

Diversity Analysis and Physico-Morphological Characteristics of Indigenous Germplasm of Lablab Bean

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ABSTRACT

Germplasm characterization is an important component of crop breeding program. In characterizing indigenous beans lablab which is used for vegetables as well pulses in Nepal. Twenty three lablab beans germplasm were evaluated for different qualitative and quantitative physico-morphological characteristics for two years during 2011 and 2012 at Horticulture Research Station Malepatan, Pokhara. The germplasm showed considerable variations in most of the qualitative and quantitative traits. Leaf size, vine color, flower color, pod color, pod shape, pod type and seed color varied among the genotypes. Variation was also observed in yield attributing characters eg, pod length and width, 10 fresh pod weight, seeds per pod and 100-seed weight. Days to 50% flowering ranged from 81 to 130 days indicating the presence of early varieties. Fresh pod weight of 10 pods was ranged from 45.0g to 162.5g. Multivariate analysis indicated four groups in these genotypes, among with ML-02 and ML-10 were distinct in comparison with other genotypes. Simple selection may be considered to develop high yielding, early type varieties from these genotypes.

Key words: Lablab bean, qualitative, quantitative, variation

सारांश

सन २०११ र २०१२ मा हिँउदे सिमीका २३ वटा जर्मप्लाज्महरूलाई तिनको संरचनागत गुणात्मक र मात्रात्मक भिन्नता छुट्टाउने मूल्यांकनका परिणामहरू संचालन गरिएको थियो। पातको आकार, लहराको (डाँठो) रङ्ग, फूलको रङ्ग, कोसाको रङ्ग, कोसाको आकार र किसिम, बीउको रङ्ग आदिमा ती मूल्यांकन गरिएका जर्मप्लाज्महरूमा प्रशस्त भिन्नता रहेको पाइयो। उत्पादनशील गुणहरू जस्तै ५०% फूल फुल्ल लाग्ने दिन, कोशाको लम्बाइ चौडाइ, हरियो कोशा तयार हुन लाग्ने दिन, दसवटा कोसाको तौल र १०० दाना बीउको तौल आदिमा पनि भिन्नता पाइयो। ५०% फूल फुल्ल लाग्ने अर्वाधि ८१ दिन देखि १३० दिन सम्म लाग्नाले छिट्टै कोसा तयार हुने सम्भावना देखियो। ताजा हरिया कोसाको तौल पनि ४५ ग्राम देखि १६२.५ ग्राम सम्म फरक पाइएकोले बढी उत्पादन दिने जातहरू पनि छनौट गर्न सकिने उक्त अध्ययनले औल्याएको छ।

INTRODUCTION

The lablab bean (*Lababpurpureus*L.), also called field bean, Indian bean, Hyacinth bean or Dolichus bean is an old domesticated pulse and multipurpose crop for human food, animal feed and cover crop (Chakravarti and Naravaneni 2006, Maass 2010). It is called *Hiunde Simi*, *Tate Simi*, *Laphre Simi* and *Machhe* in Nepal and some farmers cultivate perennially. This bean is a minor winter vegetable in Nepal and grown in most of districts of Mid Hill and Tarai areas. It is considered one of nutritious vegetable in green pod stage while pulse in the form of dry seeds (Chadha 2001). The foliage of the crop can be used as green feed, hay and silage. This crop can also grow well in alkaline and saline soil pH ranges up to 9.0 (Chadha 2001). The vine is grown at the roof top of the homestead. This bean is easy to grow with limited inputs. Most of the farmer's households grow this bean having several landraces from Midhill to Tarai zone. Conservation of some landraces has been initiated by National Genebank of Nepal Agricultural Research Council (NARC), Khumaltar (Genebank 2014). However, information on diversity and characteristics of Nepalese lablab beans is scant.

