MULTI-CROPS GERMPLASM COLLECTION FROM FAR WESTERN DEVELOPMENT REGION OF NEPAL

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ABSTRACT

To widen the genetic base for further improvement, it is necessary to collect, characterize, evaluate and conserve multi-crops genetic resources. Collection of germplasm from unexplored area was conducted during 2011. A total of 504 samples were collected from Far-Western Development Region of Nepal including a wild species of rice Oryza ruffipogon Griff from Ghoda ghodi tal of Kailali district. A random sampling method was followed for most agricultural crops, where populations were large, and variability was deliberately sought. Sampling was from household stores and from harvested lots, together with individual sampling from fields and markets where appropriate. Greater diversity was found in rice (116) followed by soybean (38), maize (35), beans (28), cowpea (26) and wheat (24). The major achievements of these collections were recognized as the acquisition of additional variability for different multi-crop genetic resources.

Key words: Conservation, diversity, exploration, multi-crops germplasm, region

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. The country is sandwiched between India in the south, east and west and China in the north. It extends over a length of 885 km from east to west and has a non-uniform width of 193 km from north to south. It has a total land area of 147,181 km^2. Nepal is predominantly a mountainous country with elevations ranging from 60m above sea level in Kechana located in eastern Terai (southern plain area) district of Jhapa to 8,848 m at the peak of the world's highest mountain, Sagarmatha. Far western development region (FWDR) is one of the five regions of the country and has nine districts, covering 19,539 km^2 (CBS, 2009). The region comprises of nine districts (Bajura, Bajhang, Achham, Darchula, Baitadi, Dadeldhura, Doti, Kailali and Kanchanpur) which are bordered by India in the South and West, China in the North and Mid Western Development Region in the East. This region is less developed than other regions of the country (MoAC, 2010) and has a population of 2,191,330. Due to its remoteness the penetration of improved varieties are very low. Therefore, the uses of local landraces are less disturbed and are in natural gene pool. So, a high priority was given to this region for collection of germplasm.

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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 which can be observed directly more on summer season in the field. Rice diversity is concentrated in the western region and wheat diversity in the far western region (Upadhyay and Joshi, et. al. 2003). Most influenced area is Terai (Kailai and Kanchanpur) with medium diversity.

Agrobiodiversity is an important component of total biological diversity, and has a crucial role in sustaining and strengthening the food and nutritional security and health of the increasing human population. The yield level of most crops has reached a plateau due to the narrow genetic base. To widen the genetic base for further improvement, it is necessary to collect, characterize, evaluate and conserve the multi-crop genetic resources. It is also important to collect landraces, which have been conserved and used by different communities as part of their tradition. Landraces are rapidly being replaced by modern cultivars due to increasing demand for more yields from limited land. Although these traditional local races have comparatively low yield, they are endowed with certain economical desirable traits, such as stress and disease tolerance and other adaptive features (Gautam et. al. 2000).

Due to the alarming depletion in the local landrace diversity as a result of over exploitation and over population, there are scopes and need for collecting any additional and fresh diversity left untouched or in exhausted in order to enrich the national gene pool. Other reasons also underline the need for an immediate and massive effort for collection and conservation of the genetic wealth. The emerging intellectual property rights (IPR) regime has necessitated enhancement of the systematic effort for survey, inventorization, collection, evaluation, domestication and characterization of native genetic diversity. Rapid habitat degradation and introduction of high yielding varieties could eventually lead to extinction of many traditional cultivars and landraces. Thus, the NAGRC is involved in constant efforts to record all available multi-crop germplasm from the different regions of Nepal. Before the establishment of NAGRC, a total of 10,781 accessions of multi-crop germplasm were collected (Gupta, 2011).

