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Research Article

Agro-morphological characterization of rice (*Oryza sativa* L.) landraces of Lamjung and Tanahun District, Nepal.

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Abstract: Agro-morphological characterization of crop is the basic criteria to provide fundamental information for plant breeding programs. An investigation was conducted in Agronomy farm of Institute of Agriculture and Animal Science, Lamjung Campus in alpha-lattice design with two replications. The objective of the study was to characterize thirty landraces of rice (*Oryza sativa* L.) of Lamjung and Tanahun district based on 30 qualitative and 8 quantitative characters, recorded as per descriptor established by IRRI, Bioversity International and WARDA. The frequency distribution of qualitative characters were studied where panicle shattering, lemma & palea color, culm lodging resistance and Leaf senescence showed high variability. The maximum value, minimum value, coefficient of variation and Pearson correlation were analyzed to study quantitative characters. The coefficient of variation ranged from 5.4% (Grain Length: Breadth ratio) to 20% (Total Tillers) indicating that selection based on the characters showing higher variation is expected to be effective. The highest correlation was corresponded to the total tillers and effective tillers (r=0.978**). Flag leaf length showed positive significant correlation with penultimate leaf length (r=0.674**), total tillers (r=0.437**), effective tillers (r=0.356**) and Grain Length: Breadth ratio (r=0.430**). UPGMA clustering of the genotypes was done where members of cluster IV were found to be more superior. Promising landraces were identified from different yield attributing characters like total tillers, total grains per panicle, 1000 grain weight, panicle length and filled grain percentage. Thus, the present study can be utilized for further rice improvement programs and can also be used for assessing genetic diversity among morphologically distinguishable rice landraces.

Key words: Characterization; Clustering; Frequency distribution; Rice Landraces.

Introduction

Rice is the most important staple food crop and ranks 1st as most cultivated cereal crop in terms of both area and production in Nepal (Joshi *et al.*, 2011; MOAD 2016/17). Nepal has a wide diversity of landraces grown from low to high altitudes (60 MASL -3050 MASL) (Bajracharya *et al.*, 2010). About 2500 rice landraces are reported in Nepal distributed in 73 out of 75 district among which only 157 landraces are being cultivated (Joshi, 2017).

Many plans and programs were formulated to increase the production of rice. However, the achievements are yet below the satisfactory level resulting into shifting of the country from a net exporter of rice to a net importer in recent years (Joshi *et al.*, 2011 and Bishwajit *et al.*, 2013). The adoption of modern varieties, their higher yield potential, better pricing and market has resulted change in varietal choice of Nepalese Farmers (Chaudhary *et al.*, 2003). Though the development of high yielding, fertilizer responsive and short period rice varieties aided for green revolution but there is excessive loss of conserved Farmers' varieties (Chakravorty and Ghosh, 2013). At Present, more than 90% of

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rice cultivation is being done using high yielding variety which clearly signifies that the landraces are disappearing at fast rate (Sinha and Mishra, 2013). Climate change scenario like erratic rainfall, disease and pest attack, genetic erosion due to developmental activities are major causes to lead the crop failure in recent days (Ali *et al.,* 2017).

Improvement in existing variety depends upon desirable genes which are possibly present in landraces and wild varieties only so their importance can never be denied in agriculture system (Shiva *et al.,* 1991). Germplasm are very important source of useful genes. The adequate characterization and evaluation are criterion both for the effective management and use of plant germplasm in breeding programs (Sarawgi *et al.,* 2014). The main objective of the present investigation was to characterize thirty landraces of rice of Lamjung and Tanahun district using agro morphological characters to provide basic information to facilitate the choice of genitors for rice plant breeding programs.

