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FARMER'S PARTICIPATORY VARIETAL SELECTION IN *JAPONICA* RICE (*Oryza sativa* L.) IN KASHMIR VALLEY

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SUMMARY

The study was undertaken during *kharif* 2013 in two districts of Kashmir valley and in each district two locations were selected under mountain irrigated agroecologies for laying out the mother trials, besides two grandmother trials at Mountain Crop Research Station, Larnoo and Krishi Vighan Kendra Pombay in RBD design with 2 replications. The experimental materials used were 10 *japonica* genotypes including popular variety (K-332) and farmer's variety as check genotypes. Participatory rural appraisal (PRA) revealed that rice ranks first among all crops and mono-cropping is usually in vogue and canal system fed by melting snow is the main source of irrigation water. Among major production constraints, low yielding varieties, blast and cold stress were considered important and farmer saved seed is the main source of seed to raise the new crop. Traits like high tillering, tall stature, more grains per panicle and variety possessing medium bold seed, high biomass, early maturing, medium threshing, white grain color with aroma were looked for by the farmers. Participatory varietal selection (PVS) through focal group discussions (FGD) identified GSL-11 and SKUA-402 as the most preferred genotype with highest ranks of 1.4 and 1.6 respectively. Analysis of variance as per Eberhart and Russel (1966) showed significant difference in the genotypes across locations for all the traits. Mean squares due to genotype × environment (linear) interaction component and environment (linear) component illustrated significance for most of the traits. Pooled deviation for all the traits except 100-grain weight was found significant. On the basis of stability parameters SKUA-402 and GSL-11 were identified as the stable genotypes for grain yield..

Key words: Eberhart and Russell model, *Japonica* rice, mountain agroecologies, PRA, PVS, stability

Key findings: The research is of utmost importance to researchers in general and plant breeders in particular. The key findings of the research highlights the importance of farmers preferences for a variety and transform the intention of breeders that it is far better to set the breeding objectives on the basis of what farmers actually want in the variety and not to decide the same at the research station and laboratories.

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INTRODUCTION

Rice is the world's most important food crop and a primary source of food for more than half of world's population. More than 90% of world's rice is grown and consumed in Asia where 60% of people live. Rice accounts for 35-75% of calories consumed by more than 3 billion Asians. It is planted to about 154 m ha annually or on about 11% of the world's cultivated land (Anonymous, 2012a). Rice possessing a significant position in the economy of state of Jammu and Kashmir (India) is grown on an area of 0.243 M ha with a production of 0.512 M tons and productivity of around 2.2 t ha^{-1} (Anonymous, 2012b). Rice being the staple food of inhabitants of Kashmir valley covering 55% (0.141 m ha^{-1}) of the total rice area of the state and is grown over an altitude range of 1350-2300 m AMSL. Plain or valley basin areas (1350-1800 m altitude) enjoy relatively better and favourable growing conditions and *indica* varieties are predominantly grown in this area whereas, mountain agroecology (high altitude region) situated between 2000 to 2300 m AMSL in foot hills, constitute 12-15% of total rice cultivated area of the valley is characterized by short growing seasons, low atmospheric temperature, cold irrigation water and insufficient solar radiation. The crop is frequently challenged by various biotic and abiotic stresses. The rice varieties cultivated in this area are mostly of *japonica* type and varietal group is much restricted. The productivity is extremely low due to cultivation of low yielding varieties under such ecologies (1-1.5t/ha). Despite the fact that rice being the only ray of hope for sustainable source of farm income and livelihood and food grain security, the high altitude rice has not received much attention from breeders, farmers and policy makers alike due to inherently narrow genetic profile, relegation to harsh environment, lack of major technological breakthroughs and lack of encouraging policy support from the government. The seed replacement rate is quite disappointing (less than 2%) [Parray *et al*. (2012)] and farmers are still growing some obsolete varieties and low yielding landraces. They have not been exposed to acceptable alternatives to their existing varieties/landraces owing to the fact of lack of appropriate genetic resources and long history of cultivation under marginal conditions and farmers interests not been taken into consideration while developing the varieties for such agroecosystems. To meet the demand of mounting population the increase in production has to be achieved under the challenges of declining resource base such as land, water, labour and other inputs without adversely affecting the quality of environment.

