between in-situ (CSBs) and ex-situ (national gene bank) conservation is highly mandatory in Nepalese context.

As CSB was initially started by the community's efforts with the assistance of non-governmental organizations, many of CSBs has different goals, functions, approaches and governance that is reasonable based on needs and requirements of the farmers. However, in the process of nationalizing CSBs through government and mainstreaming it to Crop Development Directorate and National Gene Bank in Nepal, it is important to define specific goals, functions and approaches formally. It's even important to develop national CSB strategy in addition to CSB guideline for systematic and sustainability of CSB for farmers' benefits. It's even more important to ensure the access and control over the resources by the poor and marginalized farmers to uplift their livelihoods, hence, they are able to address the challenges faced in agriculture including adverse climatic conditions.

Climate change impacts are the additional pressures to the farmers' seed and food production systems. It is estimated that the impacts will be even more severe in future that means more challenges to adapt to new climatic dynamics. CSBs are often looked from conservation aspect, but not from the climate change adaptation perspectives. Very few scientific research and publications are found on that aspect. Even limited publications are available on CSBs, its review of history, evolution, experiences, successes, challenges and prospects. In that aspect, it's importance to carry out researches focusing on CSBs in maintaining agro-biodiversity and in addressing climate change impacts that is continuously being ignored by the researchers (Vernooy et al. 2015). Additionally, the roles and contributions of women in CSBs are often neglected in related programmes and policies though they have significant roles in seed saving, farmers' seed networks (Vernooy et al. 2015).

FACTORS AFFECTING CSBs FROM CLIMATE CHANGE PERSPECTIVE

CSB is community-managed institution, hence, its success depends on the commitment of the farmers and local community in conservation and management of local and introduced landraces. It expands conservation of local landraces and practices from households to the community level that are evolved and adapted to local environment for generations (Shrestha et al. 2012).In addition, agriculture is primarily depended on available resources and local climatic conditions. Extreme and no rain can cause devastating situation in Nepalese agriculture and CSB is not apart from such harsh climatic conditions. Moreover, Nepalese agriculture and seed sector have been affected by socio-economic, demographic, political, institutional, biophysical factors (Regmi et al. 2009). Likewise, the success and great potential utility of CSBs is influenced by high technological interventions; high access to input; marginal environment and economies and frequency of natural disasters such as floods and droughts. Farmers usually neglect landraces and preferred modern varieties in the areas with high access to technologies and inputs such as fertilizers, moderntools, whereas they prefer traditional landraces in marginal, fragile and disaster prone areas with poor economies, since landraces are better adapted to the such environment as compared to modern varieties (Shrestha et al. 2006).

Furthermore, it is also influenced by the political and institutional supports, demographic and socio-economic contexts in the areas. Success of CSBs depends on the supports of the governmental and non-governmental organizations in addition to the community's own efforts, social cohesions and solidarity. The relationships, cohesion among and between farmers and their networks is crucial for success of CSBs in any area, since it is locally governed and managed through informal institutions and networks. However, support from outside both institutional and political further enhanced its effectiveness in fulfilling its goals and objectives to address the issues and challenges. For instance, the participatory crop improvement efforts in CSBs need support in enhancing new skills for PPB and to maintain healthy and genetically pure seeds locally (Vernooy et al. 2015).

The seeds and CSBare very sensitive to climate variables. The seed has direct and strong relationship with climate variablesforits germination, dormancy and viability, which reveals that climate change has inevitably affect seed ecology as well. The air temperature and rainfall interact with soil composition and type for seed germination and emergence. Likewise, soil temperature including timing and magnitude of rainfall affect seed dormancy (Ooi 2012). Mostly CSBs are constructed utilizing local materials, which meansharsh climate and extreme weather also affect the CSBs. For instance, CSBs in terai region are affected by floods, that's why, farmers constructed two storied CSBs to store seeds in the second floor (Maharjan et al. 2011b)

CONCLUSIONS

CSB has multiple functions in the farmers' livelihoods

and welfare, thus, it has gained recognitionin Nepal.It has a long history in conservation, distribution, regeneration and multiplication of seeds and fulfilling farmers' seed demands. It has made rare seeds to common and enhanced social cohesion and relationships among farmers through different on-farm activities. Additionally, it is realized that landraces are more tolerant to both biotic and abiotic stresses by both farmers and researchers. However, farmers still prefer improved and hybrid seeds found in the agro-vets and markets because of easy accessibility. CSB has played crucial roles in increasing awareness among farmers on importance of landraces and enhancing accessibility of farmers to quality seeds for better livelihood and enhanced social relationships. It has further strengthened the skills and capacities on on-farm conservation and development activities including adaptive capacities to climaticrisks and stresses. However, there are still many issues and challenges for its sustainability in Nepal due to many factors associated with its overall development and sustainability including demographic, socio-economic, political, institutional, bio-physical and environmental factors.

REFERENCES

FAO (Food and Agriculture Organization of the United Nations). 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, FAO, Rome. 369 pages

FAO (Food and Agriculture Organization of the United Nations). 2014. Community Seed Bank: Junior Farmer Field and Life School Facilitator's Guide. Food and Agriculture Organization, Rome. 30 pages.

Gyawali. S.; Sthapit, B.; Bhandari, B.; Gauchan, D.; Joshi, B.K.; Tripathi, M.; Shrestha, P.K.; Joshi K.D. and Mudwari, A.. 2006a. Participatory landrace enhancement: An economic incentive to support on-farm management of agrobiodiversity. Pages 53-56, In: Sthapit, B.R.; Shrestha, P. and Upadhyay, M.P. (Editors). On-Farm Management of Agricultural Biodiversity in Nepal: Good Practices. Revised edition 2012. NARC/LIBIRD/Bioversity International and IDRC, Nepal.