Materials and Methods

A total of 30 landraces were collected from Rainas Municipality, Lamjung and Purkot, Bhanu Municipality, Tanahun (Table 1). They were cultivated in the similar climate and altitude of research site i.e. Agronomy Farm of the Institute of Agriculture and Animal Science (IAAS), Lamjung Campus, between 28° 7' North latitude and 84° 25' East longitude, with an altitude of 632 MASL during June - November 2018. The field trials were conducted under irrigated transplanting condition. The landraces were sown in raised nursery on June 16, 2018. Twenty-two days old seedlings were subsequently transplanted into the field in alpha-lattice design with two replications. Each replication had 5 blocks and each block contained 6 treatments of $2m^2$ each. The block to block distance was 0.5m while the replication to replication distance was 1m. Each treatment was transplanted in 5 rows with 20 cm of spacing between row to row and 20 cm between plant to plant. Fertilizer dose at the rate of 100:30:30 N: P: K kg/ha was applied. The entire dose of Phosphorus along with Potassium and half dose of Nitrogen was applied as a basal dose. The remaining dose of Nitrogen was applied in two splits, one at time of tillering and remaining another at panicle initiation stage. The standard agronomic practices were adopted for normal crop growth. 30 qualitative and 8 quantitative characters were recorded as per the descriptor established by IRRI, Bioversity International and WARDA. Five random plants from each treatment were taken for recording data of various characters. Averages of the data from the sampled plants were used for various statistical analysis. Frequency distribution was computed for qualitative characters. Basic statistics (Maximum value, Minimum value and CV%), Pearson's correlation and cluster analysis were analyzed using R package, Excel 2013 and MINITAB 14 for quantitative characters.

Table 1: List of 30 landraces collected from Lamjung and Tanahun District.

S.No.	Name of landraces	Site of collection
1	Pahelo Anadi	Marysangdi Chepe Community Seed Bank
2	Rato Anadi	Local Farmer (Rainas)
3	Gokule Mansuli	Marysangdi Chepe Community Seed Bank
4	Rato Masino	Local Farmer (Rainas)
5	Thakali Lahare Marsi	Local Farmer (Rainas)
6	Pudke Dhan	Local Farmer (Rainas)
7	Eakle	Marysangdi Chepe Community Seed Bank
8	Kalo Masino	Marysangdi Chepe Community Seed Bank
9	Biramful	Marysangdi Chepe Community Seed Bank

10	Indrabeli	Local Farmer (Rainas)
11	Kalo Namdunge	Local Farmer (Rainas)
12	Jarneli	Local Farmer (Rainas)
13	Aanga	Local Farmer (Rainas)
14	Jetho Budo	Marysangdi Chepe Community Seed Bank
15	Kalo Jhinuwa	Marysangdi Chepe Community Seed Bank
16	Jhinuwa Local	Marysangdi Chepe Community Seed Bank
17	Anadi today	Marysangdi Chepe Community Seed Bank
18	Lekali Marsi	Marysangdi Chepe Community Seed Bank
19	Baryang masino	Local Farmer (Rainas)
20	Sobhara	Local Farmer (Rainas)
21	Marsi	Local Farmer (Rainas)
22	Anadi Local	Marysangdi Chepe Community Seed Bank
23	Pakhe Sali	Marysangdi Chepe Community Seed Bank
24	Mansara	Purkot Community Seed Bank, Tanahun
25	Pahele	Purkot Community Seed Bank, Tanahun
26	Chiniya	Purkot Community Seed Bank, Tanahun
27	Juhari	Purkot Community Seed Bank, Tanahun
28	Seto Anadi	Purkot Community Seed Bank, Tanahun
29	Kathe	Purkot Community Seed Bank, Tanahun
30	Bihari	Purkot Community Seed Bank, Tanahun

