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Collection and Characterization of Trait Specific Multi-crop Germplasm from Sikkim

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ABSTRACT

Considering the importance of agro-biodiversity of Sikkim, an exploration and collection tour was conducted for collection of maize, rice, buckwheat and *Vigna spp* germplasm from East, West and South districts of Sikkim. The altitude of explored area ranged between 612 to above 2900 msl. The local landraces and primitive crop germplasm were collected. It has been observed that the inhabitants practiced main agricultural in their permanent traditional fields followed by *Jhum* (Shifting) cultivation. The tribal and other farming communities in explored area are still using their traditional agriculture methods along with modern techniques. The local farmers have been growing their traditional landraces/cultivars since time immemorial either by saving their own seeds or by arranging seeds through barter or exchange system. Under this trip, 121 germplasm acces. of *Zea mays*, *Oryza sativa*, *Fagopyrum esculentum*, *F. tataricum*, *Vigna umbellata*, *V. mungo*, *V. radiate, V. angularis* and *V. unguiculata* were collected. Additionally, local indigenous traditional information practiced by the farmers was also recorded. Collected germplasm were characterized at experimental farm of ICAR-NBPGR Regional Station, Umiam, Meghalaya. Extents of diversity within the collected crop germplasm have been summarized in this study.

1. Introduction

Agriculture is the main economic activity in the entire region of North-eastern India, and despite major impact of green revolution in the irrigated areas of the country, modernization of agriculture has escaped this region as evidenced by poor adoption of modern technologies, low consumption of fertilizers and other indicators of growth (Anonymous, 2001). Sikkim is part of the Eastern Himalayan agro-biodiversity region; it is one of 22 agro-biodiversity hotspots in India, and a part of globally significant biodiversity hotspots in the region (Sharma *et al.,* 2016). Sikkim lies in between 27°04'46'' and 28°07'48'' North latitude and 88°00'58'' and 88°55'25'' East longitude on the Southern slope of the Eastern Himalayas with an area of 7096 Km^2 in the north east zone.

This state, a constituent state of North-eastern Region of India has a diversified ecosystem as evident by five different climatic zones and six different forest types within a small geographical area of 7,096 km² from an altitude of 280 to 8585 msl. With such varied altitudes, the state observes tropical, temperate and frigid climate in different regions. Agriculture is the main source of livelihood for more than 75% of the population of Sikkim and contributes around 17% of the gross state domestic product (Kumar 2012). About 69 crop species of food, vegetable, fruit, ornamental and commercial importance are cultivated, out of that nearly 178 cultivars or landraces are still available and cultivated between 300 to 2000 msl altitude in Sikkim (Rahman and Karuppaiyan 2011). It is very rich in agro-biodiversity due to its diverse location which is bordering with Bhutan and China in east, Bengal in South, Nepal and Tibet in West, and due to the diverse climate a large number of crops such as maize, rice, buckwheat, ginger, French bean, green gram, black gram, rice bean, cardamom and some horticultural crops were grown.

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Biodiversity conservation is essential for maintaining ecological balance among different living forms of the planet and for self-sustaining growth in crop production processes. Plant genetic resources (PGR) comprise one of the most crucial components of agro biodiversity, which sustains humankind by meeting its demands of food and fodder *etc*. In addition to ensuring food security, protecting environment and reviving lost resources, the heightened PGR related activities are also fuelling the development of new research breakthroughs. Keeping the importance of PGR, a germplasm exploration and collection programme was carried out under special mission for the collection of crop germplasm in three districts: East, West and South of Sikkim, North-eastern Region.The tribal and other farming communities in the targeted districts are well known to their traditional farming. The farmers have been growing traditional landraces/cultivars since long aged time either by saving their own seeds or by arranging seeds through barter or exchange system. The cardamom cultivation is the main source of income to the farmers in West and East districts while in South district the upland rice, maize, pulse: grain legumes such as rice bean, black gram, green gram, cowpea, french bean are in cultivation. The farmers have also practiced to grown vegetable crops like potato, pea, cabbage and carrot in high altitude areas.

