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Research Article

Collaborative exploration and collection of native plant genetic resources as assisted by agrobiodiversity fair

Ram P Mainali[1]*, Ajaya Karkee[1], Dipesh Neupane[2], Padma Pokhrel[3], Pradip Thapa[1], Krishna H Ghimire[1], Bal K Joshi[1] and Krishna K Mishra[1]

[1]National Agriculture Genetic Resources Centre (NAGRC, National Genebank), Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal
[2]Group of Helping Hands (SAHAS), Lalitpur, Nepal
[3]Ministry of Agriculture and Livestock Development, Singhadurbar, Kathmandu, Nepal
*Correspondence: mainalism.rp@gmail.com; ORCID: https://orcid.org/0000-0002-4637-3676
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ABSTRACT

This article describes the agrobiodiversity fair aided exploration and collection expedition of native plant genetic resources in southern Lalitpur, jointly organized by the National Agriculture Genetic Resources Centre (NAGRC) and Group of Helping Hands (SAHAS) Nepal. In-district one-day agrobiodiversity fairs were organized in February and December month of 2019, altogether two times, and these agrobiodiversity fairs were used as a tool to explore plant genetic resources found in Bagmati and Mahankal Rural Municipalities of Lalitpur district. To collect these explored genetic resources during agrobiodiversity fairs, the joint field expedition, key informant survey, diversity rich farmers discussion was used as a collection tool. The present study explored, inventoried, collected and conserved 148 accessions of 44 crop species, the highest number (18 accessions) was of chayote followed by 10 accessions each of soybean, cowpea and maize and 9 accessions of common bean. Collections are generally new and unique. Many landraces, mostly from rice (13 landraces) were identified as extinct from the surveyed areas and few are under extinction mainly due to attraction of farmers to new high yielding varieties. The collected species with orthodox seeds were tested for germination ability and those that passed a minimum of 85% germination, were preserved in seedbank of NAGRC. NAGRC plans to characterize these accessions in the coming seasons depending upon the season of crop growing. The current expedition collected eight species for which mode of propagation is vegetative or those for which seed storage behavior falls under intermediate mode. NAGRC has been started expanding field genebank coverage using these accessions.

Keywords: Biodiversity fair, Collections, Landraces, Nepal, Plant Genetic Resources

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INTRODUCTION

Nepal has unique north-south gradient and eco-geographic diversity. Five distinct climates such as hot terai, mild hills, foothill, mild mountains and icy himalayas is available. It has been expected that this topographic and climatic variation has created favorable conditions to

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grow a huge number of plant genetic resources (PGR), placing the country in 49th position in the world for agro-biodiversity (Joshi et al., 2018; Joshi *et al.*, 2020). Further, flowering plant diversity in the country is huge, accounting for two percentage of the global record (Kindlmann, 2011). The country is believed to be centre of origin of many modern crops and part of the biodiversity hotspot of the world. Nepal is an origin place of many species of fruits (Gotame et al., 2020).

National Agriculture Genetic Resources Centre (NAGRC) has been accelerating exploration, collection, characterization and conservation work since its establishment in 2010. The centre has collected and conserved around 11928 accessions of more than 90 different crop species from 61 districts of Nepal (Genebank, 2019). In total, 125 accessions of crop wild relatives were collected from 30 districts. Major crops such as rice, maize, wheat, finger millet, barley, beans, etc occupy more than two-third of collection. Many local PGR, which might have useful genetic variations for biotic and abiotic stresses are not considered to be adequately conserved *ex-situ* in the genebank. This is limiting PGR's access to breeders and users. Scientists report the projected climate change impacts in South Asia including Nepal. Being a Himalayan country, the impact of climate change in Nepal is expected to be higher than the average for the entire globe. This could threaten the survival and distribution of plant biodiversity (Xu *et al.*, 2009; Tse-ring et al., 2010; Bhattacharjee et al., 2017). Hence, there is need of exploration of as much unique and endangered crops genetic resources, especially in virgin or previously unexplored areas of the remote hills and mountains.