Results and Discussions

Qualitative Characters

Qualitative characters are considered as marker characters in the identification of landraces of rice, which are less independent to the environmental responses (Singh *et al.,* 2014). Qualitative characters are the most important characters to identify a plant variety and are mostly genetically controlled (Singh and Mishra, 2013). Qualitative characters are significant for plant description and mainly influenced by the consumers preference, socio-economic scenario and natural selection (Swargi *et al.,* 2014). Frequency distribution for 30 qualitative traits are presented in Table no. 2. The ligule color, Collar color and Auricle color showed less variability. The 80% of the landraces had whitish ligule color, 93% had light green collar color and 87% had yellowish green auricle color. 60% of the stigma color of total landraces were yellow while 40% were white. 87% of the landraces were found to have green basal leaf sheath color followed by 13% of green with purple line and 7% of purple basal leaf sheath color. Most of the landraces (93%) showed no anthocyanin coloration on leaf sheath. Frequency of two-cleft ligule was found to be 90% whereas only 10% had truncate ligule shape. Most of the culm were erect (93%) and semi erect (7%). Farmers prefer awn less grain because awns are objectionable in threshing and milling (Singh *et al.,* 2014). In the collected landraces, 77% of the grains were awn less, while 13% had awn on tip only and remaining 10% had awn on upper half, upper three quarters and whole length of grain which is desirable. Culm anthocyanin coloration on nodes were found to be absent in 97% of the landraces. The culm lodging resistant of the collected landraces were found to be very strong (37%), very weak (27%), intermediate (23%), strong (10%) and weak (3%). Flag leaf angle is important growth character in which maximum photosynthesis occurred. It might be due to the higher light penetration in the crop canopy due to erect leaf (Zaman *et al.,* 2005; Zafar *et al.,* 2004). In our study, 53% of the landraces had erect, 30% semi erect and 17% horizontal Flag leaf attitude.

Panicle exsertion showed moderate variability with 50% moderately well exserted, 30% well exserted, 17% just exserted and 3% partly exserted. No landraces were found with enclosed panicle exsertion. Panicle threshability had low variability. 67% are easily threshable, 27% are intermediate and 6% are difficult to thresh. Panicle shattering showed high variability in the collected landraces. 37% of the landraces showed low shattering followed by 33% very low, 13% moderate, 10% high and 7% very high shattering. Frequency of glabrous type leaf blade pubescence was 53%, intermediate (37%) and pubescent (10%) in the landraces collected. Rice plant with pubescence leaf blade irritates workers skin during harvesting and threshing, thus glabrousness is fairly desirable (Singh *et al.,* 2014). Lemma and palea color also showed high variability, in which the maximum was Straw color (43%) followed by Gold and Gold furrows (23%), Brown (tawny) (17%), Brown Furrows (13%) and Purple furrows (3%). The 50% of the spikelet are fertile, 37% are highly fertile and 13% are partly sterile.

Table 2: Frequency distribution of thirty qualitative traits of collected thirty rice landraces from Tanahun and Lamjung District.

	Characters	Description with code	Frequency	Frequency %
1.	Basal Leaf Sheath(color)	2-Green with Purple lines	4	13
		1-Green	24	80
		4-Purple	2	7
2.	Leaf Sheath: Anthocyanin coloration	0-Absent	28	93
		5-Medium	2	7
3.	Leaf Blade: Anthocyanin coloration	0-Absent	17	57
		1-Present	13	43
4	Leaf Blade Pubescence	2-Intermediate	11	37
		3-Pubescent	3	10
		1-Glabrous	16	53
5.	Ligule Color	1-Whitish	24	80
		2-Yellowish Green	6	20
6.	Ligule shape	3-Two Cleft	27	90
		1-Truncate	3	10
7.	Collar Color	2-Light Green	28	93
		3-Purple	2	7
8.	Auricle Color	2-Yellowish green	26	86
		3-Purple	2	7
		1-Whitish	2	7
9.	Stigma color	3-Yellow	18	60
		1-white	12	40
10.	Awn distribution	0-Awnless	23	77
		1-Tip only	4	14
		3-Upper half only	1	3
		5-Whole length	1	3
		4-Upper three quarter only	1	3
11.	Culm: Anthocyanin Coloration on nodes	0-Absent	29	97
		1-Purple	1	3
12.	Culm: Underlying Node Color	2-Green	23	77
		1-Light Gold	7	23
13.	Culm: Underlying Internode Color	2-Green	5	17
		1-Light Gold	25	83