The objective of this study was to devise the way to enhance productivity in high altitude marginal ecologies through focus on better understanding farmer's varietal preferences by using farmers' participatory varietal selection (PVS). PVS approach has been employed by many workers to evaluate, identify and disseminate different genotypes on farmer's field as per farmer's tastes about various traits and their perception and aspirations about varietal specification (Joshi *et al*. 2005; Witcombe *et al*. 2005; Gyawali *et al.* 2010; Yadavendra and Witcombe, 2013). The role of genotype x environment interaction in rice under varied conditions have been reported by Sambandon *et al*. (2008), Kadhem and Al-Nedawi (2011), Bose *et al.* (2012) and Mosavi *et al*. (2013).When participatory techniques are appropriately employed in plant breeding they can have a quick impact by identifying improved crop varieties for resource poor farmers in marginal environments who previously were entirely dependent on landraces (Virk *et al.,* 2003; Witcombe *et al.*, 2003).

MATERIALS AND METHODS

This investigation was conducted during *kharif* 2013 in two districts of Kashmir viz., Anantnag (34˚ N latitude; 74˚ E Longitude) and Pulwama (33.87˚ N Latitude; 74.89˚ E Longitude).Although both are southern districts of Kashmir valley, however the latter district is relatively warmer and rice crop cultivation starts 1 to 2 weeks earlier than the former district. The sunshine hours are also relatively better in the former district and more number of favorable days is available for the crop. Before laying out the PVS trials, Participatory Rural Appraisal was conducted at 16 sites representing high altitude mountain agro ecologies of Kashmir valley and 50 farmers at each site were identified for such study. The Household Level Questionnaire (HLQ) was composed of some easy questions and same were asked to the farmers in vernacular language with the purpose to identify background information, rice production constraints as well as the farmer's perception about rice varietal specifications. The qualitative comparison data generated through PRA was analyzed using χ^2-test as used by Virk *et al*. (2003).

The two grandmother trials (on Research Station) were laid at experimental farms of Mountain Crop Research Station, Larnoo (2290 m ASL) and KVK, Pombay (1860 m AMSL). In each district, two locations and at each location two farmers were identified to lay out the mother trial (trials in the farmer's fields). The trials were designed by the researcher but laid and managed by the identified farmers. The material for such trials was composed of 10 genotypes. The test genotypes were developed at MRCFC, Khudwani during 2008 and trait combinations preferable for mountain agroecosystems were taken into consideration while selecting the parents for making crosses and further selecting the material in advance generations. The advanced breeding materials of such crosses along with some released and preleased varieties including popular variety and farmer's variety (Table 1) were taken directly to farmer's field during 2013 to seek farmer's preferences through PVS and at the same time estimation of G x E interaction were carried out to observe a change in magnitude of response across locations. Both grandmother and mother trials were laid out in randomised block design with 2 replications (researcher designed) represented by 3 rows of 2 meter length and inter- and intra-row spacing of 20 cm and 15 cm respectively with a plot size of 1.2 m^2.

Table 1. Brief description of the genotypes used in the present study.