Around 50% of agricultural genetic diversity has been lost already in Nepal (Joshi et al., 2020). This loss called genetic erosion could be attributed due to change in land use, preference of farmers towards new and improved seeds and many more other anthropogenic activities. Only four percentage of agricultural species have been conserved demanding further conservation works in the country. This situation has triggered conservationists for collection, conservation and sustainable use of diversity. For collection works, sensitization on the importance of PGR conservation for all levels is considered a key element (Joshi et al., 2020). Agro-biodiversity fair is one of the important tools to sensitize the community and stakeholders. National genebank is the sole organization leading collection and conservation of PGR for food and agriculture in the country, however, the past collection expeditions undermine the importance of role of a local non-government organization (NGO) for a collaborative expedition, inventorying and collection efforts. In this regard, the present study aims to develop effective collection and conservation using biodiversity fair and the government-NGO collaboration as a tool.

MATERIALS AND METHODS

Two agrobiodiversity fairs were organized jointly by Dalchoki Community Seed Bank and Group of Helping Hands (SAHAS) Nepal, a national NGO, in collaboration with NAGRC and Agriculture Knowledge Centre, Lalitpur on 16 February 2019 at Konjyosom-03, Dalchoki and on 28 December 2019 at Bagmati-07, Gimdi. Farmers from Konjyosom, Bagmati and Mahankal Rural Municipalities were invited to participate and display their local seeds and crops. For each agrobiodiversity fair, a minimum of 35 stalls and several individual farmers' products were displayed. There were displays from individual farmers as well as from their groups. More than 500 farmers participated together in both events. There were two days visits to each diversity fair where we observed richness in local crop

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biodiversity. Biodiversity rich farmers were identified using a direct query. All the information was used for better expedition planning.

In the first week of December 2019, we visited local diversity rich farmers as facilitated SAHAS Nepal local technicians in Bagamati and Mahankal Rural Municipalities of southern Lalitpur (Figure 1) which is located ~40 km south of Lalitpur Metropolitan City and is inhabited by diverse ethnic groups. Key informant survey (KIS), discussion with women groups, direct visit to field, farm store and public orchards were made. A total of 77 local diversity rich farmers were consulted using face to face interviews. Only local landraces with at least one different morphological character were collected. Among landraces, chayote fruit diversity was huge in the study area, therefore the phenotypic classes for qualitative traits for fruits of chayote was recorded to calculate Shannon-Weaver diversity index (H') following Shannon and Weaver (1979). During field collection, seeds with similar characteristics were bulked and provided with a single collection number. Conservation status of crop landraces (common, vulnerable (localized), endangered, rare and extinct) were identified based on population size and distribution at species and genotype level. Grouping technique, called five cell analysis of agrobiodiversity, is described in Figure 2, however, focus was given to identify extinct and rare at species or genotype level, in particular following Joshi and Gauchan, (2017) and Joshi (2018). The passport information was collected along with the seed. The passport data consists of geological information, local names and other taxonomical information, sowing and harvest times, unique characters, growing history, etc. of the collected materials. The geological information encompassed latitude, longitude and altitude were collected using Garmin eTrex GPS Technology. Collected seeds, after giving unique collection numbers, were managed at Seed Laboratory of NAGRC and tested for germination potentiality, condition provided that the sufficient seed amount is available. Seeds of each collection will be sent to long-term and mid-term storage with unique accession number upon passing the germination test. Accession with insufficient seeds was sent to short term storage lab for regeneration work which could be done during the coming favorable growing season. Vegetative seeds were sorted and sent to the field genebank unit. Collected species were grouped under different agrobiodiversity groups according to latest classification adopted by Nepal genebank and reported.

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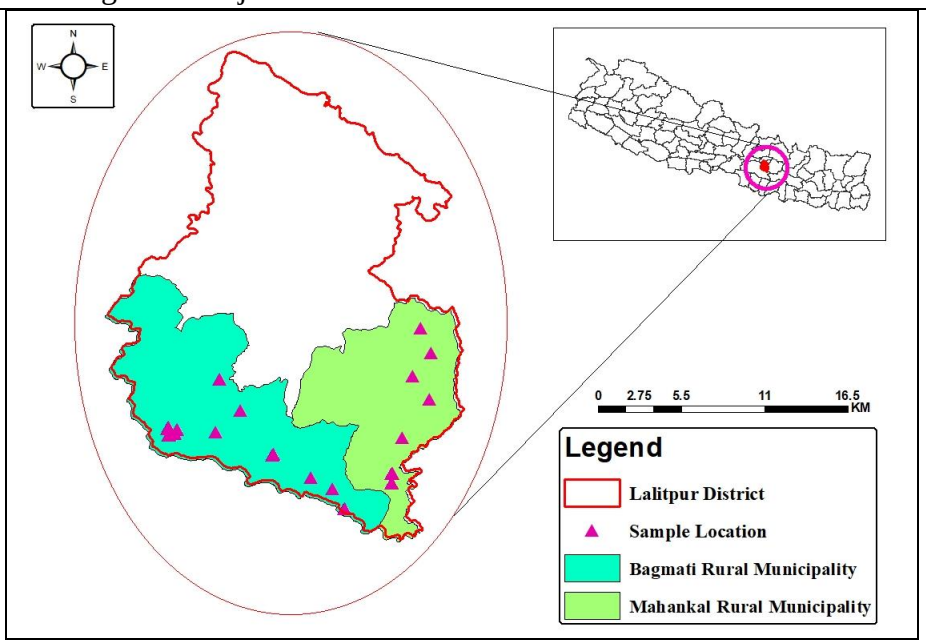