14.	Culm: Lodging Resistance	9-Very Strong	11	37
		1-Very weak	8	27
		5-Intermediate	7	23
		7-Strong	3	10
		3-Weak	1	3
15.	Flag Leaf: Attitude	1-Erect	16	53
		3-Semi Erect	9	30
		5-Horizontal	5	17
16.	Leaf: Senescence	3-Early	11	36
		5-Intermediate	5	17
		1-Very Early	5	17
		7-Late	9	30
17.	Sterile lemma color	2-Gold	5	17
		1-Straw	21	70
		4-Purple	4	13
18.	Panicle: Exsertion	3-Partly Exserted	1	3
		9-Well Exserted	9	30
		7-Moderately Well Exserted	15	50
		5-Just Exserted	5	17
19.	Panicle: Shattering	1-very low	10	33
		5-Moderate	4	13
		3-Low	11	37
		7-High	3	10
		9-Very High	2	7
20.	Panicle: Threshability	3-Easy	20	67
		2-Intermediate	8	26
		1-Difficult	2	7
21.	Lemma and Palea pubescence	3-Hairs on upper portion	17	57
		4-Short Hairs	13	43
22.	Lemma and Palea color (late)	3-Gold and Gold furrows	7	23
		6-Brown Furrows	4	14
		2-Straw	13	43
		4-Brown (tawny)	5	17
		10-Purple furrows	1	3
23.	Lemma: anthocyanin coloration of keel	0-Absent	20	67
		5-Medium	6	20
		1-Very Weak	1	3
		7-Strong	2	7
		3-Weak	1	3
24.	Lemma: anthocyanin coloration of area below apiculus(late)	0-Absent	19	64
		5-Medium	4	13
		7-Strong	7	23
25.	Lemma: coloration of apiculus (late)	2-Straw	17	57
		3-Brown (tawny)	12	40
		8-Purple apex	1	3
26.	Lemma: shape of apiculus (late)	1-Pointed	30	100
27.	Spikelet: fertility	5-Highly fertile	11	37
		4-Fertile	15	50
		3-Partly Sterile	4	13
28.	Caryopsis Shape	2-Semiround	10	33

		3-Half spindle shaped	12	40
		4-Spindle Shaped	7	24
		5-Long spindle shaped	1	3
29.	Caryopsis: pericarp color	1-White	27	90
		2-Light Brown	1	3
		5-Red	2	7
30.	Endosperm Type	3-Glutinous (waxy)	19	63
		1-Non glutinous (non-waxy)	6	20
		2-Intermediate	5	17

Quantitative Results

Basic statistics of Quantitative characters

Basis statistics for Penultimate leaf length (cm) (PPL), Total tillers (TT), Effective tillers (ET), Plant height (cm) (PH), Total grains per panicle (TGP), Panicle length (cm) (PL), Grain Length Breadth ratio (LBR), Flag leaf length (cm) (FLL) are presented in Table 3. CV value ranges from 5.4% - 20%. Total Tillers, Effective Tillers and Total Grains per Panicle have CV values above 10% indicating that selection based on these characters is expected to be effective (Zafar *et al.*, 2004).

Table 3: Maximum value, Minimum value and Coefficient of variation for 8 quantitative characters among 30 landraces from Lamjung and Tanahun district.

Characters	Maximum Value	Minimum Value	CV%
PLL	68.15	45.62	8.8
TT	11.10	3.56	20
ET	10.08	3.20	19.8
PH	187.64	127.31	6.2
TGP	225.04	84.65	11.1
PL	35.43	19.70	8.2
LBR	3.68	2.02	5.4
FLL	50.81	25.90	8.4

Pearson's Correlation analysis

A measure of the degree to which variables vary together or a measure of intensity of association is correlation. Correlation insight the direction and magnitude of association between yield and its components which is the key for selection (Sarawgi *et al.*, 2014). Association and correlation correlation between characters are represented in Table 4.

In the present study, the highest correlation was corresponded to the total tillers and effective tillers (r=0.978). Flag leaf length positively correlated with plant height (r= 0.089) and positive significantly with total tillers (r=0.437) and effective tillers (r=0.356). Similar results were also reported by Wattoo *et al.*, (2010). Flag leaf length showed positive significant correlation with penultimate leaf length (r= 0.674) and Grain Length: Breadth ratio (r=0.430). Both source (photosynthetic rate) and sink (partitioning to grain) strengths are associated with the high grain yield. Flag leaf area is an important factor which determines yield potential through affecting photosynthetic rate. Thus, it is very sensible that flag leaf area is highly associated with yield and yield traits. (Bing *et al.*, 2006). Penultimate leaf length showed positively significant correlation with Grain Length: Breadth ratio (r=0.494) and total tillers (0.340). Plant height showed positive correlation with effective tillers (r=0.227). Similar results were reported in Rajeswari and Nadarajan, 2004. Plant height also showed positively significant correlation with panicle length (r=0.588) indicating the importance of plant height in improving panicle length by large stem reserve mobilization (Zafar *et al.*, 2004). Also, the result agrees with Surek and Beser, (2003).