Gyawali, S.; Sthapit, B.; Joshi, B. K.; Mudwari, A. and Bajracharya, J.. 2006b. Participatory plant breeding: A strategy of on-farm conservation and improvement of landraces. Pages 49-52, In: Sthapit, B.R.; Shrestha, P. and Upadhyay, M.P. (Editors). On-Farm Management of Agricultural Biodiversity in Nepal: Good Practices. Revised edition 2012. NARC/LIBIRD/Bioversity International and IDRC, Nepal.

Khanal, N.P. and Maharjan, K L.. 2015. Community Seed Production Sustainability in Rice-Wheat Farming. Springer, Tokyo. 177 pages.

Maharjan, S. K.; Gurung, A. R. and Sthapit, B.. 2011a. Enhancing on-farm conservation of agro-biodiversity through community seed bank: An experience of Western Nepal. Journal of Agriculture and Environment 12: 132-139

Maharjan, S.K.; Sigdel, E.R.; Sthapit, B. and Regmi, B.R.. 2011b. Tharu community's perception on climate changes and their adaptive initiations to withstand its impacts in Western Terai of Nepal. International NGO Journal of the Physical Sciences. Vol. 6(2): 035-042, http:// www.academicjournals.org/INGOJ.

Maharjan, S.K.; Subedi, A.; Shrestha, P.; Gurung, A.; Sthapit, S.; Rana, R.; Sigdel, E.K.; Karki, D. and Sthapit, B.. 2011c. Community seed bank: Reaching to poor farmers and building climate resiliency in western Nepal. Pages 54-67, In: Acharya, K.P.; Tripathi, D.M.; Joshi, J. and Gurung, U.M. (Editors) Leveraging the Landscapes: Conservation Beyond the Boundaries. Nepal Foresters Association (NFA), Kathmandu.

Ministry of Environment. 2010. National Adaptation Programme of Action to Climate Change. Ministry of Environment, Kathmandu, Nepal. 96 pages.

Ooi, M. K.J.. 2012. Seed bank persistence and climate change. Seed Science Research 22 (Supplement S1): S53-S60, Research Online, University of Wollongong

Pionetti, C.. 2006. Seed Diversity in the Drylands: Women and Farming in South India. Gatekeeper 126, International Institute for Environment and Development, London. Available at: http://pubs.iied.org/pdfs/14520IIED.pdf

Pokhrel, C.P.; Bhandari, V.; Lakhe, P. and Yadav, R.K.P. 2012. Agro-biodiversity conservation through seed banking: A case study from Mid-Western and Far-Western Nepal. Ecoprint 19: 39-47. Ecological Society (ECOS), Nepal.

Progressio. 2009. Seed Saving and Climate Change in Zimbabwe. Progressio Zimbabwe, Harare. 50 pages.

Regmi, B. R.; Thapa, L.; Suwal, R.; Khadka, S.; Sharma, G. B. and Tamang, B.. 2009. Agro-biodiversity: An opportunity for mainstreaming community based adaptation to climate change. Journal of Forest and Livelihood. 8(1):111-119.

Shrestha, P.; Sthapit, S.; Devkota, R. and Vernooy, R.. 2012. National Workshop on Community Seed Banks: Workshop Summary Report. 14-15/06/2012, Pokhara. LIBIRD/USC Canada Asia/Oxfam Nepal/Bioversity International, Rome.

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. Pages 41-44, In: Sthapit, B.R.; Shrestha, P. and Upadhyay, M.P. (Editors). On-Farm Management of Agricultural Biodiversity in Nepal: Good Practices. Revised edition 2012. NARC,Kathmandu/LIBIRD, Pokhara/Bioversity International and IDRC, Nepal.

Sthapit, B.. 2013. Emerging theory and practice; Community seed banks, seed system resilience and food security. Pages 16-40, In: Shrestha, P.; Vernooy, R. and Chaudhary, P. (Editors.). Community Seed Banks in Nepal: Past, Present and Future. Proceedings of a National Workshop, LIBIRD/USC-Canada/Asia, Oxfam, Development Fund, IFAD/ Biodiversity International, 14-15/06/2012, Pokhara

Sthapit, B.R.; Shrestha, P. and Upadhyay, M. P. (Editors). 2006. On-Farm Management of Agricultural Biodiversity in Nepal: Good Practices. NARC, Kathmandu/LIBIRD, Pokhara/Bioversity International, Rome. 84 pages.

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. Pages 17-20, In: Sthapit, B.R.; Shrestha, P. and Upadhyay, M.P. (Editors). On-Farm Management of Agricultural Biodiversity in Nepal: Good Practices. Revised edition 2012. NARC, Kathmandu/LIBIRD, Pokhara/Bioversity International and IDRC, Nepal.

Vernooy, R.; Shrestha, P. and Sthapit, B. (Editors). 2015. Community Seed Banks: Origins, Evolution and Prospects. Routledge. Routledge, London. 296 pages.

Vernooy, R.; Sthapit, B.; Galluzzi, G. and Shrestha, P.. 2014. The multiple functions and services of community seed banks. Resources 3: 636-656, DOI 10.3390/resources3040636.

Worede, M. 2011. Establishing a community seed supply system: Community seed bank complexes in Africa. Pages 361-377, In: Ching, L.L.; Edwards, S. and El-Hage Scialabba, N. (Editors) Climate Change and Food Systems Resilience in Sub-Saharan Africa. Food and Agriculture Organization, Rome.

Zofeen. T. E.. 2014. Seed banks help communities adapt to climate change. www.thethirdpole.net (retrieved on 16/09/2015)

Received 16 January 2017
Accepted 19 July 2017