Figure 1: Showing survey sites, Bagmati and Mahankal Rural Municipality

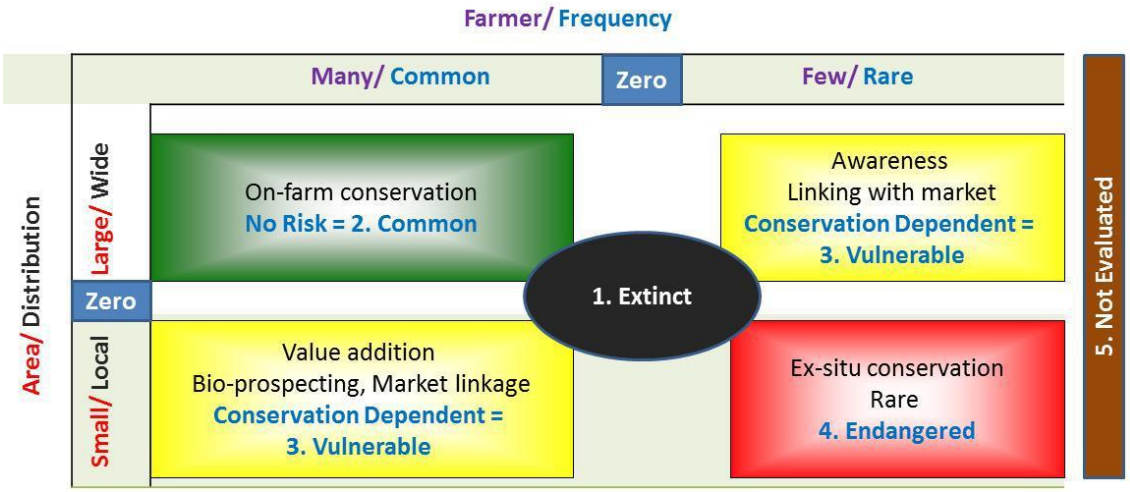

Figure 2: Five Cell analysis to identify threatened population of landraces based on their distribution and population size (Source: Joshi and Gauchan, 2017)

RESULTS AND DISCUSSION

Dual role of agrobiodiversity fair: community sensitization on value of local crop biodiversity and accelerating their conservation

Since the last few decades, agrobiodiversity fair has been used as a tool for encouraging in-situ and on-farm conservation of local landraces (Sthapit et al. 2006; Joshi and Ghimire, 2017). Agrobiodiversity fairs which were taken as reference for exploration and collection of local crop landraces for the present study, were organized under NGO-public collaboration. Before event/fair day, organizers agreed on the purpose of the event as agrobiodiversity conservation and utilization, set up scale and norms for the event and work division for

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managing spots, stalls and guests. Further, the organizer had prepared the data recording sheet/format, had oriented participants or local community groups before the day of agrobiodiversity fair. The fair started with the activities such as registration, stall setting and inauguration, observation of local crop diversity display/exhibition, interaction and knowledge sharing, stall evaluation, cultural events with singing folk songs, cultural dancing. In addition, social interaction, participatory seed exchange and intergroup competition and awarding the winners took place during the day. These activities were expected to sensitize or flow positive messages to the community and other stakeholders including political leaders on the value of promotion and utilization of local crop diversity. Further, local farmers and women farmers groups were motivated to share germplasm and traditional knowledge, learn, participate and get awarded. The participatory seed exchange (PSE) activity is likely to contribute to conservation of local landraces through utilization perspectives.