Genotypes	Pedigree	Remarks
Advance lines		
1) K-08-73	Kohsar x K332	Intervarietal *Japonica* crosses conducted in 2008.
2) K-08-63	Koshikari x K-508	
3) K-08-69	Koshikari x K475	
Pipeline varieties		
4) SKUA-524	GSL-25	Genetic stock and some pure line selections
5) SKUA-506	Larnoo selection-2	
Pre-released		
6) SKUA-402	Parental lines were *Kohsar(a* released variety) and PS 86014-TR 891-7-2-1 (IRCTN-nursery)	
Germplasm lines		
7) GSL-61	V_7 (IVT-I) of 2012	Material selected from research trials of MCRS
8) GSL-11		
Checks		
9) K-332		Popular variety
10) Farmer's check		Variety grown by the farmer

Preference data

A group of farmers were allowed to vote for their preferred genotypes as per their own selection and preferential indices during farm walk by depositing paper ballots in a bag in front of each plot. During the farm walk the bag was placed in front of each plot in the trial, and the bag served as ballot box for genotype. Each farmer was given 2 ballot of different color and was asked to vote for preferred variety. The preferential score (PS) was calculated as:

$$PS = \frac{\text{No. of positive votes – No. of negative votes}}{\text{Total no. of votes}}$$

(De-Boef and Thijssen, 2007)

The data on various quantitative traits namely, days to 50% flowering, days to maturity, plant height(cm), number of panicles plant^{-1}, panicle length (cm), number of grains panicle^{-1}, biological yield plot^{-1} (kg), grain yield plot^{-1} (kg) and 100-grain weight were recorded at appropriate stages. The data generated from replicated grandmother and mother trials was analyzed through ANOVA.

Stability analysis

Linear model of Eberhart and Russell (1966) was followed for analyzing the stability of the 10 genotypes across 6 locations including 4 farmers' locations by model: $Y_{ij} = \mu_{i} + bi_{Ij} + S^2_{ij}$ using *WINDOSTAT* software version 8.5 (Windostat Inc. Hyderabad, India).

RESULTS AND DISCUSSION

In this investigation PRA was conducted to obtain the background information of mountain agroecologies of Kashmir valley, to identify major production constraints and to determine the farmer's perception about varietal specification of rice crop. The background information revealed that under mountain irrigated ecosystem of Kashmir valley, only rice is being grown however, mono-cropping is in vogue due to limited number of favourable days available for other crop (data not shown). Further main source of irrigation water is the canal system fed by melting snow. Among major production constraints, low yielding varieties was identified a significant factor in limiting rice crop production followed by diseases particularly blast. Cold stress was also identified a concern to rice crop posing a big threat particularly at critical stages of crop growth. Further farmer's saved seed of traditionally grown rice varieties is the main source of seed to raise the new crop. Regarding specification of new varieties for low production potential system of mountain agroecologies of Kashmir, farmers showed their willingness for the varieties which possess high tillering, tall stature, long panicle, more grains panicle^{-1} and medium bold grained varieties. In addition the varieties should have high biomass, early maturity and medium threshability. Regarding postharvest traits, the characters looked for by the farmers were easy milling, high head rice recovery, high volume expansion of cooked rice, soft texture of cooked rice preferably with aroma. The PRA if conducted in a systematic manner can better identify the traits needed in new variety (Sthapit *et al*., 1996; Joshi *et al*., 2002). Joshi and Witcombe (1996) carried out PRA and got the valid information that there was no adoption of improved cultivars in any crop and improved cultivars available in the market did not meet the farmer's needs. The PRA proved to be quick and effective method of identifying and characterizing what the farmers grow and subsequently showed the importance of PRA as first step in choosing which cultivars should be tested with farmers. HLQ were conducted to determine the perception for new varieties in Nepal (Joshi and Witcombe, 2002). Farmers identified varieties and preferred those having early maturity, market price, good milling and eating qualities and shape of the grain. Virk *et al*. (2003) and Witcombe *et al*. (2005) conducted PRA and identified constraints of the target area and the traits the farmer require in a variety which in turn are important for goal setting in a plant breeding program.