Because of varied topography, a wide range of indigenous crops is grown. Low-lying areas are used for rice cultivation, while the hill slopes are used for vegetable and horticultural crop cultivation. Large-scale crop cultivation and monoculture is practically absent. Cultivation of upland paddy, maize, beans, chilli, cucurbits, Colocasia spp., Dioscorea spp., etc., using local landraces is common. Among exotic crops, potato, tomato, pea, capsicum, and cole crops are prominant.

However, due to changing land use patterns and the gradual introduction of high-yielding varieties, the local indigenous germplasm of various crop species are slowly disappearing. Therefore, an attempt has been made to collect the diversity of indigenous crops, particularly species of grain legumes (cowpea, French bean, winged bean and others), cucurbits (pumpkin, cucumber, bottle gourd, bitter gourd and snake gourd), spices (onion, chillies), vegetables (brinjal and okra),

from different sites within far western development region. Since these crops exhibit a wide range of variability and there has been no systematic account of the crop resources of the region, it is essential to document such resources. With this aim, an exploration for the collection of germplasm was planned and executed.

The objectives of exploration were:

- to visit unexplored areas to collect the variability of different indigenous crop species in order to prepare an inventory;
- to study morphological variability among the genotypes collected, especially the major agricultural crops, and
- to conserve the collection ex situ (field gene bank or medium-term storage as appropriate).

MATERIALS AND METHODS

The exploration trip for the collection of multi-crop germplasm was conducted during September 2010/11 in the Far Western Development Region of Nepal. Remote and unexplored localities were given priority. Unexplored localities are the areas, which is not covered in the previous collection mission from the centre. The area covered during the trip lies between 110 m and 2150 m altitude. However, most localities were situated in the 110 m to 2078 m range. Local flora, literature and information gathered from maps, previous collection reports, provided background information and the assistance of local agricultural offices helped to determine the current areas of crop diversity concentration. However, no prior specific eco-geographical survey was carried out in this belt.

The normal collecting routes followed and the six collecting districts of FWDR are shown in Figure 1. A random sampling method was followed for most agricultural crops, where populations were large, and variability was deliberately sought. Sampling was from household stores and from harvested lots, together with individual sampling from fields and markets wherever appropriate. Samples were in the form of seed, bulbs, corms, rhizomes, tubers, etc., as shown in Figure 2 according to the crop and the mode of propagation.

Standard passport data for each accession were recorded at the time of collection. These data include crop name, botanical name, local name of the variety or landrace, village, district, region, altitude, latitude, longitude, type of sample, method of sample, soil type, crop season, ecosystem, topography, farmer or donor name, source of collection, ethnic race of farmer, and any special feature of the collection, including local knowledge, if any. Each accession was subsequently assigned the registration number by the National Agriculture Genetic Resources Centre (NAGRC), Khumaltar, Lalitpur.

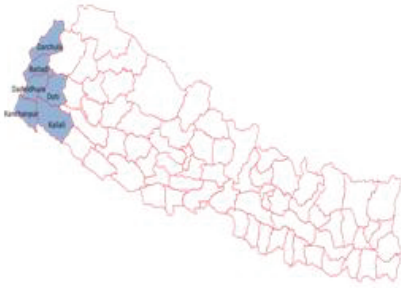

Figure 1: Map of Nepal showing multi-crop germplasm collecting sites of FWDR

Fig. 1: Map of Nepal showing multi-crops germplasm collecting sites of FWDR

Fig. 2: Mr. Gupta & Mr. Shah collecting germplasm with passport data information from Darchula

RESULTS AND DISCUSSION

MULTI-CROPS GERMPLASM COLLECTED

A total of 504 accessions of 48 crops germplasm were collected from the far western development regions (Annex 1). Wide diversity was found in rice (116), soybean (38), maize (35), beans (28), cowpea (26), wheat (24) and bitter gourd (23). Other material included various pseudocereals, legumes, oil seeds, fibre crop, vegetables and spices. Maximum diversity from Darchula (179) district were collected followed by Kailali (137) and Dadeldhura (67). One species of wild rice *Oryza ruffipogon* Griff also collected from Ghoda ghodi tal (200 m) of Kailali district (Table 1). Shrestha and Upadhyay 1999 also reported that a mission travelled during 1989 to the far western terai region covering Kailali and Kanchanpur districts regarding wild rice field survey, and found existence of wild species *O. ruffipogon* and wild relatives of *Hygroryza aristata* in the Ghoda ghodi tal of Kailali district.