The display of local agrobiodiversity and discussion during the event day allowed researchers to explore unique crop and landraces, assess richness of local agrobiodiversity, locate diversity rich niches and custodians who have been maintained and promoted unique crops, landraces and associated traditional knowledge since ages. The list of unique landraces and potential farmers or groups of farmers to be communicated for further collection expedition were determined.

Collection and conservation of plant genetic resources

The expedition covered two Rural Municipalities of Lalitpur district where rice, maize, buckwheat, finger millet and beans are grown as the main crops. The altitude of the collection site ranged from 520 m (river basin) to 1600 m asl. Considering crops grown in the study area, the location is rich in agro-biodiversity where vegetables and pulses diversity was enormous. We collected 148 accessions which belong to 33 genera. From a total of 148 accessions, 18 accessions were of chayote. Other larger collection includes 10 accessions each of maize, soybean and cowpea, 9 accessions of french bean, 8 accessions of finger millet, 7 accessions of sponge gourd, 4 accessions of coriander, etc. All the collected accessions included only landraces. Most of the accessions were characterized by good taste, adaptive to local conditions and resistant to insect pests and diseases. Many species behind the eyes of researchers and policymakers, for example, lima bean, perilla, tamarillo, weedy tomato, etc were also collected (Table 1). Most of the collected species have orthodox type of seed (119 accessions). Eighty accessions passed minimum germination standard (85% germination), which were then conserved ex-situ in seedbank of NAGRC for long-term and medium-term storage. Along with these accessions, NAGRC plans to characterize those accessions with insufficient quantity of seeds and/or insufficient germination ability in the coming seasons depending upon the season of crop growing. Further, only few species (eight species) have vegetative modes of propagation or seed storage behavior falls under intermediate mode. NAGRC has been started expanding field genebank coverage using these accessions.

Chayote was an amazing crop in the study area of which shoot (leafy vegetables), fruit (curry) and tuber (curry as well as dessert after boiling) were equally valuable food sources for locals. Detail in-field characterization of chayote fruit was made and their descriptor states, frequency, proportions and Shannon-Weaver diversity indices (H') for each qualitative trait is calculated and depicted in Table 2. Huge morphological diversity of chayote fruits was observed, ranging from very small to big in size, smooth to spiny surface, and green,

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intermediate to white colour (Figure 3). All observed traits/variables were found to be polymorphic. The diversity index (H') ranged from 0.57 to 0.96, indicate medium to high diversity is present in the collection of Chayote fruit for the qualitative traits. Some variables represent consumer-preferred trait with a higher diversity index, which might include fruit size (0.87), fruit colour (0.96) and spine distribution (0.87) (Table 2) indicating their potential uses in the future selection program.

Farmers told us that the chayote cultivation area is increasing. They found to cultivate chayote with different agro-morphology together. Most of the farmers reported that the landrace with smaller fruit size is tastier than bigger sized. Preference for skin color was different among people. Many farmers believed that accessions with spiny fruits have better taste however there is a contrasting opinion too. Many people liked boiled *Jibro*, a juvenile endocarp of chayote fruit, because of unique taste. Those farmers cultivating chayote more than household need most often found to eat *Jibro* and rest fruit part used for animal feed.

Table 1. List of crop accessions collected during collaborative expedition 2019

SN	Crop	Scientific name	Local Name	Collection number (number of accessions in parenthesis)
	Cereals			
1.	Barley	*Hordeum vulgare* L.	Sthaniya Jau	C010768, C010769 [2]
2.	Common Buckwheat	*Fagopyrum esculentum* Moench.	Mithe Phapar, Kalo/Mithe Amale Phapar	C010713, C010750, C010767 [3]
3.	Maize	*Zea mays* L.	Sthaniya Makai, Dudhilo Makai, Murali Makai, Kholme Makai, Pahelo Makai, Seto Makai, Rato Makai	C010806, C010805, C010804 C010734, C010724, C010723, C010712, C010798, C010789, C010784 [10]
4.	Rice, paddy	*Oryza sativa* L.	Basmati Honcho Dhan, Basmati Aglo Dhan	C010751, C010765, C010764 [3]
5.	Wheat	*Triticum aestivum* L.	Sthaniya Ganhu	C010741 [1]
	Millets			
1.	Finger Millet	*Eluesine coracana* L. Gaertn.	Sthaniya Kodo, Nang Katuwa Kodo, Barmandi Kodo, Seto Kodo, Rato Dalle Kodo	C010809, C010756, C010755, C010722, C010799, C010793, C010785, C010783 [8]
2.	Sorghum	*Sorghum biclor* L.	Kongre	C010722 [1]
	Pulses			
1.	Common Bean	*Phaseolus vulgaris* L.	Kongre Simi, Chhirbire Simi, Kalo Simi, Kailo Simi, Seto Simi, Kaju Simi, Chhirke Putali Simi	C010700, C010701, C010702, C010703, C010722, C010729, C010735, C010757, C010797 [9]
2.	Black Gram	*Vigna mungo* L.	Kalo Mas	C010705, C010722, C010788 [3]
3.	Cowpea	*Vigna unguiculata* L.	Sthaniya Bodi, Seto Bodi, Gajale Bodi,	C010801, C010737, C010727, C010710,