Assessment of genetic diversity is important for crop improvement. Characterization is the preliminary works helps to support conservation and utilization effectively (Chakravarti 2006, Genebank 2014). Lablab is one of the most diverse domesticated legume species with largest agro-morphological diversity in South Asia, even though originated in Africa (Maass 2010). It is a tropical crop mainly grown in South Asia (specifically India, Nepal and Bangladesh), South East Asia and Africa. Considerable variations have been noticed in this bean in Bangladesh and India (Islam 2014, Rai et al 2010). Great range of variations exists in the plant and pod characters among the landraces grown in Nepal. They differs also by name eg *Kerau Simi*, *Laphre Simi*, *Machhe Simi*, etc. On the basis of physicomorphological traits, landraces of this bean can be classified into two groups, namely, the 'bushy field cultivars' and 'twining pole garden cultivars'. Only pole type exists in Nepal which is generally grown for home consumption. Since, characterization and diversity assessment are necessary on lablab beans. Therefore, we aimed to collect lablab bean landraces for diversity characterization based on physicomorphological traits using multivariate analysis tools.

MATERIALS AND METHODS

A total of 23 indigenous germplasm of twining pole genotypes of lablab bean were collected including passport data (Table 1) from seven districts namely, Myagdi, Baglung, Parbat, Syangja, Gulmi, Kaski and Rupandehi in 2010 and 2011. To characterize and assess

the diversity among these genotypes field experiments were conducted in June to February 2011 and same months in 2012 at Agriculture Research Station, Malepatan, Pokhara. Soil type of the experimental plot was sandy loam with having soil pH 5.5 or less.

Unreplicated design was adopted for this study. The plot size was 2m x 2m accommodating four hills per plot. Four seeds per hill were planted initially. In each hill six kilogram of farm yard manure (FYM) was added. Inorganic fertilizers were applied @ 10 kg nitrogen (N), 25 kg phosphorus (P) and 25 kg potassium (K) per ha as basal fertilizers. At knee height stage of seedlings, two seedlings per hills were maintained. First side dressing of 5 kg N was applied one month after seeding and; Second side dressing of 5 kg N was applied 60 days after seeding. Seedlings were supported by bamboo stick. Weeding and irrigation was done whenever necessary. The crop was protected from aphid by spraying Niconim (product of Neem) at the rate of five ml/L of water at 15 days interval. Physico-morphological qualitative and quantitative traits were recorded each year from all four hills of each genotype following the descriptors of AVRDC (www.avrdc.org) and Sultana (2001). Quantitative data were recorded from each hill and averaged over the plot each year. Mean value over the years were presented. These mean data were then subjected to cluster and principal component analysis as described by Joshi et al (2010) for genetic diversity analysis using Mintab software. Fresh pods of 15 genotypes were tested organoleptically providing to 15 different consumers (one genotype to each consumer) in 2011 and their views were recorded.

Table 1. Passport information of lablab bean genotypes used in the study

Genotype	Local name	Altitude, m	Farmer (donor) name	Collection site
ML-01	Tate Simi/Lafre	650	JyotiDumre	Tulsi Bhayangja-5, Syangja
ML-02	Tate Simi	650	JyotiDumre	Tulsi Bhayangja-5, Syangja
ML-03	Hiunde Simi	650	GunakharDhakal	Tulsi Bhayangja-2, Syangja
ML-04	Hiunde Simi	650	GunakharDhakal	Tulsi Bhayangja-2, Jimuwa, Syangja
ML-05	Hiunde Simi	1000	BalBahadur Nepali	Khurkot, Parbat
ML-07	Machhe Simi	800	Devi Prasad Bhusal (Bermeli)	Devasthan-7, Parbat
ML-08	Machhe Simi	950	JagatBahadur GC	Narayansthan-2, Balewa, Baglung
ML-09	Hiunde Simi	125	Lekha KC	Shankarnagar-1, Rupendehi
ML-10	Hiunde Simi	120	Home Bahadur Rana	Kahariya-1, Tulsipur, Rupendehi
ML-11	Hiunde Simi	1000	Man bahadur KC	Singha-4, Tatopani, Myagdi
ML-15	Hiunde Simi	875	Hari GC	Durlungchok, Kusma, Parbat
ML-16	Hiunde Simi	100	DevBahadur Poon	Padsari-5, Rupendehi
ML-17	Hiunde Simi	100	DevBahadur Poon	Padsari-5, Rupendehi
ML-18	Hiunde Simi	100	DevBahadur Poon	Padsari-5, Rupendehi
ML-19	Hiunde Simi	100	Geru Poon	Padsari, Rupendehi
ML-20	Hiunde Simi	850	Geru Poon	Malepatan, Pokhara, Kaski
ML-21	Hiunde Simi	1250	Geru Poon	Gaidakot-3, Raja, Gulmi
ML-22	Hiunde Simi	1250	Geru Poon	Arkhal-6, Gulmi
ML-23	Hiunde Simi	1250	Geru Poon	Arkhal-6, Dandakharka, Gulmi
ML-25	Hiunde Simi	1450	SitaSubedi	Dhikurpokhari, Kaski
ML-26	Hiunde Simi	950	Lokmaya GC	Narayansthan, Balawa, Baglung
ML-27	Hiunde Simi	1050	KharpaniPulkoMukhkoGhar*	Sardikhola-9, Kaski
ML-28	Hiunde Simi	650	NildebBhattarai	Jagradevi-9, Lalyang, Syangja