2. Materials and Methods

During this exploration, the local farmers were enquired primarily about targeted native crop landraces and for area of diversity. Based on the information, fine grid survey was conducted in East, West and South districts of Sikkim for collection of targeted crop landraces. The explored area falls under the mid to high altitude with ranging from 612 to 2900 msl. During this exploration trip a total of 2500 Km road distance was covered. Fresh seed stocks for each cultivar were collected from fields, threshing yards and farmer's store. Along with this, farmer's opinions about peculiarities and shortcomings of the cultivars were also recorded. The study area is inhabitant by different tribal groups like *Nepali, Bhutia, Sherpa, Lepcha, Rai, Gurung, Limboo, and Tamang*. The native crop landraces/cultivars of the state have been in cultivation since time immemorial. These landraces had supported the food needs over a long period of time, to fulfil the food needs of people of Sikkim (Subba, 2002).

Standard practice and procedures developed by ICAR-NBPGR, New Delhi were followed for collection of germplasm (Pareek *et al.,* 2000). The collection of germplasm was concentrated in the area where the possibilities of maximum diversities were available; depending upon the local information based on village Headman and local farmers. The remote, identified gaps and unexplored sites were the priority for the collection. Random sampling, selective and bulk sampling methods were followed for collection of crop germplasm and sampling was done mainly from farmer's field, thrashing yard and household stores. Passport data on each accession was recorded during the collection, following the standard procedure. Amongst the collected accessions (acces), rice, maize, buckwheat and rice bean were initially multiplied at experimental farm of ICAR-NBPGR Regional Station, Umiam, Meghalaya in the year 2012-13. All the multiplied seeds were sown two consecutive years *i.e.* 2013-14 and 2014-15 for characterization for agro-morphological traits. These two years mean data were used for further statistical analysis. The indigenous traditional information on conserving different crops seed and other agricultural practice by the inhabitants were also recorded.

3. Results and Discussion

In this exploration and collection tour a total of 121 germplasm samples of diverse crop landraces of maize, rice, buckwheat, black gram, green gram, adzuki bean and cowpea were collected from 54 different sites with complete passport information (Table 1). During this survey and exploration of germplasm it was observed that mixed cropping system is very popular in East and West districts, and the farmers prefer to grow maize, black gram, green gram, french bean, lowland and upland/hilly rice. The diverse material collected from different agro-ecological zones is the result of traditional crop improvement. Based on the indigenous knowledge of farmers and the data collected showed that the altitude plays an important role in variation (Subba *et al*., 2001). Farmers of the hilly region are traditionally dependent on their skill and natural resources to grow the crops what they need (Rai, 1995) and to continue to grow the local landraces due to its adaptability in their environment, availability of seed, low input requirements, quality, taste and tolerance/resistance to different biotic/abiotic stresses. The majority of farmers still rely on indigenous landraces which are the result of farmer's selection over the last several decades. It has been observed that rice is the major food crop but maize and buckwheat also have the place in their food habits and the people used in different ways as to make *Chapaties* and other traditional food preparations. In higher altitude pockets tribal people kept boiled dry cobs on their *Chulahs/Angithies*, and used to eat with dry and roasted meat and also prepare a local wine called *Chhang* from maize and buckwheat. A wide range of variability in rice, maize, buckwheat and rice bean was observed in collected germplasm for various traits (Table 2) which are as under.

Table 1. Germplasm collected from East, West and South Districts of Sikkim

S. No.	Crops Name	East Dist.	West Dist.	South Dist.	Total acc. collected	Name of collected landraces
1	*Zea mays*	11	25	9	45	*Pahelimakai, Setimakai, Rathimakai, Muralimakai, Gadbade, Kuchungtakmr Makai, Kuchungdarimakai Banchareymakai*
2	*Oryza sativa*	5	9	3	17	*Bhangeri, Charakidhan, Chompay, Jamati, KaloDhan, Karkidhan, Khimtidhan, Krishna Bhog, Mashina, Nunia, Phudungay, Tulsi, Attay, Tholoattay*
3	*Fagopyrum esculentum*	3	9	4	16	*Meethaphaper*
4	*Fagopyrum tataricum*	2	4	-	6	*Teetaphaper*
5	*Vigna umbellata*	5	11	5	21	*Maysam*
6	*Vigna mungo*	3	4	-	7	*Kalo Dal*
7	*Vigna radiata*	-	6	1	7	*Payali Dal*
8	*Vigna angularis*	-	1	-	1	*Ratomusam*
9	*Vigna unguiculata*	-	1	-	1	*Swaitmusam*
Total		**29**	**71**	**22**	**121**	