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SN	Crop	Scientific name	Local Name	Collection number (number of accessions in parenthesis)
			Rato Ghyu Bodi, Kalo Bodi, Tane Bodi	C010709, C010796, C010790, C010761, C010763 [10]
4.	Horse Gram	*Dolichos biflorus* Roxb.	Sthaniya Gahat	C010726, C010791 [2]
5.	Kidney Bean	*Phaseolus vulgaris* L.	Chhirke Mirke Rajma, Himali Rajma	C010749, C010778 [2]
6.	Pea	*Pisum sativum* L.	Sthaniya Kerau, Pulami/Tangar Kerau	C010719, C010731, C010732 [2]
7.	Rice Bean	*Vigna umbellata* Thung. Ohwi & Ohashi	Masyang, Siltung	C010711, C010720, C010766 [3]
8.	Soybean	*Glycine max* L. Merr.	Mailo Bhatamas, Kalo Bhatamas, Thulo Bhatamas, Hariyo Bhatamas, Sano Bhatamas, Seto Bhatamas	C010808, C010706, C010740, C010733, C010730, C010726, C010742, C010795, C010792, C010771 [10]
9.	Field Pea	*Pisum sativum* L.	Sano Kerau	C010719 [1]
10.	Hycinth Bean	*Dolichos lablab* L.	Tate/Hiude Simi	C010813, C010802, C010739, C010736, C010730 [5]
11.	Lima Bean	*Phaseolus lunatus L.*	Bakhra Marne Daal Simi	C011074 [1]
	Oilseed Crops			
1.	Mustard, Rapeseed	*Brassica campestris* L. var. *toria* Duth & Full	Kalo Tori	C010744, C010746, C010886 [3]
2.	Perilla	*Perilla frutescens* L.	Lokal Silam, Seto Silam	C010704, C010800 [2]
3.	Sarson	*Brassica campestris* L. *var. sarson* Prain.	Sarnsyu	C010756 [1]
4.	Sesame	*Sesamum indicum* L.	Sthaniya Til	
5.	Sunflower	*Helianthus annuus* L.	Suryamukhi	C010714 [1]
	Sugar and Starch Crops			
1.	Sugarcane*	*Saccharum officinarum* L.	Sthaniya Ukhu	C0108380 [1]
	Vegetables			
1.	Brinjal	*Solanum melongena* L.	Tite Bhanta, Hariyo Bhanta, Lokal Bhanta	C010707, C010715, C010780 [3]
2.	Broad leaf mustard	*Brassica juncea var. rugosa*	Rato Rayo	C010773 [1]
3.	Chayote*	*Sechium edule* Jacq.	Thulo Skus, Thulo Jhuse Skus, Karela, Sthaniya Lamcho Skus, Lamcho Skus, Seto Skus, Hariyo Skus, Sano Skus, Chillo Skus	C010810, C010811, C010812, C010816, C010817, C010824, C010825, C010826, C010827, C010828, C010829, C010830, C010831, C010832, C010833, C010834, C010835, C010836