Tabel 1. Germplasms collected from Far Western Development Region

SN	Crop Group	Baitadi	Dadeldhura	Doti	Kailali	Kanchanpur	Darchula	Total
1	Cereals	20	25	29	28	17	71	190
2	Pseudo cereals	0	4	0	2	0	2	8
3	Millets	4	4	6	1	0	24	39
4	Pulses	24	23	10	44	4	42	147
5	Oilseeds	2	3	1	10	2	11	29
6	Vegetables	2	6	0	41	0	28	77
7	Spices	0	1	0	8	0	1	10
8	Others	0	1	0	3	0	0	4
	Total	52	67	46	137	23	179	504

DIVERSITY IN FOOD CROPS

High diversity is found in Baitadi, Dadeldhura, Doti, Kailali, Kanchanpur and Darchula districts of the country. Farmers in those districts are growing diverse crops as well as unique/rare crops to fulfill their basic needs and to avert the risk from adverse climatic condition. Rice, maize, wheat, finger millet, proso millet, soybean, black gram, and phaseolus beans are the major food crops. The agro ecological variation is very high. People grow local cultivars of different crop species. The adoption of improved varieties is very nominal due to unique ecosystem and inaccessibility of new material and information. Major food crop diversity collected from the region are given in Annex-I.

CROP SPECIES DIVERSITY

District wise species diversity is shown in Table 2. Eight to thirty nine different crop species have been collected from Kanchanpur and Kailali district respectively. Kailali district shows higher crop species diversity (39) followed by Darchula (25), Dadeldhura (21) and Baitadi (14) district. FWDR is rich in terms of plant genera, species, subspecies, populations, varieties, lines, races, ecotypes, mutants, biotypes etc. These materials were evolved due to the diverse agro-ecological conditions and sharp climatic variation. Wide variability is observed within a species and among the species of the genus in many morphological and agronomical traits. Farmers in FWDR were found growing different crops to fulfill their basic needs and to avert the risk from adverse climatic condition.

Table 2. Crop diversity collected from far western development region

SN	District	Species diversity	Crop diversity collected
1	Baitadi	14	Barley, Beans, Black gram, Cowpea, Finger millet, Horse gram, Lentil, Maize, Mustard, Pea, Rice, Ricebean, Soybean, Wheat.
2	Dadeldhura	21	Amaranths, Amilarcha, Barley, Beans, Black gram, Buckwheat, Coriander, Cowpea, Finger millet, Foxtail millet, Horse gram, Lentil, Maize, Mustard, Pea, Pumpkin, Rice, Ricebean, Sesame, Soybean, Wheat.
3	Doti	9	Black gram, finger millet, horse gram, maize, mustard, rice, ricebean, soybean, wheat.
4	Kailali	39	Amaranths, Amilarcha, Barley, Beans, Bitter gourd, Black gram, Bottle gourd, Broad bean, Broad leaf mustard, Buckwheat, Chilly, Coriander, Cowpea, Cucumber, Fennel, Fenugreek, Green gram, Hemp, Horse gram, Jute, Lentil, Maize, Mustard, Okra, Pea, Pumpkin, Radish, Rice, Ricebean, Serpentina, Sesame, Snake gourd, Sorghum, Soybean, Sponge gourd, Sword bean, Water melon, Wheat, Wild rice (*Oryza ruffipogon*).
5	Kanchanpur	8	Broad bean, Grass pea, Lentil, Linseed, Mustard, Pea, Rice, Wheat.
6	Darchula	25	Barley, Beans, Black gram, Broad leaf mustard, Chilly, Coriander, Cowpea, Chenopodium sp., Finger millet, Foxtail millet, Garden cress, Horse gram, Maize, Mustard, Pea, Perilla, Proso millet, Radish, Rice, Ricebean, Sesame, Sorghum, Soybean, Sunflower, Wheat.