Rice (*Oryza sativa*)

The crop grows from valleys to higher places as irrigated and rain-fed conditions from an altitude of 612m at Budang (West Sikkim) and highest 1620m at Tintek (East Sikkim). A total 17 diverse landraces of rice were collected from this trip and maximum diversity collected from West Sikkim district, which shows that major diversity existed in this district. Diversity was observed for husk colour, kernel colour, grain size, grain shape, grain fineness and numbers of tillers. The collected landraces are *Bhangeri, Charaki, Chompay, Jamati, Kalodhan, Karkidhan, Khimtidhan, Mehkodhan, Krishnabhog, Mashna, Nuniadhan* (grain black, scented and awaned), *Phudungay, Tulsi, Moto Attey, Attey* and *TholoAttey.* The characterized data showedthat number of tillers per plant showed wide variation among the germplasm; it was maximum (21.0) with RSR/SKS-12 and minimum (2.3) for RSR/SKS-95. The mean panicle length was observed 21.0 cm having CV of 13.7%. Days to maturity minimum was recorded 89 days with RSR/SKS-18 and RSR/SKS-100 while maximum 115 days for RSR/SKS-42. The highest 100-seed weight of 2.2 g was recorded for RSR/SKS-103 and RSR/SKS-58 followed by 2.1 g for RSR/SKS-9 and RSR/SKS-95. The CV for 100-seed weight was observed 17.0% with mean value 1.8 g. Early maturity was recorded with RSR/SKS-18, RSR/SKS-42 and RSR/SKS-109 (126 days) and late maturity with RSR/SKS-95 (160 days) with mean value 140.5 days and CV of 8.3%. Highest grain yield/plant was recorded for RSR/SKS-58 (15.2 g) followed by RSR/SKS-103 (11.3 g). Good variation was observed in husk colour; golden (33 acces.), brown furrows on straw (18 acces.), golden brown (12 acces.), brown (08 acces.) and straw colour (17 acces.).

The landrace *Attey* cultivated by the framers of West Sikkim at all elevations and found resistant to many diseases (Sharma *et al*., 2015).

Maize (*Zea mays*)

Large extent of diversity was observed and collected in maize (45 acces.), from three diverse districts *viz.* East Sikkim (11), West Sikkim (25) and South Sikkim (9). The collection trend shows that major diversity existed in West Sikkim district followed by East Sikkim district. The impressive landraces diversity are *Muralimakai*, *Kali makai* (with dark purpilish-black colour), *Rathimakai* (dark red kernel), *Pahenlimakai* (with yellow/ orange flint kernel type), *Setimakai* (with white kernel), *Payalimakai, Chaptymakai* (white dented type kernel), *Gadbade* (predominantly white and some purple flint kernel), *Banchareymakai* (high altitude maize with yellow, flint kernel), *Kuchungdari*makai (orange coloured popcorn type kernel) and *Kuchungtakmrmakai* (mixed yellow, white, purple and red kernel) were collected. The collected germplasm was characterized for 13 qualitative and 13 quantitative traits. In quantitative characters, maximum days to tasseling and silking were recorded 85 and 86 days for RSR/SKS-67 and minimum 62 and 65 days for RSR/SKS-75, respectively. Maximum plant height (322 cm) recorded for acces. RSR/SKS-120 and minimum (144 cm) for RSR/SKS-38. Maximum ear width (5.5 cm) for RSR/SKS-38 followed by 5.4 cm in RSR/SKS-75 and minimum (4.1 cm) for RSR/SKS-61 with a mean value 4.6 cm and CV 7.5%. Maximum ear length (32.8 cm) recorded for acces. RSR/SKS-78 and minimum (21.6 cm) for RSR/SKS-2 with a mean 27.31 cm and CV of 8.3%.