In this investigation, 10 genotypes including 2 checks were evaluated by farmers in 5 PVS trials; 4 locations in the farmer's fields and one location at MCRS, Larnoo (Table 2). Just one week before harvest Focal Group Discussions were used to evaluate the varieties. At village Pastuna (Tral) highest preferential scoring i.e. lowest rank value was recorded on GSL-11 (1) followed by SKUA-402 (2) and SKUA-524 (3). The lowest preference was recorded for K-08-63(10). Similarly at village Satoora (Tral) maximum scoring was recorded for GSL-11 (1) and the minimum for Farmer's check (10). At Larnoo Village SKUA-402 received maximum number of votes and ranked 1st followed by SKUA-524 (2), GSL-11(2) and GSL-61 (4). The maximum farmer's votes at village Khretti were recorded for SKUA-402(1) followed by GSL-11(2), SKUA-524 (3) and so on, while as maximum number of negative votes was recorded for farmers' check (10). At Research Station most preferred variety was SKUA-402 (1) and GSL-11 (1). The variety that received maximum number of negative votes was K-08-63 (10). There was significant interaction between varieties and locations as observed from the data of preferential ranking. Most of the variations in ranking between sites were for the lower ranked entries. Farmer's variety was the least preferred type and was at par with the test genotype K-08-63 (Table 3). Also genotypes GSL-11, SKUA-402 and SKUA-524 were found at par in terms of rank summation index and mean preference ranking and significantly different from K-08-73, K-08-69, SKUA-506, GSL-61 and K-332 and the genotypes of latter group in turn were statistically at par. K-08-63 was least preferred and was at par with the farmer's variety. The reasons of the preference for varieties were related to many traits including high biomass (biological yield) and grain yield, early maturity, good plant height (100-110 cm) and free from blast disease. PVS approach has been employed by so many rice workers to evaluate, identify and disseminate different genotypes on farmer's field as per his tastes regarding various traits and their perception about varietal specification (Joshi *et al*. 2005; Witcombe *et al*. 2005; Gyawali *et al*. 2010; Yadavendra and Witcombe 2013).

Table 2. Farmers preference ranking (scoring) of different test varieties of rice in mother trials at five locations.

Genotypes	Pastuna, Tral (n = 26, f = 20)		Satoora, Tral (n = 26, f = 16)		Larnoo (n = 19, f = 15)		Khreti village (n = 28, f = 25)		Research station (n = 13, f = 13)	
	Positive votes	Preferential scoring	Positive votes	Preferential scoring	Positive votes	Preferential scoring	Positive votes	Preferential scoring	Positive votes	Preferential scoring
K-08-73	12	0.2	11	0.38	11	0.47	17	0.36	8	0.23
K-08-63	8	-0.2	12	0.50	11	0.47	16	0.28	7	0.08
K-08-69	13	0.3	13	0.63	8	0.07	12	0.16	9	0.38
SKUA-524	15	0.5	14	0.75	13	0.73	20	0.60	10	0.54
SKUA-506	9	-0.1	10	0.25	10	0.00	18	0.44	9	0.38
SKUA-402	17	0.7	13	0.63	14	0.87	22	0.76	12	0.85
GSL-61	14	0.4	11	0.38	12	0.60	15	0.20	7	0.15
GSL-11	18	0.8	15	0.88	13	0.73	21	0.68	12	0.85
K-332	11	0.1	9	0.13	12	0.60	14	0.12	8	0.23
F. check	10	0	8	0.00	7	-0.07	13	0.04	9	0.23

n = Number of farmers assemble; f = farmers who actually participated in preferential scoring

Table 3. Cumulative/average ranks of genotype over five locations.