VARIETAL DIVERSITY COLLECTED IN MAJOR CROPS

Varietal diversity in major crops such as rice, maize wheat Soybean and beans are also found in Far Western Development Region (Annex 2). Maize, wheat, soybean and beans shows higher diversity in Darchula. It may be due to the remoteness with less accessibility for high yielding varieties. In the country the local variety in maize and wheat is very rare but in FWDR the local variety of maize and wheat are growing by the farmers. Many type of awn and awnless variety of wheat and the maize variety with small cob were collected from this region during the mission.The number showing only one accessions of wheat in Doti, Kailali and Kanchanpur are in the stage of extinction.

GENETIC EROSION

The Russian Scientist, Nicoli Ivanovic Vavilov and H Harlan respectively in the 1920s and 1930s noticed that traditional crop varieties or landraces were lost from the fields and gardens around the world (Brush 2000). For the subsequent 60 years scientific efforts to conserve plant genetic diversity focused on collecting materials and placing them in *ex situ* storage. Various institutions created gene banks and millions of accessions were accumulated and preserved in low temperature low humidity facilitated gene banks.

Loss of genetic diversity is the common threat to the sustainable use of plant genetic resources to meet the present needs and aspiration of future generation (Chang, 1985). The spread of high yielding varieties has contributed to the gradual disappearance of landraces besides loss of habitats, market forces and population pressure. Chaudhary *et. al.* (2003) reported that genetic erosion was measured in terms of changes in the number of farmers growing each landraces and the areas covered by a landrace. There are 200 cultivated species, 500 wild edible plants and 120 cultivated plant species reported in Nepal (Upadhyay and Joshi 2003).As per the conversation with the old farmers,*Dhunmuniya, Jarneli, Karangi, Mansara, Rahimanuwa* varieties of rice are grown by few farmers and are in the stage of extinction. *Satha, Sugapankhi* and *Gurra* varieties of rice landraces are lost from Kanchanpur district.Farmers were expressing their anxiety that how the seed of those varieties can be retrieved for cultivation. Rijal *et. al.* (1998) also reported that 11 rice landraces under threat and 11 landraces have been lost in Seti River valley. Deforestation, land encroachment and urbanization have further increased the pace of genetic erosion.

CONSERVATION STATUS

Collection of germplasm is the primary task for conservation and proper use of genetic resources. After collecting the germplasm, various task like data recording, seed handling, registration, and further processing of seeds will be initiated. The collected germplasms were grown in the field for seed increase and detailed agromorphological characterization. The seeds has to pass through seed processing such as cleaning, drying, viability testing in the seed lab the National Agriculture Genetic Resources Centre (NAGRC), Khumaltar, Lalitpur for storing in

the short-term(5-100C & 40-45% RH) and long-term (-200C)module. All the samples were accompanied by a copy of the relevant passport data information sheets.Different crop commodity research program under Nepal Agricultural Research Council (NARC) is one of the germplasm utilization centre responsible for varietal development in the country. Therefore, utilization part should be strong for running ex-situ conservation of germplasm effectively because of costly works of ex-situ conservation such as rejuvenation, screening duplicates, preliminary characterization etc.