Note: M = Malepatan, L = Lablab bean (ARS2013). * Respondent did not give name of farmer and this is the term used to identify the house.

RESULTS

Qualitative Characters

The sizes of the leaves of each genotype were observed visually. Three different sizes of the leaves among 23 genotypes were noted. Fifteen genotypes had medium sized leaves whereas seven genotypes had small sized leaves and one genotype had relatively large sized leaves (Table 2). Chlorophyll content in the plant, expressed by the foliage color of the vegetative part did not have too much variation. Among the 23 genotypes, 17 (73.9%) were observed green and six (26.15%) were purple vine. Three types of flower color were observed. Flower color of 12 (52.17%) was purple, 8 (34.78%) white, and 3 (13.04%) pink.

Pod color was of three different kinds: green, purple and white. There were 12 (52.17%) genotypes with green colored pods, 7 (30.43%) with purple and 4 (17.39%) with white colored pods. Pod shapes were straight, slightly curved and curved pods (Table 2). The numbers of genotypes having slightly curved pods were 12 (52.17%), having straight pod shaped 10 (43.48%), and pod with curved shaped 1 (4.35%). There were 13 (56.52%) genotypes with flat type pods and 10 (43.48%) genotypes with round type pods.

According to seed coat color, genotypes were classified into five groups (Table 2). These were brown, black, white, black brown and gray brown. Among the 23 genotypes, 12 (52.17%) had brown seed coat followed by 7 (30.43%) genotypes with black coated seeds. Two genotypes had gray black and one brown black and one with white color seed coat. Considering the cooking quality, taste and over all performance of fresh pods, ML-09 was found best among the genotypes (Table 3). ML-09 was preferred by consumers due to small and bold pod with fiberless. It is also known as pea type bean. Other genotypes preferred by consumers were ML-02, ML-04, ML-08, ML-09, ML-10, ML-15, ML-18, ML-19, and ML-20. Five genotypes, namely ML-02, ML-05, ML-08, ML-09 and ML-18 were found high yielders and they are recommended for further yield verification trial.

Table 2. Qualitative physio-morphological characteristics of lablab beans germplasms

