Crop Genetic Resources and Genebank Activities in Nepal

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Abstract : Nepal possesses extreme variations in altitude, topography, climatic conditions, socio-cultural composition and farming practices that have evolved immense diversity in natural flora and fauna as well as cultivated crop species. Nepal Agricultural Research Council has been regularly collecting the crop genetic resources since 1986. The provision for access and benefit sharing mechanism within Nepal is yet to be implemented and it is in the process of being a legal document. Realizing the significance of conservation and sustainable use of Plant Genetic Resources in national development and to meet the national obligation of implementing international agreements, the Government of Nepal endorsed the establishment of National Agriculture Genetic Resources Center (NAGRC) in 2010. The seed repository of NAGRC has 10,781 accessions of the orthodox seeds collected from different regions of Nepal. The establishment of the center has become a milestone in conservation and sustainable use of agricultural genetic resources and ensuring the availability of the valuable genetic resources for posterity.

Key word : conservation, crop genetic resources, diversity, genebank, Nepal

Introduction

Nepal is a landlocked country located between 26°22′ to 30°27′ north latitude and 80°4′ to 88°12′ east longitude in South Asia. It covers an area of 147,181 km² and possesses a wide range of plant genetic diversity at both species and intra-species levels. Forest and agriculture occupy 42.2% and 26.5% of land, respectively. Agriculture shares 33% of GDP and supports livelihood to 65% of the workforce in the country[1]. About 21% of the total land area is used for cultivation and the major food crops are paddy (45%), maize (20%), wheat (18%), millet (5%) and potato (3%) together sharing for 75% of cropped area[2]. It is estimated that over 6500 species of flowering plants exist, out of which 370 are endemic[3]. The foothills of the Himalayas are considered as the cradle of flowering plants. The richness in fauna is exhibited by available diversity in 640 species of butterflies, 5000 species of insects, 185 species of fishes, 400 species of agro-horticultural crops, 60 species of wild edible fruits and 300 species of orchids[4,5]. Diversity in agricultural genetic resources indicates availability of more than 500 edible species, of which nearly 200 species are cultivated. Rice, the native crop of the region, possesses 2000 local farmers' varieties and four related wild species[6]. The extreme variations in altitude, complex topography, varied climatic conditions, and antiquity of agriculture/forest system have generated immense diversity in flora and fauna.

There are 60 species of amaranth in the world at least 11 species have been reported with cultivated types for grain, green vegetables, wild and weedy types in Nepal[7]. Nepal, being proximal to the origin and secondary sources of origin of different cultivated plants, has harbored numerous wild relatives of cultivated agricultural crop plants like rice, wheat, barley, buckwheat, citrus and other fruit crops, several vegetable crops, etc. It is reported that 83 different wild relatives of 46 genera under 18 families of 36 agricultural crops exists[8]. A total of 216 improved varieties of 44 crops have been released representing cereals,

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Table 1. Food crop genetic resources in agro-ecological regions of Nepal.

	Zones (altitude)	Food crop genetic resources
1	Terai (60-1000m)	rice, maize, wheat, chickpea, pigeonpea, lentil, jute, niger, sesame, perilla, wild relatives of rice, sugarcane, kodo millet, eggplant, okra, grasspea etc.
2	Hill (1000-3000m)	rice, maize, wheat, barley, naked barley, foxtail millet, buckwheat, ricebean, finger millet, blackgram, soybean, field peas, perilla, niger, sesame, *Brassica* species, wild relatives of buckwheat, amaranths, finger millet, ricebean, pigeonpea etc.
3	Mountain (3000-8848m)	cold tolerant rice, proso millet, wheat, naked barley, maize, buckwheat, amaranths, chenopods, ricebean, blackgram, soybean, field peas, radish, sesame, *Brassica* species, perilla etc.

legumes, oil seeds, potato, vegetables, industrial crops and forage. There is an increasing interest in neglected and underutilized crop species for export and domestic markets. To meet the national obligation of implementing international agreements for conservation and sustainable use of agro-biodiversity in national perspective, the Government of Nepal endorsed the establishment of National Agriculture Genetic Resources Center (NAGRC) in 2010. The establishment of the center has become a milestone in conservation and sustainable use of agro-biodiversity and ensuring the availability of the valuable genetic resources for posterity.