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SN	Crop	Scientific name	Local Name	Collection number (number of accessions in parenthesis)
				[18]
4.	Garden Cress	*Lepidium sativum* L.	Sthaniya Chamsur	C010708 [1]
5.	Cucumber	*Cucumus sativus* L.	Sthaniya Kankro	C010738 [1]
6.	Okra	*Abelmoschus esculentus* L. Moench.	Ramtoriya, Chille Bhindi, Lokal Bhindi	C010736, C010762 [2]
7.	Pumpkin	*Cucurbita moschata* Duchesne.	Kaddu, Jaante Farsi, Madale Farsi, Dalle Farsi	C010815, C010814, C010794, C010699, C010697, C010748 [6]
8.	Radish	*Raphaus sativus* L.	Choto, Chalisdine Mula	C010743 [1]
9.	Sponge Gourd	*Luffa aegyptiaca* Mill.	Chhoto Ghiraula, Hariyo Ghiraula, Seto Ghiraula	C010745, C010746, C010777, C010781, C010818, C011075, C011076 [7]
10.	Taro*	*Colocasia esculenta* L.	Kalo Dudhe Pindalu, Panchamukhe Pindalu, Dudhe Pindalu	C010821, C010822, C010823 [3]
11.	Tomato	*Lycopersicon lycopersicum* L. Karsten	Pahelo Lokal Tamatar	C010803, C011078 [2]
12.	Yam*	*Dioscorea alata* L.	Tarul, Gittha, Ghar Tarul, Hatti Tarul, Paile Tarul	C010774, C010775, C010787, C0108370) [4]
	Fruits			
1.	Pineapple*	*Ananas comosus* L. Merr.	Sthaniya Bhuikatahar	C010776 [1]
2.	Pumelo**	*Citrus maxima* Merr.	Bhogate	C011077 [1]
	Spices			
1.	Chilli pepper	*Capsicum frutescens L.*	Jire Khursani, Seto Jire Khursani	C010759, C010760, C010770 [3]
2.	Chilli pepper	*Capsicum annum* L	Tamang Khursani, Jyanmara Khursani, Thulo Khursani	C010716, C010717 [2]
3.	Coriander	*Coriandrum sativum* L.	Sthaniya Dhaniya	C010758, C010779, C010748, C010807 [4]
4.	Ginger*	*Zingiber officinalis*	Aduwa	C010820 [1]
5.	Tamarillo	*Solanum betaceum Cav.*	Metar	C010752 [1]
6.	Turmeric*	*Corcuma domestica* L.	Besar/Haledo	C010819 [1]

*vegetative mode of propagation or seed storage behavior **intermediate mode of seed storage behavior and rest without any symbol represents orthodox nature of seed storage behavior. Value in [] represents number of accessions of respective species presented in the given row.

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Table 2. Descriptor states, their frequency and proportion of phenotypic classes and Shannon-Weaver (H′) for chayote fruit qualitative variables

SN	Characters	Observed phenotypic class	Frequency	Proportion %	Shannon-Weaver diversity index (H')
1	Fruit Color	Green	6	33	0.96
		Intermediate	4	22	
		White to cream	8	44	
2	Fruit size	Small	2	11	0.87
		Medium	9	50	
		Large	7	39	
3	Fruit shape	Elongated	6	33	0.83
		Globular	1	6	
		Intermediate	5	28	
		Flat	6	33	
4	Spine distribution	Non	9	50	0.87
		Intermediate	7	39	
		Large and or entire	2	11	
5	Furrows	Non	1	6	0.66
		Shallow entire	4	22	
		Deep at apex and bottom	13	72	
6	Skin Texture	Rough	12	67	0.57
		Smooth	6	33	


Smooth white type


Round white type


Long white type


Green short type


Smooth green and fleshy type


Green long type


Fade-green and thin spiny type


Long rough and green type


Thin and thick spiny type

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Spiny intermediate type (bitter gourd type)

Strong spiny type

Sparse-spiny white type

Figure 3. Chayote diversity observed in southern Lalitpur. Local community assigned their name based on external morphology

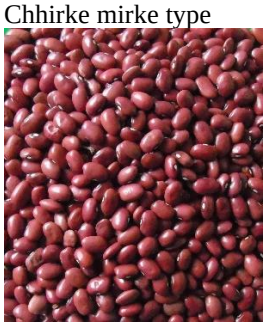
Pulses, in general, provide dense nutrition and constitute a major diet to local people. These crops are grown in the specific niche and therefore offer unique PGR. In surveyed areas, huge inter- and intra-specific diversity among pulses was observed. Among the pulse list, diversity of common bean (Figure 4) and cowpea was incredible. These species have dual-purpose, matured seed reported using as *daal* and unmatured green pod as curry. Farmers reported that few cowpea landraces such as *Gajale Bodi* are resistant to insect pests which might be due to hard-skinned pod. According to locals, *Kaleswori bean* (Figure 4) is tastier among other bean landraces. Horse gram is believed to reduce the size of the stone and push it from the gallbladder or kidney. Pulses are also linked to culture. For example, black seeded soybean is compulsory in ritual ceremony of the Tamang community, in particular. A huge number of common beans were collected during this survey seems to be similar to the previous collection from other places, however, the present collection consisted of wide seed coat color diversity within a small geographic boundary.