CONCLUSIONS

The germplasm collected from FWDR are very useful assets for the country. Some germplasms were found very unique and useful in the context of climate change. The UJkalo of rice variety from Dadeldhura district means upland variety in local language. According to the farmers this variety can tolerate drought and is very suitable for upland conditions which is a reality of this region. This variety was common in most district of FWDR. In Darchula district diversity of germplasm was high followed by Baitadi. The gene found in the Ujkalo variety which make this variety resistance for drought could be used for making some other variety for drought resistance. Likewise, few gemplasm (Poke dhan, Sal dhan, Raimanuwa, Khajiya, Leki dhan) collected from this region with unique traits for quality, taste and aroma. Those can be used by the breeders of respective national crop research program for incorporating those genes in further crop improvement. The team tried to collect the germplasm from different sites so that it could be representative of the area inspite of short time duration of travel. Like the Huti of Darchula which lies in Northern west part of the district. Similarily Shankarpur and Gokuleshwor which is in southerand eastern part of the district.In the light of the variability found in different crops, based on quantitative and a few qualitative traits, the collected germplasm might prove to be a source for some important characters. These useful traits could be used for further crop improvement through different breeding techniques. The stability of morphological and physiochemical characters will be determined by on-farm evaluation and characterization. The richness of crop diversity in the areas explored cannot be limited to the results of this study alone, which has provided an initial outline of the occurrence of diversity, leaving great scope for further collection, study and evaluation in different ecological situations.

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Annex-I: Collection of mullti-crops germplasm

Crop/Districts	Baitadi	Dadeldhura	Doti	Kailali	Kanchanpur	Darchula	Total
Amaranths	-	3	-	1	-	-	4
Barley	5	2	-	2	-	5	14
Beans	2	5	-	5	-	16	28
Bitter gourd	-	-	-	5	-	-	5
Black gram	4	5	4	4	-	6	23
Bottle gourd	-	-	-	3	-	-	3
Broad bean	-	-	-	1	1	-	2
Broad leaf mustard	-	-	-	2	-	4	6
Buckwheat	-	1	-	1	-	-	2
Chilly	-	-	-	2	-	4	6
Coriander	-	1	-	5	-	1	7
Cowpea	4	2	-	14	-	6	26
Cucumber	-	-	-	2	-	-	2
Chenopodium sp.	-	-	-	-	-	2	2
Fennel	-	-	-	1	-	-	1
Fenugreek	-	-	-	2	-	-	2
Finger millet	4	3	6	-	-	11	24
Foxtail millet	-	1	-	-	-	6	7
Grass pea	-	-	-	-	1	-	1
Green gram	-	-	-	1	-	-	1
Garden cress	-	-	-	-	-	1	1
Hemp	-	-	-	1	-	-	1
Horse gram	4	3	2	3	-	4	16
Jute	-	-	-	3	-	-	3
Lentil	2	2	-	2	1	-	7
Linseed	-	-	-	-	1	-	1
Maize	4	2	6	8	-	15	35
Mustard	2	1	1	4	1	4	13
Okra	-	-	-	2	-	-	2
Pea	2	1	-	4	1	3	11
Pumpkin	-	1	-	3	-	-	4
Perilla	-	-	-	-	-	1	1
Proso millet	-	-	-	-	-	6	6
Radish	-	-	-	1	-	2	3
Rice	7	18	22	16	16	37	116
Ricebean	3	3	1	7	-	8	22
Serpentina	-	-	-	1	-	-	1
Sesame	-	2	-	6	-	6	14
Snake gourd	-	-	-	2	-	-	2
Sorghum	-	-	-	1	-	1	2
Soybean	5	7	3	8	-	15	38
Sponge gourd	-	-	-	7	-	-	7
Sword bean	-	-	-	1	-	-	1
Sunflower	-	-	-	-	-	1	1
Water melon	-	-	-	1	-	-	1
Wheat	4	3	1	1	1	14	24
Wild rice	-	-	-	1	-	-	1
Amilarcha	-	1	-	3	-	-	4
Total	52	67	46	137	23	179	504

Annex 2 Verietal diversity of major crops collected from far western development region