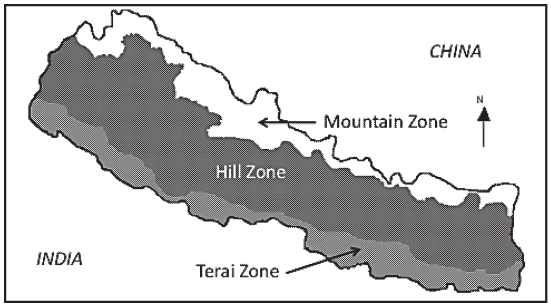

Fig. 1 Map of agro-ecological zone in Nepal.

Historical perspective of plant genetic resources activities

Plant exploration and collection activities carried out in Nepal indicate that several foreign explorers were involved in collecting plant genetic resources (PGR) of Nepal. The first was a German missionary Herrlich in 1937-38. Later in 1952-53, a Japanese team led by Prof. Kihara of Kyoto University, collected PGR. Similarly, British Scientists J.R. Witcombe and A.M. Martimore in 1971 and L.W. Beer in 1975 further added PGR to the collection of native crops. The Bioversity International, former International Board for Plant Genetic Resources (IBPGR), since its inception, has supported exploration and collection activities. With the team supported by the Japanese fund, several multi-crop explorations for collecting PGR in Nepal hills were undertaken.

The Government of Nepal first started the collection and evaluation of indigenous plant materials in 1940. However, due emphasis was put only after 1972 with the establishment of Vegetable Development Division[9]. A Plant Genetic Resources Section was established for food crops in 1984 at Agriculture Botany Division, Nepal Agricultural Research Council (NARC), Khumaltar and actively involved in PGR exploration, collection and conservation activities. Since then, NARC has continued its efforts in regular collection of the crop plant genetic resources.

Diversity of major food crop genetic resources

Nepal is one of the probable homelands of some food crop species. A total of 550 crop species are identified as food value. Food crop species are distributed in all the three agro-ecological zones (Table 1, Fig. 1). Species richness is indicated in terms of the existence of intra- and inter- landraces/species diversity. Significant diversity exists at all levels of ecosystem, genera, species and genetic level. Relatively mountain region is the least affected by modern technology with low diversity but intervened by modern techniques. Most influenced area is Terai with medium diversity. These statements are also supported by morphological, biochemical and molecular studies. Diversity is linked positively to diversity

of community, e.g. diversity in ethnic group, wealth category etc.

Diversity can be observed directly more on summer season in the field. Free gene flow at national and international level promoted the expansion of the popular modern varieties over a large area. Co-evolution system is also distributed due to different measures of biotic stress control. Location of agro-biodiversity depends on the crop species such as rice diversity is concentrated in the western region and wheat diversity in the far and mid-western region.

Threats to plant genetic resources

Over the last century, increased human population pressure, poverty, land degradation, environmental change, introduction of modern varieties and national policy has contributed to the erosion of crop genetic resources in Nepal. This has resulted in a loss of option to farmers to cope with change and farming community is increasingly vulnerable to access to food and livelihoods. In nature, variability has been maintained by natural hybridization, spontaneous mutation and adaptation of crop species in the specific environments. However, the increasing demand of food and socioeconomic development have adversely affected the evolutionary processes and encouraged exploitation of biological resources causing extreme deforestation, degradation of ecosystem, land encroachment for urbanization and arable farming, replacement of landraces etc. The rice ecosystem of Ajigara Tal in Kapilvastu district of Nepal is a typical example of ecosystem under threat[3]. Wild rice *Oryza nivara* in shallow water and *Oryza rufipogon* in deep water is surrounded by local rice landraces cultivated by farmers. Farmers harvest wild rice for their specific needs. Inter-specific crosses between wild rice and landraces enhanced genetic diversity, which is apparently visible in the surrounding area. Land encroachment and draining of swampy lands continued to be a threat to wetland system.