Genotype	Flower color	Pod color	Vine color	Seed color	Leaf size	Pod form	Pod type
ML-01	Pink	Green	Green	Black	Medium	Slightly curved	Flat
ML-02	white	Green	Green	Brown	Medium	Straight	Flat, attractive
ML-03	White	Green	Green	Brown	Medium	Straight	Flat
ML-04	Purple	Purple	Purple	Brown	Medium	Slightly curved	Round
ML-05	Purple	Green	Green	Black	Medium	Slightly curved	Round
ML-07	Pink	Green	Green	Gray black	Medium	Slightly curved	Round
ML-08	Purple	Green	Green	Gray black	Medium	Slightly curved	Round, attractive
ML-09	Purple	Purple	Purple	Black	Small	Slightly Curved	Flat
ML-10	White	White	Purple	Brown	Small	Straight	Round
ML-11	Purple	Purple	Purple	Black	Medium	Semi curved	Round
ML-15	purple	Purple	Purple	Black	Medium	Slightly curved	Flat
ML-16	White	Green	Green	White	Medium	Straight	Flat
ML-17	White	Green	Green	Brown	Medium	Straight	Flat
ML-18	Purple	Green	Green	Brown	Small	Curved	Round
ML-19	Purple	Purple	Purple	Brown	Small	Slightly Curved	Round
ML-20	Purple	White	Green	Black	Medium	Curved	Flat
ML-21	White	Green	Green	Brown	Small	Slightly Curved	Flat
ML-22	Pink	Purple	Green	Brown	Large	Curved	Round
ML-23	Purple	White	Green	Brown	Medium	Straight	Flat
ML-25	Purple	Green	Green	Brown	Medium	Straight	Round
ML-26	White	Green	Green	Brown	Medium	Straight	Flat
ML-27	Purple	White	Green	Black brown	small	straight	Flat
ML-28	Purple	Purple	Purple	Black	small	straight	Flat

Table 3. Consumers' views on the germplasm of pole type lablab beans

Genotype	Consumer comments
ML-01	Tasty, soft, slightly fibrous, no presence of insects
ML-02	Tasty, soft and no insect found inside pod
ML-03	Ok, fibrous and presence of insects inside pod
ML-04	Tasty, soft, no insects found inside pod
ML-05	Tasty, little fiber, soft, presence of insects inside pod
ML-07	Ok, soft, slightly fibrous, presence of insects in small scale
ML-08	Tasty, soft, presence of insects in small scale
ML-09	Tasty, soft, presence of insects in small scale
ML-10	Tasty, soft, no presence of insects
ML-11	Tasty, soft, slightly fibrous, no presence of insects
ML-15	Tasty, soft, slightly fibrous, no presence of insects
ML-16	Tasty, soft, slightly fibrous, no presence of insects
ML-17	Tasty, soft, slightly fibrous, no presence of insects
ML-18	Tasty, soft, slightly fibrous, presence of insects in small scale
ML-19	Tasty, soft, slightly fibrous, presence of insects inside pod
ML-20	Tasty, soft, slightly fibrous, no presence of insects

Quantitative Characters

Wide range of variation (49 days difference) was observed in days to 50% flowering among tested genotypes (Table 4). The genotypes ML-09 and ML-15 flowered at 81 days and other early flowering genotypes were ML-22 (85.5 days), ML-27, and ML-28 (86.5 days). Based on the two years result, ML-02, ML-11, ML-19, ML-20 were flowered in 120 days, whereas ML-17 and ML-16 were observed extremely late flowering type which took 124 and 130 days to flower respectively. Variation was also observed in fresh pod maturity days for culinary purpose. The difference in pod maturity for days to first harvest was 44.5 between early and late type genotypes. ML-15 took only 119 days for harvesting first fresh pods. Other early types were ML-22 (122 days), ML-27, ML-28 (124 days). Late types in pod maturity were ML-17, ML-19, ML-20 ML-23, ML-25, which took 164 days for harvesting fresh pods. ML-16 was extremely late maturing type which took 165.5 days for first fresh pod harvest. Pod length varied from 5.35 to 15.45 cm (Table 4). The longest pod was of ML-05 (15.45 cm), followed by ML-08 (14.7 cm) and ML-18 (13.95 cm). Whereas shortest pod length was recorded in ML-09 (5.35 cm) followed by ML-22 (6.45 cm) and ML-10 (6.5 cm). Pod width ranged from 3.9 to 9.11 cm. The widest pod was recorded in ML-02 (9.11 cm), followed by ML-28 (6.5 cm), ML-05 (6.3 cm), and ML-01 (6.2 cm) whereas, the shortest pod width was recorded in ML-19 (3.9 cm).