Table 2. Variability of quantitative characters observed in collected germplasm

Crop	Characters	Accessions			Best check value
		Range	Mean	CV (%)	
Rice	Leaf length (cm)	20.8 - 32.4	27.3	14.0	Sarsha (41.9)
	Leaf width (cm)	1.1 - 2.2	1.6	22.0	Sarsha (2.2)
	Days to 50% flowering	89.0 - 115.0	105.8	9.2	Noba (104.3)
	No. of tillers /plant	2.3 - 21.0	8.0	52.2	Naba (11.9)
	Plant height (cm)	79.7 - 139.7	116.6	14.9	Sarsha (140.8)
	Panicle length (cm)	15.3 - 24.3	21.0	13.7	Sarsha (25.9)
	Five panicle weight (g)	2.4 - 10.8	6.5	31.9	Sarsha (19.1)
	Days to maturity	126 - 160	140.5	8.3	Noba (132.8)
	100 seed weight (g)	1.1 - 2.2	1.8	17.0	Sarsha (2.6)
	Yield/plant (g)	1.3 - 15.2	6.1	65.0	Kalingan (12.2); Sarsha (12.0)
Maize	Days to taseling	62.0 - 85.0	71.9	8.8	RCM1-1 (62.5)
	Days to silking	65.0 - 86.0	73.7	7.6	RCM1-1 (65.0)
	Plant height (cm)	144.0 - 322.0	235.1	17.8	Local Red (241.0)
	Ear length (cm)	21.6 - 32.8	27.3	8.27	Delhi check (27.9)
	Ear width (cm)	4.1 - 5.5	106.3	26.2	Delhi check (4.9); Local red (4.9)
	Ear height (cm)	54.0 -171.0	106.3	26.2	Local red (114.3)
	Days to 80% maturity	114.0 -134.0	122.0	4.1	RCM1-1 (114.0)
	No. kernel rows	8.7 - 16.7	11.0	14.3	RCM1-1 (12.6); Local yellow (14.6)
	No. kernal/rows	16.8 - 35.4	25.8	15.5	Local yellow (27.8)
	Cob length (cm)	12.0 - 19.1	14.9	12.2	Local red (15.3); Local white (15.3)
	Cob width (cm)	2.5 - 4.6	3.7	12.0	Delhi check (3.9)
	100 seed wt (g)	14.3 - 40.5	28.0	21.5	Local red (33.6)
	Yield/plant (g)	28.0 - 170.0	79.7	29.7	Local white (108.3)
Rice bean	Days to 50% flowering	54.0 - 88.0	67.1	12.4	PRR1 (49.9)
	Plant height (cm)	71.6 - 145.2	116.3	17.6	PRR2 (102.7)
	Branches/plant	3.2 - 8.2	5.6	26.2	RBL6 (4.5)
	No. of pods/plant	54.2 - 199.2	151.8	27.3	RBL6 (111.7)
	Pod length (cm)	2.9 - 13.5	10.6	20.7	PRR1 (9.6); RBL6 (9.6)
	Days to 80% maturity	105.0 - 156.0	122.4	10.2	RBL1 (115.6)
	100 seed wt (g)	6.9 - 25.5	12.8	45.4	PRR1 (7.4)
	Yield/plot (g)	50.0 - 773.0	342.9	56.5	RBL1 (428.1)
Buckwheat	Days to 50% flowering	28.0 - 40.0	32.3	10.0	Reshuwat (29)
	Leaf length (cm)	4.7 - 8.0	6.4	15.4	Kulugangri (6.8)
	Leaf width (cm)	4.1 - 6.4	5.3	11.5	Kulugangri (6.0); Reshuwat (6.0)
	No. of internodes/plant	3.2 - 9.0	5.2	33.2	Shimla B1 (9.2)
	No. of primary branches/plant	2.8 - 13.2	6.6	45.4	Shimla B1 (10.8)
	Plant height (cm)	34.9 - 73.6	58.5	24.4	Shimla B1 (71.1)
	Days to 80% maturity	74.0 - 99.0	84.8	9.4	Reshuwat (78)
	100 seed weight (g)	1.1 - 2.9	2.3	23.9	Reshuwat (2.9); Phesru (2.9)
	Yield/plant (g)	0.5 - 10.8	3.3	66.1	Shimla B1 (4.7)

Ear height showed large variation which is indicated by CV% *i.e.* 26.2, maximum ear height for acces. RSR/SKS-67 (171 cm) and minimum RSR/SKS-38 (54 cm) were observed. The maximum cob length was 19.1 cm for the acces. RSR/SKS-104 and minimum 12.0 cm in RSR/SKS-5 with CV of 12.2%. The maximum cob diameter observed 4.6 cm was for RSR/SKS-38 followed by 4.5 cm for RSR/SKS-75 and the minimum 2.5 cm for RSR/SKS-56. The maximum number of kernel rows *i.e.* 16.8 for RSR/SKS-76 followed by 16.2 RSR/SKS-38 and minimum 8.7 for RSR/SKS-5. The CV was 14.3% with a mean value 11 for number of kernel rows. The maximum number of kernel/ rows (35.4) was seen in RSR/SKS-76 while minimum (16.8) in the acces. RSR/SKS-39 was recorded. The maximum 100-seed weight (170 g) was recorded for RSR/SKS-89 and minimum (28.0 g) RSR/SKS-20 with a CV of 29.6%.