Table 4: Pearson Correlation matrix among eight quantitative characters for 30 rice landraces of Lamjung and Tanahun district.

	PLL	TT	ET	PH	TGP	PL	LBR	FLL
PLL	1	0.340**	0.296*	0.310*	0.098	-0.090	0.494**	0.674**
TT		1	0.978**	0.200	-0.202	-0.258*	0.147	0.437**
ET			1	0.227	-0.221	-.0254*	0.142	0.356**
PH				1	-0.139	0.588**	0.145	0.089
TGP					1	0.161	-0.118	0.088
PL						1	-0.256*	-0.257*
LBR							1	0.430**
FLL								1

Penultimate leaf length (cm) (PPL), Total tillers (TT), Effective tillers (ET), Plant height (cm) (PH), Total grains per panicle (TGP), Panicle length (cm) (PL), Grain Length Breadth ratio (LBR), Flag leaf length (cm) (FLL)

**. Correlation is significant at the 0.01 Level (2-tailed); *. Correlation is significant at the 0.05 Level (2-tailed)

Effective tillers had registered negative significant correlation with panicle length (r= -0.254) and total grains per panicle (r= -0.221). Also, Grain Length: Breadth ratio showed negative correlation with total grains per panicle (r= -0.118) similar to the result of Lakshmi *et al.*, 2014. Total grains per panicle was negatively correlated with plant height (r= -0.139) as like the result of Chakraborty and Chakraborty, 2010. It directs that tallness of rice plant decreases the grain yield due to high accumulation of photosynthates in vegetative parts compared to reproductive parts and increases lodging susceptibility (Roy *et al.*, 2015).

Panicle length was negatively significant correlated with Grain Length: Breadth ratio (r= -0.256) and Flag leaf length (r= -0.257) and total tillers (r= -0.258). Such negative correlations arise mostly due to competition for a common possibility, such as nutrient supply. If one component gets advantage over the other, a negative correlation may arise (Debnath *et al.*, 2014). Negative correlation among traits show retrogressive association between the traits, i.e. increase in a particular trait may lead to a decrease in the other, simultaneous selection may be considered in this case for variety improvement (Osundare *et al.*, 2017).

Cluster Analysis

A dendrogram was constructed by using UPGMA clustering method based on average linkage and Euclidean distance across the 30 landraces. The cluster analysis grouped the landraces into four clusters for 8 quantitative traits. (Table 5) (Figure 1)

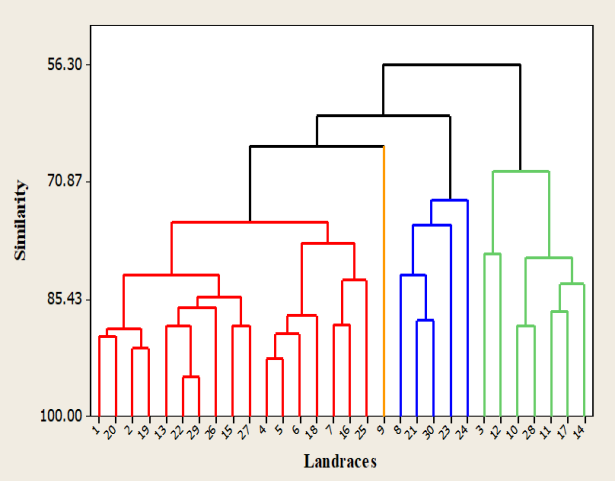

Figure 1: Dendrogram of 30 landraces of rice cultivars of Lamjung and Tanahun District derived by UPGMA from 8 qualitative traits. Codes of cultivars are showed in Table 1.