It has been reported that the level of genetic erosion is increasing in rice, maize and wheat. In Karnali zone genetic diversity has been maintained due to the specificity of landraces, undisturbed forests, remoteness etc., while in Kapilvastu and Banke districts the level of genetic erosion was maximum in rice and maize. Many rice landraces like “anadi”, “tauli” and “thapachiniya” are vanishing from the general cultivation.

National Agriculture Genetic Resources Centre (NAGRC)

For conservation and sustainable use of agro biodiversity in national development and to meet the national obligation of implementing international agreements, the Government of Nepal endorsed the establishment of National Agriculture Genetic Resources Center in 2010. The establishment of the center has become a milestone in conservation and sustainable use of agricultural genetic resources and ensuring the availability of the valuable genetic resources for posterity. The main mission is to conserve and sustainable use of agricultural genetic resources for sustained agricultural growth and livelihood with the following objectives :

- To explore and conserve the endangered/ rare/ unique and available genetic resources for promoting sustainable use.
- To characterize and evaluate genetic resources and avail the resources to researchers, academicians, farmers, entrepreneurs and related stakeholders.
- To restore the genetic resources conserved in international genetic resources centers/ institutions.
- To manage database/ registration of agricultural genetic resources and associated knowledge.

Activities of NAGRC

The mission and activities of NAGRC are summarized as follows :

- Exploration and collection of agricultural genetic resources.
- Characterization and evaluation.
- Conservation of agriculture genetic resources.

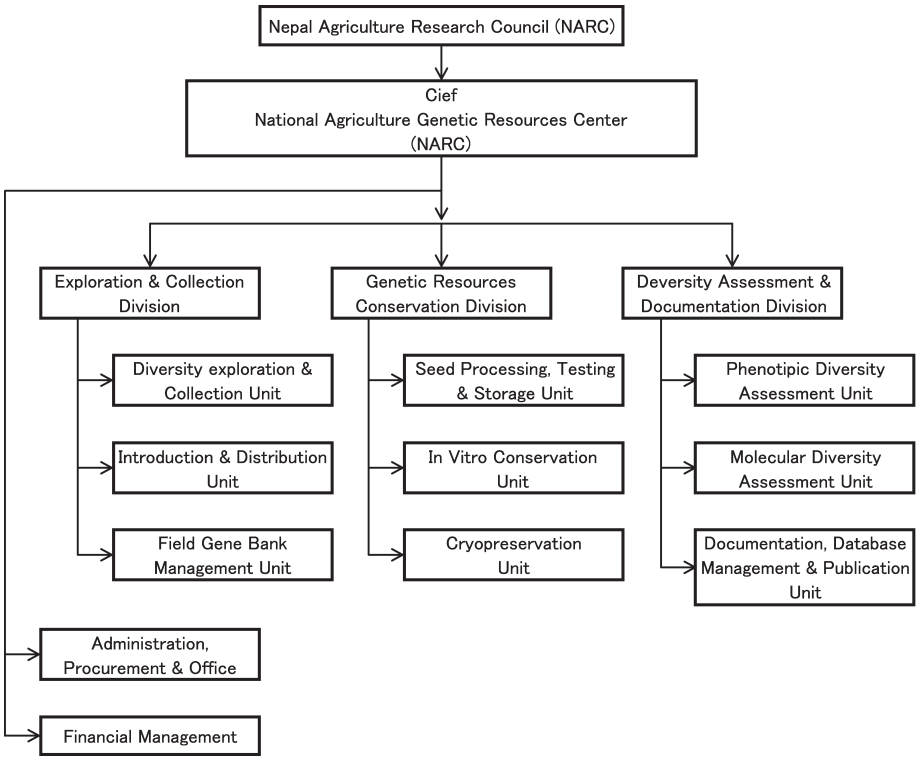

Fig. 2 Organizational structure of National Agriculture Genetic Resources Centre.