Districts	Local name of varieties and number of samples collected				
	Rice	Maize	Wheat	Soybean	Beans
Baitadi	Dada Basmati, Rolyal Ghaiya, Anjana dhan, Churi Dhan, Thapachine Dhan, Bogatani Ghaiya, (7).	Ghoge Makai, Dhaulo Makai, Seto Makai (4)	Sun khole, Daugi, Nanu, Mudule gahun (4)	Seto Bhatta, Kallo Bhatta (5)	Rato Sotho, Seto Simi (2)
Dadeldhura	Shyam Giro, Daule Ghaiya, Bhutyal Ghaiya, Chatunge Dhan, Sunaulo Ghaiya Rato Dhan, Subedi Jhuse Ghaiya, Salo Dhan, Morade Marsho, Marshi, Chhoti, Jaule (Ghaiya), Parmal, Chainpure, Sali Dhan, Shyam Zero Seto, Tude Dhan (18).	Sathiya makai, Local Seto Makai (2)	Pahadi Gahun, Gharelu Gahun, Local Gahun (3)	Kalo Thulo Bhatta, Rato Bhatta, kalo Thulo Bhatta, Seto Bhatta, Nepali Bhatta, Khairo Bhatta (7)	Local simi, Seto Sutho, Khalenge Shotto, Kalo Simi, Rato Simi (5)
Doti	Sunaulo Ghaiya, Chakamale Ghaiya, Nishan Puri, Rato Dhan, Purano Ghaiya, Ladkhade Ghaiya, Ram jawano Ghaiya, Thapachine, Shyam Gira, Jhimma Dhan, Kalo jaule Ghaiya, Rate Ghaiya, Nau Gire Ghaiya, Anjana, Saunaulo Ghaya, Kalo Dhan, Jhamma Gaiya, Dhal Badale (Ghaiya), Gurra Dhan, Dai Dhan, Syaudo, Jaule (Ghaiya), (22).	Nanu makai, Murali makai, Sathiya makai, Local Makai (6)	Mudule Gahun (1)	Kalo Bhatta, Moto Bhatta (3)	
Kailali	Anadi, Bhale mansuli, Shyamjeera, Makar kaddu dhan, Seto anadi, Dhunmuniya dhan, Tilki dhan, Kariya jarhan, Karangi dhan, Rahimanwa dhan, Jangali dhan (16)	Baisakhi makai, Makai, Pahenlo makai, Seto makai (8)	Gahun (1)	Kalo bhatta, Kairo bhatta, Bhatta, Seto bhatta, Kalo bhatta (Bharthar), Bhatara (8)	Madane simi, Bhote simi, Kause simi, Simi (5)
Kanchanpur	Rahimanwa dhan, Mahakaniya anadi, Mansara, Belkhole dhan, Nimoi dhan, Dhunmuniya dhan, Tilki dhan, Shyamjeera, Karangi dhan, Ghiukari dhan, Madhukur, Anadi seto, Suhapat dhan, Kalo jadahan, Thapachini, (16)		Rato gahun (1)		
Darchula	Bangai, Local dhan, Goji, Jaule, Lamadya, Poke dhan, Rato dhan, Chhoti dhan, Sal dhan, Chamade, Raimanuwa, Rewli dhan, Jhaduwa dhan, Jauli dhan, Jhini dhan, Lamade dhan, Moto dhan,Dudhi dhan, Khajiya dhan, Rajmati dhan, Leki dhan, (37).	Ghoga makai, Local makai, Dhaule makai, Bikasi makai, Hansa makai, Seto makai, Murali makai, Nan dhaule, Seto ghoga makai (15)	Local gahun, Dautkhani, Khijhadi, Thulo chaudadi, Gahun, Geri, Dauti gahun, Betkume gahun, Bombe gahun (14)	Bhattu, Kalo bhatta, Seto bhatta, Khairo bhatta, Bhatta, Dhaule bhatta, Khairo, seto bhatta (15)	Rajma simi, Thulo sotta, Kalo sotta, Rato Rajma, Male sotto, Seto sotta (Simi), Sitoli rajma, Kalo simi (16)