Chhirke mirke type

Dal type common bean

Blue chhirke type

Kaju type



Red seed coat type

Dull brown seed coat type, (Kaleswori simi)

White seed coat type

Mixture seed coat type (butterfly simi)

Figure 4. Major seed colour diversity among bean landraces observed in southern Lalitpur

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Taro diversity is found to be huge though only a few unique accessions were collected such as *Paanch Mukhe* (five mouthed), *Dudhe* (milky), among others. Farmers frequently reported that yam bearing a sufficient number of fruits (air potato or *gittha*), is not tastier but those yams bearing a smaller number of *gittha* are reported to have better taste. Very few farmers had yam, of which *gittha* part is used as curry after boiling. Farmers told us that this type of yam produces fruits of bigger size however such yam produces very small underground tubers. Further, farmers reported that biennial harvested yam is more delicious than a single year harvest.

A distinct group of chilli peppers was observed. *Jire Khursani* (small but strong), *Tamang Khursani* and *Akabare Khursani* were found to be popular. Akabare Khursani are believed to possess medicinal value especially for acidity problem despites its strong pungency. The taxonomic identification of these species is still confusing, however, the present study followed the discussion provided in Nemoto et al. (2017). One of the interesting spice crops, perilla is an important ingredient of pickle and oil source for many of the households however later case is reported by very few farmers. Farmers found to cultivate most of the spice crops using only small areas in the kitchen garden.

Along the route, two wild relatives of brinjal, namely *Solanum torvum* Sw. and *Solanum xanthocarpum* Schrad and Wendl., were also observed. The usefulness of these two wild species in not studied yet. Its usefulness to stress tolerance might be the future area of interest. These species should be collected during the coming ripening season.

Diversity loss

Five cell analysis for plant genetic resources identified some endangered and rare landraces. Few landraces, mostly from rice were identified as extinct and few are under extinction mainly due to preference of farmers to newer and high yielding varieties. Local rice varieties with good taste and other important traits such as *Lalbeti Dhan*, *Pokhreli Dhan*, *Dhulikheli Marshi*, *Ghouriya/Gaure Dhan*, *Kale Dhan*, *Gola Dhan*, *Chhote Marsi/Marshe*, *Jarneli Dhan*, *Bagane Dhan*, *Badure Dhan*, etc were extinct from the study area (Table 3) mainly because of low yield, lodging problems and introduction of high yielding varieties, for example, Makwanpur-1 rice variety. Few similar named local rice germplasm are being conserved in long-term storage in NAGRC which includes, for example *Dhulikheli Marshi*, *Pokhreli* etc. However, there is no collection of rice landraces from the study area. *Anadi Dhan*, a very special sticky rice having religious value is near to extinct from the place.

Table 3. List of local rice varieties that are undergone extinct from the southern Lalitpur

SN	Name of landrace	Characters
1.	Lalbeti	Yellow grain, good yield,
2.	Pokhreli	Local taste
3.	Dhulikheli Marshi	Delicious taste on cooking, good for bitten rice purpose, grain sterility problem, lodging problem, bad swelling quality on cooking
4.	Gauriya/Gaurya	Tall but lodging tolerance, good cooking quality especially rice elongation while cooking (good increase in volume), lower-yielding
5.	Gerneli	Tall, local taste
6.	Gola	Tall, suitable for bitten rice
7.	Kale	Nutritious, religious use
8.	Chhote Marshi/Marshe	Suitable for bitten rice
9.	Thade	Tall, prone to lodging
10.	Ghiu Kumari	Aromatic

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11.	Jira Sari	Smaller grain,
12.	Siurame	Eating quality for poor, suitable to local rice milling, wetting resistance, delicious,
13.	Bagane	Local taste
14.	Badure	Local taste

Source: Key informants, FGD and personal interview

A locally called six-month cauliflower (cauliflower curd used to mature in six months with unique taste and hardy type), called *Garve Cauli* has already been lost from the studied area. Key informants reported that this landrace of cauliflower is of perennial type and can also be grown vegetatively (without seed but using branch/bud directly). This might be because of a suitable altitude available in some places of surveyed villages. Further, many local broadleaf mustards were already extinct from the study area, maybe old varieties were replaced by new natural crosses. Southern Lalitpur is a hub of many local landraces of leaf mustard. Two local varieties of leaf mustard (*Guzmuzze* and *Dunde Rayo*) originated from that place are registered in National Seed Board with the mutual efforts from Dalchoki community seed bank, SAHAS Nepal and NAGRC back in 2014. Mustard with red peduncle (good as a rainy season *mustard saag* and can be grown during the rainy season) is under threat.