- Seed testing and processing
- Rejuvenation and multiplication of agriculture genetic resources
- Documentation and exchange of information
- Exploration and promotion of traditional knowledge, skill and technology.

Organizational structure of NAGRC

NAGRC is working national level in the field of agriculture genetic resources conservation under NARC (Fig. 2). Its prioritized programme is to conserve genetic resources *ex-situ*, *in-situ*, use and institutional capacity building.

Evaluation and utilization

The conservation of crop genetic resources is meaningful only if they are properly characterized and evaluated to access the extent of diversity and the variability is utilized for the betterment of mankind. The characterization and evaluation of cereals, grain legumes and oilseed landraces have been done on regular basis. The descriptors published by IBPGR are used for the purpose. Landraces exhibit extreme variation in agro-morphological traits, resistance to biotic and abiotic stresses and adaptation. A total of 230 varieties of 45 different crops along with complete package of practices have been released and registered since 1960[10]. Out of 230 food crop varieties released by National Seed Board, 32 were developed by local selection directly and 11 were developed by the hybridization of local and exotic germplasm. Many other landraces are being used to develop food crop varieties. National crop research programmes are actively involved in evaluation and utilization of indigenous germplasm to develop varieties suitable for various cropping systems in different ecological regions of Nepal.

Documentation and conservation of PGR

Documentation of *ex-situ* PGR collections has been initiated and passport data of 10,781 accessions have been documented in MS Excel programme[6]. Table 2 shows the collection and preservation of 90 food crops germplasm in Nepal. Though, a better system needs to be developed for documentation of *ex-situ* PGR collections. Scientific documentation of *ex-situ* PGR will be the major priority. To complete this task NAGRC

Table 2. Collection and preservation of germplasm in gene bank.

Crop categories	No. of species	No. of accessions
Cereals	11	4715
Millets	6	977
Pseudo cereals	3	383
Pulses	22	3357
Oilseeds	10	640
Vegetables	20	603
Spices	10	75
Fiber crops	3	0011
Miscellaneous	5	20
Total	90	10,781

needs a documentation expert and facility to establish the complete documentation system and provide training for the staff with the responsibility of day to day task for documentation.

On-farm conservation of PGR

Realizing the global concern for agro-biodiversity conservation, NARC and Bioversity International initiated the Nepal component of the global project on "Strengthening the Scientific Basis of *In situ* Conservation of Agricultural Biodiversity" in 1997 in three eco-geographical regions, Jumla (Mountain), Kaski (Hill) and Bara (Terai). In the process of on-farm management of Plant Genetic Resouces for Food and Agriculture (PGRFA) several good practices have been identified and developed for conservation and sustainable use of PGRFA. These practices are being replicated in three mid and far western districts through institutional arrangement of Ministry of Forest and Soil Conservation and Ministry of Agriculture and Cooperatives. However, visualizing the level of diversity in the nation, the present effort is quite limited to mobilize stakeholders involved in conservation and use of PGRFA. There is no subsidy mechanism in place to promote on-farm management of PGRFA in Nepal. However, the *in situ* conservation project has built a model to link *in situ* conservation with genetic, socio-economic and ecological benefit to farming communities.