Genotypes	Individual ranks					Cumulative rank	Average of ranks	Pooled preference
	Research Station, Larnoo	Satoora	Village Larnoo	Khretti	Pastuna			
K-08-73	6	6	6	5	7	30	6.0	1.64
K-08-63	10	5	6	6	10	37	7.4	1.13
K-08-69	5	3	8	8	4	28	5.6	1.50
SKUA-524	3	2	2	3	3	13	2.6	3.12
SKUA-506	9	8	9	4	4	34	6.8	1.03
SKUA-402	2	3	1	1	1	8	1.6	3.81
GSL-61	4	6	4	7	9	30	6.0	1.73
GSL-11	1	1	2	2	1	7	1.4	3.94
K-332	7	9	4	8	7	35	7.0	1.18
F. check	8	10	10	10	4	42	8.4	0.35
SE						3.95	0.79	0.39

Virk *et al.* (2003) used FGDs to evaluate the varieties for grain and straw yield, grain type, grain color through overall ranking. Joshi *et al.* (2007) through client oriented breeding determined farmer's preferences and adoption and identified varieties for Bangladesh and Nepal. Further significant interaction between varieties and locations for the preferences ranking was recorded. Most of the variations in ranking between sites were for the lower ranked varieties (Witcombe *et al*., 2005).

Estimation of the genotype x environment interaction is an important consideration in plant breeding programs because it otherwise reduces the progress from selection in the target environment (Hill, 1975). The most desirable property of genotypes for acceptability for commercial cultivation is their stable performance across locations (environments), which also remain the aim of breeders to develop or identify such genotypes that are stable across a range of environments. The significant genotype x environment interaction reduces the usefulness of genotypic means for identifying superior cultivars. Eberhart and Russel model (1966) is a widely used where regression and deviation from regression are taken for analysing stability of a variety. They recommended growing of varieties in adequate number of environments (covering a full range of possible environmental conditions so that useful information is available regarding the stability. The analysis of variance in this study revealed the existence of significant differences among the genotypes for all the traits viz., days to flowering, days to maturity, plant height (cm), number of panicle plant^{-1}, panicle length (cm), number of seeds panicle^{-1}, biological yield plot^{-1} (kg), grain yield plot^{-1} (kg) and 100-seed weight (g) indicating the presence of genetic variability in the experimental material under investigation (Table 4). The analysis of variance for different components following Eberhart and Russell model (1966) revealed that mean squares due to environment + (genotype × environment) were significant for most of the traits except panicle length and 100 seed weight depicted the distinct nature of environment and genotype × environment interaction on phenotypic expression (Table 5). Similarly genotype × environment was found significant except for panicle length and 100 seed weight. Genotype × environment (linear) interaction component illustrated non-significance only for 100 seed weight whereas, for rest of the traits it showed high significance indicating that location (environment) had a marked influence on the expression on the genotypes and their behaviour could be more precisely predicted over environments. Mean square due to environment (linear) component was found to be non-significant only for 100-seed weight however, for all the other characters the same was observed to be significant implied that means of genotypes varied considerably at different locations. Further significant pooled deviation for all the traits except 100-grain weight suggested that the performance of different genotypes fluctuated considerably from their respective linear path of response to environments. Predominance of linear component of genotype × environment to non-linear component (pooled deviation) suggested that genotype × environment interaction was largely the outcome of linear function of genotype × environment and performance can be predicted across the environments with great precision. On the basis of this component, the stability of genotype performance can be predicted and recommended for cultivation with high degree of confidence across more or less equivalent ecologies. Significant estimates of G x E and other components for different agro-morphological traits in rice have been reported under different environments such as dry/wet seasons, tropical/subtropical conditions, marginal/rich soil environments besides, different management practices like dates of sowing, using various spacing, different doses of fertilizers and irrigational levels etc. (Deshpande *et al*. 2003; and Swamy and Kumar,2003; Kadhem and Al-Nedawi 2011; Bose *et al*. 2012; Mosavi *et al*. 2013) and Sellammal and Robin (2013). G x E interaction is a major concern in plant breeding for 2 main reasons; first, it reduces progress from selection, and second, it makes cultivar recommendation difficult because it is statistically impossible to understand the main effects (Kang and Gauch, 1996). There is a general agreement among breeders that average yield alone may not be sufficient to estimate the performance of certain genotype, since it does not indicate the relative performance as compared to other genotypes over different environments. Apart from yield

Table 4. Analysis of variance for different morphological, maturity, yield and yield component traits in selected rice genotypes across 6 environments.