Table 4. Quantitative physico-morphological characteristics of lab lab beans characterized during 2011 and 2012

Genotype	Flowering days	Pod maturity days for first harvest	Pod length, cm	Pod width, cm	Weight of 10 pods, g	Seeds per pod	100-seed weight, g
ML-01	118.0	153	9.15	6.21	122.5	4.55	36.0
ML-02	120.5	157.5	10.65	9.11	162.5	4.5	45.6
ML-03	116.5	153	12.55	5.72	107.5	4.1	23.5
ML-04	116.5	156	14.3	4.5	130	4.5	28.5
ML-05	116.5	156	15.45	6.3	162.5	4.5	29.0
ML-07	116.5	156	10.45	5.55	100	3.65	34.7
ML-08	116.0	153	14.7	4.85	130	4.85	35.1
ML-09	81.0	140	5.35	4.92	65.0	4.15	28.1
ML-10	117.5	152.5	6.55	4.02	45.0	4.0	18.7
ML-11	120.5	154.5	12.35	4.92	77.5	3.45	27.5
ML-15	81.0	119	10.3	5.65	80.0	5.2	29.7
ML-16	130.0	165.5	7.0	4.35	62.5	4.1	32.7
ML-17	124.0	163.5	10.25	4.5	105	4.7	25.0
ML-18	117.5	159.5	13.95	5.31	110	4.4	42.0
ML-19	120.5	163.5	13.0	3.9	75.0	5.2	28.5
ML-20	120.5	163.5	12.2	4.75	95.0	5.45	33.5
ML-21	93.5	129	7.9	5.0	75.0	4.1	32.0
ML-22	85.5	122.5	6.45	3.98	67.5	3.6	30.0
ML-23	107.0	163.5	10.1	5.1	70.0	4.9	37.0
ML-25	106.5	163.5	10.0	5.07	97.5	5.8	29.6
ML-26	120.5	153.5	8.45	4.05	115	4.05	29.5
ML-27	86.5	123.5	8.1	6.2	85.0	4.65	27.5
ML-28	86.5	123.5	9.05	6.55	90.0	4.05	39.0

The maximum weight of 10 fresh pods was recorded in ML-02 and ML-05 (162.5 g) followed by ML-04 and ML-08 (130 g) (Table 4). The minimum weight was recorded in ML-10 (45.0 g) followed by ML-16 (62.5 g) and ML-09 (65.0g). The maximum number of seeds per pod was recorded in ML-25 (6) followed by ML-20 (5). Other genotypes with higher seeds number per pod were ML-15 and ML-19 (5). The minimum seeds number of per pod was recorded in ML-11 (3) followed by ML-07 and ML-22 (4). Great variation was recorded in seed weight which ranged from 18.7 to 45.6g/100 seeds). The two years mean data showed that the highest 100-seed weight was recorded in ML-18 (44.0g) followed by ML-02 (41.2g). Other bold grain type genotypes were ML-25 (39.3g), ML-28 (38.0 g) and ML-20 (37.0 g). The lowest 100-seed weight was recorded in ML-10 (18.7g).

Cluster Analysis

Cluster analysis was undertaken to objectively divide the germplasm into natural groups. Clustering was performed on standardized variables using Euclidean distance for single linkage method. This clustering in natural groups is represented by a dendrogram progressively dividing the accessions into smaller and smaller groups (KC 2001). There were four clusters, among which cluster I consisted of the highest number of genotypes ie 15 genotypes followed by cluster II with 6 genotypes (Figure 1, Table 5). Two genotype namely ML-10 and ML-02 made separate clusters individually, indicating unique features in these two genotypes among the 23 genotypes of lablab beans.