The inter cluster distance (Table 6) was maximum in between cluster II and III (86.1664) and minimum in between cluster I and IV (42.1345). The range of inter-cluster values ranged from 42.1345 to 86.1664 showed medium range of diversity.

Table 5: Distribution of 30 Landraces of Lamjung and Tanahun district in different clusters

Cluster No.	Landrace Serial No.	Total number of Landraces
I	1,20,2,19,13,22,29,26,15,27,4,5,6,18,7,16,25	17
II	3,12,10,28,11,17,14	7
III	8,21,30,23,24	5
IV	9	1

Table 6: Distance between cluster centroids of 30 rice landraces from Lamjung and Tanahun district.

	Cluster I	Cluster II	Cluster III	Cluster IV
Cluster I	0.0000	44.5718	42.7304	42.1345
Cluster II		0.0000	86.1664	49.3212
Cluster III			0.0000	75.8108
Cluster IV				0.0000

Table 7: Average value of quantitative characters of each cluster.

Quantitative characters	Cluster I	Cluster II	Cluster III	Cluster IV
Average of Grain L: B Ratio	2.703	2.762	3.122	3.354
Average of Flag Leaf Length(cm)	36.227	36.887	36.688	46.380
Average of Panicle Length(cm)	28.025	26.000	24.458	31.750
Average of Plant Height (cm)	158.907	145.207	159.977	189.380
Average of Total Grain Panicle	153.127	195.458	110.633	179.000
Average of Penutimate Leaf Length	56.076	54.647	55.116	62.790
Average of Total Tillers	6.500	5.929	8.000	9.300
Average of Effective Tiller	6.053	5.657	7.700	8.700

The intra-cluster distance between cluster I and II was 44.5718, cluster I and III was 42.7304, cluster III and IV was 75.8108 & cluster II and IV was 49.3212. The intra-cluster values in all the four clusters were low indicating the genotypes within the same clusters were closely related. Genotypes of distant clusters were preferred to obtain wide spectrum of variation among the segregation and to execute maximum heterosis in crossing (Hosan *et al.*, 2010). Average value of Grain Length: Breadth Ratio, Flag leaf length, Panicle length, Penultimate leaf length, Total tillers and Effective tillers were found high in cluster IV (Table 7). Thus, cluster IV was found to be high yield potentiality. Total grains per panicle was found highest and plant height was found lowest in cluster II. Thus, cluster IV and cluster II can be recommended for varietal development and crop improvement.

Identification of promising varieties

The mean and standard error of following yield attributing characters were calculated. The landraces which showed higher value than the sum of Mean and SE were identified as promising varieties as shown in Table 8. Rato Masino, Thakali lahare Marsi, Biramful and Lekali Marsi were found to have highest number of yield attributing characters (4 out of 5 characters).

Table 8: Promising landraces for different yield attributing characters among 30 landraces from Lamjung and Tanahun district.

Yield Attributing Characters	Value	S.N of Landraces
Total Tiller	7.07	5,7,9,13,20,23,24,25,29,30
Total Grain/panicle	162.33	2,3,4,5,6,9,10,11,12,14,17,18,28
1000 seed weight	26.61	1,2,4,11,12,13,14,17,18,21,22,26,28

Panicle Length (Cm)	27.76	4,5,6,7,8,9,10,15,16,18,21,27
Filled Grain Percentage	79.09	1,2,3,4,5,6,9,10,11,12,14,18,19,22,23,25,26,27,28

Conclusion

The frequency distribution of qualitative characters were studied in which panicle shattering, lemma & palea color, culm lodging resistance and Leaf senescence showed high variability. Total tillers, effective tillers and total grain per panicle showed high coefficient of variation which means selection based on these characters will be effective. Flag leaf length was positively significant correlated to effective tillers, total tillers and grain length: breadth ratio. Plant height was also found positively correlated to panicle length suggesting that selection for these characters would improve grain yield. Landraces of Cluster IV and Cluster II can be suggested for further use in varietal development and crop improvement program. Landraces Rato Masino, Thakali Lahare Marsi, Biramful, Lekali Marsi were found to be promising varieties for yield. Overall, this study provides basic information for rice variety improvement as well as breeding programs.

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