A wide range of variability was observed for qualitative characters. Early plant vigor observed very good in 21 and good in 24 acces. Leaf colour green (24 acces.), light green (9 acces.) and dark green (12 acces.) were observed. Leaf width observed as narrow in 4, medium in 25 and bold in 16 acces. Leaf texture was observed normal in 3, smooth in 16 and lathery in 26 acces. Kernel colours observed orange (12 acces.), white (10 acces.), yellow (11 acces.), light yellow (04 acces.), purple (01 acces.), red (02 acces.), brown (03 acces.), variegated (01 acces.) and white cap (01 accession). Kernel row arrangement was recorded regular for all the acces. The grain texture was observed as round (28 acces.), flat (05 acces.), beaked (08 acces.) and dented (04 acces.). The grain shape was recorded as rounded (16 acces.), dented (01 acces.), flat (02 acces.) and pointed (26 acces.). The grain size was recorded as bold (22 acces.), medium (19 acces.) and small (04 acces.). Each collected accession showed distinct variations among the collected genotypes based on the above morphological features (Figure.1). The maize landrace *Muralimakai* (a popcorn type) with highly prolific in cob bearing (2-5/plants) and with immense breeding value was collected from Martam, Bermoik of West Sikkim. It was also observed the indigenous landraces give better yield as high yielding varieties and found resistant to many diseases and pest the similar findings reported by Sharma *et al*. 2015.

Buckwheat (*Fagopyrum*spp.)

The known buckwheat landraces are *mitheyphapar* (*Fagopyrum esculentum*) and *titeyphaper* (*F. tataricum) in* Sikkim. In this crop 22 germplasm samples of *mitheyphapar*(16 acces.) and *titephaper*(6 acces.) were collected.

The maximum diversity (13 acces.) were collected from West Sikkim district followed by (5 acces.) from East Sikkim district. This proves that rich diversity of buckwheat is existed in West Sikkim district and due to the suitable climate for buckwheat; farmers are growing two crops in one year. It is grown in two seasons *viz.* September to December and second crop period is from December to March. The observations on 16 quantitative and qualitative traits were recorded. Minimum days to 50% flowering recorded in RSR/SKS-71 (28 days) with a mean value of 32.3 days and CV of 10%. Leaf length maximum recorded was 8 cm for RSR/SKS-81 and minimum 4.7 cm for RSR/SKS-105. The leaf width maximum was 6.4 cm for RSR/SKS-81 and minimum 4.1 cm for RSR/SKS-68. Number of internodes maximum was 9 for RSR/SKS-7 followed by 8.8 for RSR/SKS-14 and minimum 3.2 for RSR/SKS-23 with CV of 33.2%. Maximum number of primary branches recorded were13.2 for RSR/SKS-14 and minimum 2.8 for RSR/SKS-23 with 45.4 CV%. Highest plant height was 73.6 cm recorded for RSR/SKS-106 followed by 73.5 cm for RSR/SKS-97 while shortest plant 34.9 cm observed in RSR/SKS-105. The CV of plant height recorded 24.4% with a mean value 58.54 cm. RSR/SKS-23 and RSR/SKS-26 taken 74 days to maturity and recorded early maturing acces. Accession RSR/SKS-97 recorded maximum 2.92 g of 100-seed weight and minimum 1.15 g for RSR/SKS-7 with a CV 23.9%. Yield/plant recorded 10.76 g for RSR/SKS-97 with a CV value of 66.1%.

In qualitative traits, early plant vigor observed good in 16 acces, poor in 04 acces. and very good in 06 acces. Flower colour observed green in 05 acces, pink in 06 acces. and white in 11 acces. Leaf colour was green in 20 acces. and dark green in 02 acces.. Leaf margin colour was red in 12 acces. and green in 10 acces.. Leaf blade shape was hastate in 05 acces. andsagittate in 17 acces. Seed colour observed black (15 acces.) and brown (07 acces.). Seed shape recorded as triangular (07 acces.) and conoidal (15 acces.).