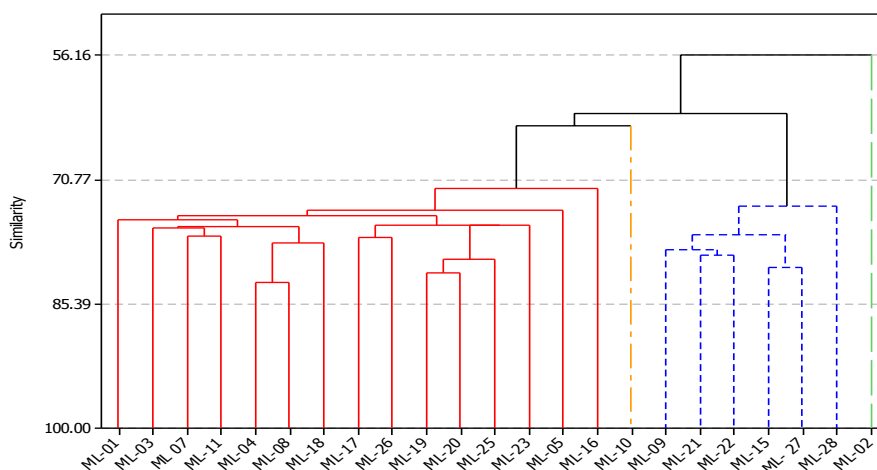


Figure 1. Cluster analysis of 23 accessions of lablab beans collected from different parts of Nepal and characterized over two years in Pokhara, Nepal.

Table 5. Distribution of 23 genotypes in different clusters based on yield and physico-morphological traits

Cluster	No. of genotype	Name of genotype	Percent
I	15	MI01, ML03, ML07, ML11, ML04, ML08, ML18, ML17, ML26, ML19, ML20, ML25, ML23, ML06, ML16, ML10	65.22
II	1	ML10	4.35
III	6	ML09, MI21, ML22, ML15, ML27, ML28	6.26
IV	1	ML02	4.35

Principal Component Analysis

The first two principal components with eigen values greater than 1.0 accounted for about 66% of the variation among the collection (Table 6). Third and fourth components accounted for 14 and 9% of the total variation. Here principal component reduces the dimensionality of multivariate data by removing interrelations among variables and eigen value represents the variance of principal component (Matus 1999). The first principal component (PC1) which explained 39% variation, was associated mainly with days to 50% flowering, pod maturity, pod length and pod weight. The second principal component (PC2) was responsible for about 26% of the variation and was mainly related to pod width and 100 seed weight.

Table 6. Eigen analysis and principal component coefficients based on correlation matrix of six variables measured in 23 lablab bean genotypes evaluated over two years

Variable	PC1	PC2	PC3	PC4
Eigen value	2.77	1.87	0.99	0.69
Proportion	0.396	0.267	0.142	0.099
Cumulative	0.396	0.663	0.805	0.904
Flowering days	0.429	-0.413	-0.337	-0.138
Pod maturity first harvest	0.425	-0.435	-0.105	-0.359
Pod length	0.473	-0.053	0.190	0.529
Pod width	0.235	0.595	-0.120	-0.040
10-pod weight	0.485	0.264	-0.067	0.390
Seeds/pod	0.217	-0.030	0.897	-0.265
100-seed weight	0.272	0.462	-0.127	-0.590

The dispersion of the 23 genotypes in Figure 2 showed considerable amount of variability because of collections from different areas. Four distinct groups can also be observed based on the principal component analysis. ML-02 is located very far from the center and has positively higher value for most of the traits whereas, ML-10 has relatively small value for most of the traits and located in the third quadrant.