Conclusion

Nepal is rich in PGRFA. An estimate indicates the availability of nearly 500 wild and semi wild edible plants, out of which 200 plant species have been domesticated and cultivated. Diversity richness is apparently visible at ecosystem, species and genetic levels. Awareness of exploration and collection in PGRFA has been largely created by the explorers from abroad and Bioversity International (then IBPGR/IPGRI). With the inception of NARC, the mission of exploration and collection continued to be in high priority. The initiative led to the establishment of NAGRC in 2010. The NAGRC is committed to the conservation and sustainable use of agricultural genetic resources for posterity. Government of Nepal has prepared draft legislation for Access to and Fair and Equitable Benefit Sharing (ABS). The endorsement of ABS, Farmer's Right and Intellectual Property Right legislations under consideration by the Parliament/constituent assembly. Increased assistance for donors would create a favorable environment for increasing infrastructure facilities and capacity building of human resource in NAGRC. The collaborative support would ensure conservation and sustainable use of agriculture genetic resources for the betterment of Nepalese people.

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References

1) ES, 2009/10. Economic Survey, Ministry of Finance, Government of Nepal, Kathmandu.
2) MoAC, 2010. Selected Indicators of Nepalese Agriculture and Population. Ministry of Agriculture and Cooperatives, Kathmandu, Nepal.
3) Upadhyay, MP. 1999. Status of Plant Genetic

Resources Conservation and Utilization in Nepal. Proceedings of Wild Relatives of Cultivated Plants in Nepal. The Green Energy Mission/Nepal. pp. 183–189.
4) NBS, 2002. National Biodiversity Strategies–Ministry of Forest and Soil Conservation, Nepal.
5) Gautam, J.C. 2008. Country report on the State of the Nepal's Plant Genetic Resources for Food and Agriculture, submitted to Commission of Genetic Resources for Food and Agriculture, FAO. pp.38. Available at ftp://ftp.fao.org/ag/agp/countryreports/NepalFinalReport.pdf
6) Gupta, SR and MP Upadhyay .2000. The Wild and weedy rice in Nepal In : Proceedings of 22nd National Summer Crops Research Workshop. NARC, Nepal. March 27–29, 2000. pp. 104–113.
7) Hara, H., WT Stearn and LHJ Williams. 1978. An Enumeration of the Flowering Plants of Nepal (Vol. 1). A Joint project of British Museum (Nepal History) and the University of Tokyo. Trustees of British Museum (Natural History), London. p. 138.
8) Shrestha, GL and B. Shrestha. 1996. New Frontiers of Knowledge on Nepalese Plants. In : Environment and biodiversity : in the context of South Asia. Jha, PK ; Ghimire, GPS ; Karmacharya, SB ; Baral, SR and Lacoul P (Eds.) Ecological Society, Kathmandu, Nepal. pp. 161–171.
9) Upadhyay MP and Joshi BK. 2003. Plant Genetic Resources in SAARC countries : Their conservation and management. Nepal chapter. SAARC Agriculture Information Center, pp. 297–422.
10) NARC. 2010. Released and registered crops varieties in Nepal. Communication, Publication and Documentation Division, NARC. Khumaltar, Lalitpur, Nepal.

ネパールにおける作物遺伝資源とジーンバンク事業

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要 約

ネパールは，非常に変化に富んだ標高，地形，気象条件，社会文化構造，農業形態を有しており，自然の動植物相はもとより栽培作物種においても計りしれない多様性を進化させてきた。ネパール農業研究評議会（NARC）は，1986年以来，定期的に作物遺伝資源の収集をおこなってきた。しかし，ネパール国内における遺伝資源におけるアクセスと利益配分に関する規定は，まだ実施されておらず，法整備化の過程にある。国家の発展における作物遺伝資源の保全と持続的利用の重要性を理解し，国際協約を履行する国家義務を果たすために，ネパール政府の支持を得て2010年に国立農業遺伝資源センター（NAGRC）が設立された。現在，NAGRC の種子貯蔵庫には，各地から収集された伝統的な種子10,781アクセッションが保存されている。本センターの設立は，農業遺伝資源の保全と持続的利用における一里塚となっており，子孫に対して価値のある遺伝資源の利用を保証する。

キーワード：作物遺伝資源，ジーンバンク，多様性，ネパール，保全