Rice bean (*Vigna umbellata*)

The known centre of origin of rice bean is in Indo-China. It is thought to be derived from wild form, *i.e. V. umbellata* var. *gracilis*, distributed from Southern China through the North Vietnam, Laos, Thailand in to Mayanmar and India. Rice bean is called with different local names like *Masyam, Moto musam* and *Pangrimasam*, it is the major pulse crop grown and consumed in the surveyed area of Sikkim. Diverse germplasm samples were collected (22 acces.) and diversity observed in seed size (medium, bold and very bold), pod size (up to 18cm), seed colour (brown/ brownish-cream / brownish-grey and mottled, chocolate-brown cream, dark brown, grayish, dark red / light yellow).

Data were recorded on 16 quantitative and qualitative traits and observed that early 50% flowering in 54 days for accession RSR/SKS-25 followed by 58 days for RSR/SKS-94. Maximum plant height of 145.2 cm recorded for RSR/SKS-3 followed by 142.6 cm for RSR/SKS-53 and minimum of 71.6 cm for RSR/SKS-25. Number of branches/plant found 8.2 for RSR/SKS-101 and minimum of 3.2 for RSR/SKS-13 with CV value of 26.2%. Maximum number of pods/plant calculated 199.2 for RSR/SKS-117 followed by 198.6 for RSR/SKS-83 with CV of 27.3%. Largest pod length recorded 13.5 cm for RSR/SKS-117 and minimum 2.9 cm for RSR/SKS-77 with CV of 20.7%. 100-seed weight recorded 25.5 g for RSR/SKS-117 followed by 24.1 for RSR/SKS-101 with CV of 45.4%. Early maturing accessions was RSR/SKS-50 (105 days) followed by RSR/SKS-47 (106 days), RSR/SKS-53 (108 days) and RSR/SKS-108 (108 days). In qualitative traits, early plant vigor recorded poor (03 acces.), good (04 acces.) and very good (12 acces.). All the studied accession showed indeterminate type plant habit, yellow flower colour, brown pod colour and cylindrical seed shape.

In this exploration trip less diversity was observed in other pulses *i.e.* black gram (*Kalo dal*), green gram (*Payali dal, Seti dal*) for traits like seed shape, size and colour (Figure2). However, interestingly these are the major pulse crop and cultivated in a large area. Another pulse adzuki bean grown in south and west districts of Sikkim but now it is almost disappear. Only one accession was collected with small and dark red seeds which is different with ordinary one. It is grown as mixed crop with maize, rice and sometimes with other pulse crops also. The black gram and green gram grown as mixed crop with maize and rice but in some pockets of south district these pulses grown as a sole crop during *Kharif* season. It is observed that rice bean, black gram and green gram grown on rice field bunds in all the three districts.

Conclusion

On the basis of collected and characterized germplasm data it may be concluded that substantial plant diversity exists in Sikkim in agri-horticultural crops. The morphological and physiological diversity includes variation in plant type, reactions to pests and adaptability. Selection of crops/plants in the states is a social phenomenon, a relationship between the society and the available plants diversity is obvious and this social phenomenon depends on customs and rituals. It was also observed that women are playing a very key and important role in the sustenance of agricultural activities and maintain the folk varieties in study areas. The local crop landraces, which are the main source of livelihood, needs to be improved in the benefit of farmers. The indigenous traditional knowledge on local crop landraces is commendable among the local people. However, immense deforestation and the loss of species in the region is a matter of great concern. It is due to urbanization, industrialization, change in climate and introduction of improved varieties, resulted in an erosion of traditional values, traditional conservation and the biodiversity. For effective plant genetic resources management, there is urgent need for collaborative approach among the government and other local agencies. Diversity mapping should be done on priority for effective management, conservation and use of crop species and their relatives. There is a need to develop/ identify new genotypes on prevalent crops and cropping system, the ethnic group and economic background of indigenous communities. Efforts needed for strengthening of *on-farm in-situ* conservation in Sikkim for safeguarding of traditional varieties/ germplasm.

Figure 1. Variability in Maize

Figure 2. Variability in *Vigna spp.*

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