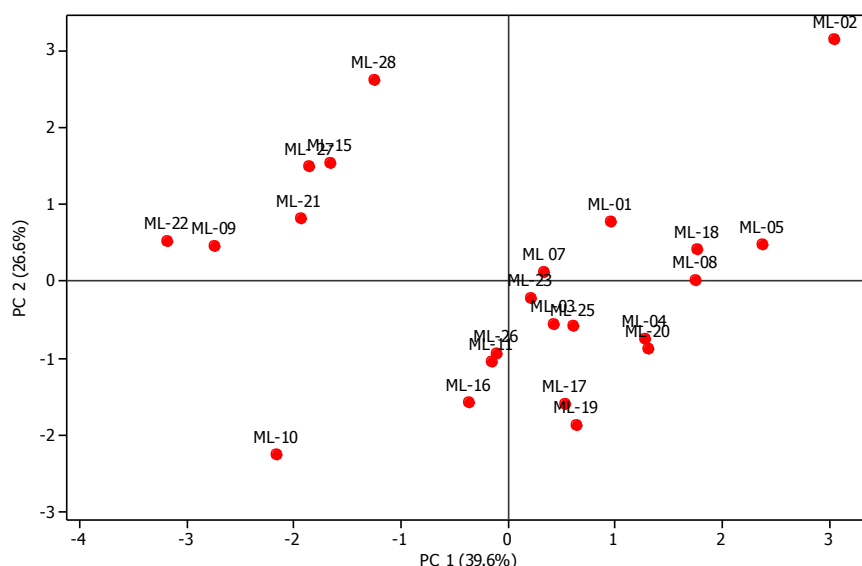


Figure 2. Principal component analysis of 23 accessions of lab lab beans collected from different district of Nepal and characterized over two year in Pokhara, Nepal.

DISCUSSION

Germplasm characterization is an important component of breeding program for an effective and efficient management and utilization. Assessment of genetic diversity is an essential component in germplasm characterization and conservation (Chakravarthi 2006). Morphological markers have been used for assessment of relationships among lab labbean genotypes and for estimating genetic diversity among them (Table 2, 4, Figure 2). The germplasm used in present studies showed a wide variation in morphological traits like number of pods/plant and pod length (Table 2, Table 4, Figure 1, Table 6, Figure 2). The immense genetic diversity of landraces of crops is the most directly useful and economically valuable part of biodiversity. Unlike high yielding varieties, the landraces maintained by farmers are endowed with tremendous genetic variability, as they are not subjected to subtle selection over a long period. Such diversity should be conserved by collecting extensively from the local areas removing duplicates in the collection.

In present findings the color of vine color we observed was similar to that of Islam (2010) who reported that large portion (43.2%) were green vine color in Bangladesh. Islam et al (2002) divided stem color in two groups such as green and purple, which was also similar with the present results. Pod color is very important in the market and consumer prefer green pod. More than half of the germplasm have green pod. Islam (2010) also reported 52.3% were green color pod in his study. Pod length is directly related to total economic harvest. Priority should therefore be given to ML-05 for further advancing and selecting the genotypes. Variation in pod length was similar to Islam (2010) who reported variation on it from 3.96 cm to 18.20 cm.

The plant has many outstanding qualities. It is tolerant of high-temperatures and drought, can thrive in deep sands to heavy clays and produces a large bulk of green material with high protein concentration (Kay 1979). These qualities enable the plant to provide food, fodder and soil protection during prolonged dry periods when many other plant species have become desiccated (Schaaffhausen 1963, Wood 1983). Lablab is better adapted to drought than common beans (*Phaseolus vulgaris*) or cowpea (*Vigna unguiculata*). Variation therefore observed in these genotypes can be very important sources for developing site specific variety targeting drought areas in western Nepal.

We observed diversity in farmers' preferred traits based on the assessment of genetic diversity using phenotype. The information generated here may have limitations, since most of the morphological characters are greatly influenced by environmental factors and the development stage of the plant. Further diversity assessment is recommended using DNA markers.

Results obtained from this study are very useful to enhance the genetic management and improvement of this multipurpose crop species particularly to develop high yielding variety. The narrow genetic base for breeding stocks may be increased including these genotypes. Extensive exchange of germplasm among smallholder farmers across the country may dilute the existing diversity. The identified genetically distinct genotypes could be potentially important source for further improvement of lab labbean.

CONCLUSION

The evaluated germplasm showed significant variations in most of the qualitative and quantitative traits. Variation was observed in both phenological and yield attributing characters. Simple location specific evaluation and selection may be sufficient to develop high yielding, early type varieties from these genotypes.

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