As a highly cross-pollinated crop, many old varieties of maize are being replaced by new crosses. The area under maize with red cob is decreasing and therefore under threat. Causes of threat frequently reported by farmers include invasion of wild animals, for example, porcupine, the introduction of hybrid varieties etc. Maybe new natural crosses of maize have a role to replace old varieties. Another grain crop, sorghum area is decreasing leading near to extinction due to its low productivity and insect pest problems. The buckwheat area is reported decreasing because of increasing threat of wild animals in the study area.

A cowpea landrace i.e *Ghiu Bodi*, generally cultivate along with maize, is under threat because of preference of animals towards this crop and people left to grow. Many local bean landraces are no more in cultivation. Rice bean with yellow seed coat color is already lost from this area because of insect pest problems. Pigeon pea, a famous pulse crop of few years back is now lost from the surveyed area because of insect pest problems. The cultivation area of linseed, millet, horse gram and white adzuki bean is also decreasing.

The next step for collection and conservation

Many species were identified as unique landraces however were not collected during the present expedition as they were either at standing crop in a field or adequate amount of seed was not available. Such species or varieties of species includes grass pea (*Lathyrus sativus* L.), lentil (*Lens culinaris* Medik.), sword bean (*Cannavalia ensiformis* L.), garlic (*Allium sativa* L.), fennel (*Foeniculum vulgare* L.), snake gourd (*Trichosanthes cucumerina* L.), linseed (*Linum usitatissimum* L.), mustard (*Brassica campestris* var. *juncea*) variety *Majhkhande Rayo*, rice (*Oryza sativa* L.) variety *Bagane Dhan* etc. These species should be collected during the next expedition. Interestingly, the study area is rich in lablab bean (*Dolichos lablab* L.) diversity (Figure 5), As most of the farmers' grown varieties did not reach the maturity stage during the survey, therefore it was not possible to collect their seeds. Due to its huge diversity, collection mission targeting lablab bean should be prioritized in the future. Interestingly, we also observed one unique landrace of forage shrub plant, locally called *Hattipaile Ghas* or chuletro (*Brassaiopsis hainla* Buch.), a big leaved forage plant popular in Mahankal Rural Municipality, which can be feed cattle after removing small spine

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from the branch stem. Seeds and propagation materials of this fodder should be collected for conservation purposes.

Figure 5. Lablab bean diversity observed in southern Lalitpur.

CONCLUSION

The current study enriched Nepal genebank with new 148 accessions. Few collected accessions yet to multiply and conserve for long-term while few others are yet to collect from the study area. We propose at least four short expedition covering main harvesting seasons for collecting seeds of all-season crops considering many local landraces are under threat due to the introduction of modern cultivars. Alarming loss of landraces prompting an urgent need for collection and conservation as many species and accessions as possible, not only in the study area but also in other agrobiodiversity-rich areas. As in present study, the threatened population of landraces should be identified using Five Cell analysis and these population should be prioritized during collection. Seeds should be multiplied in sufficient quantity and

should be distributed upon request for research and utilization. Characterization, evaluation and conservation of local landraces should be given priority.

We found collaborative exploration and collection of unique native landraces as assisted by agrobiodiversity fair as an important tool to collect a huge number of genetic resources in a short time with spending minimal resources. A similar kind of collaborative collection by like-minded actors is very much needed to promote conservation of agrobiodiversity in other regions of the country too.

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Authors' Contributions

Ram P Mainali, Ajaya Karkee, Dipesh Neupane, Bal K Joshi designed the working procedures. Ram P Mainali, Ajaya Karkee, Dipesh Neupane, Krishna H Ghimire, Krishna K Mishra visited fields and collected data. Ram P Mainali and Padma Pokhrel analyzed the data and wrote the initial draft. Krishna H Ghimire, Bal K Joshi, Pradeep Thapa provided critical feedback and finalized the draft. All authors read, revised and accepted the manuscript for journal publication.

Conflicts of Interest

The authors declare that there is no conflict of interest among authors for manuscript publication

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