Source of variation	d.f.	Days to 50% flowering	Days to Maturity	Plant height	No. of panicles plant^{-1}	Panicle length	Seeds panicle^{-1}	Biological yield plot^{-1}	Grain yield plot^{-1}	100-seed weight
Replication	1	0.408	6.075	9.918	0.102	0.31	50.44	153.21	0.001	0.003
Genotypes	59	59.32**	27.34**	110.17**	5.36**	7.01**	492.60**	249.35**	0.82**	0.52**
Error	59	8.696	6.38	1.776	1.531	19.594	19.594	50.06	0.003	0.0003
Bartlett's test for homogeneity of variances		0.4633	1.5035	11.769	4.992	7.235	0.008	7.396	21.28	9.471
C.V.		6.281	4.651	2.238	4.992	5.705	7.917	6.625	10.402	8.516

*Significant at *P* = 0.05; **Significant at *P* = 0.01

Table 5. Analysis of variance for stability of different traits in selected rice genotypes across 6 environments.

Source of variation	d.f.	Mean squares								
		Days to 50% flowering	Days to Maturity	Plant height	No. of panicles plant^{-1}	Panicle length	Seeds panicle^{-1}	Biological yield plot^{-1}	Grain yield plot^{-1}	100-seed weight
Genotypes	9	223.97**	121.418**	257.953**	12.657**	19.088**	1390.038**	0.555**	0.037**	18.70**
Environment + (Genotypes × Environment)	50	4.786**	3.851**	26.334**	1.840*	0.704	40.429**	0.028*	0.017*	0.029
Environment	5	1.813**	4.563**	28.408*	1.317**	1.089	62.635**	0.050*	0.011**	0.008
Genotypes × Environment	45	4.897**	3.772**	17.478*	1.725*	0.661	37.961**	0.250**	0.019*	0.310
Environment (linear)	1	11.325**	22.801**	142.026**	1.583**	1.444*	313.194**	0.262**	0.021**	0.420
Genotype × Environment (linear)	9	10.36**	10.882**	42.867*	1.823**	0.204	60.841*	0.019**	0.045*	0.050
Pooled deviation (non-linear)	40	3.227**	1.802**	10.017**	0.582**	0.698**	17.328*	0.016**	0.011*	0.024
Pooled error	60	0.908	0.583	0.956	0.75	0.264	0.055	0.108	0.018	0.064

*Significant at *P* = 0.05; **Significant at *P* = 0.01

Table 6. Stability parameters for panicle length, seeds panicle-1, biological yield and grain yield in selected rice genotypes evaluated across 6 random environments.

Genotypes	Days to 50% flowering			Days to Maturity			Plant height (cm)			Number of panicle plant^{-1}		
	Mean ($\bar{X}$)	b_i	Mean ($\bar{X}$)	Mean ($\bar{X}$)	b_i	S^2d_i	b_i	S^2d_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i
K-08-73	90.83	0.89	77.91	15.91	0.21	0.93	0.07	1.46	9.58**	140.75	0.32	4.13**
K-08-63	92.83	2.11	68.00	17.91	-2.63	-0.22	-0.35	4.01*	0.52	142.33	2.35	4.96**
K-08-69	90.66	-4.53	75.12	15.25	1.89	0.33	0.20	-0.14	1.99*	139.58	-1.11	4.36**
SKUA-524	87.83	-1.16	87.83	14.83	2.00	-0.45	1.33	3.74*	-0.23	136.75	0.76	1.77*
SKUA-506	95.33	0.21	70.83	13.91	-0.74	0.28	2.17	17.43**	1.04	143.41	2.02	5.6**
SKUA-402	87.5	2.58	82.83	16.58	3.26	0.13	4.94	40.12**	1.18	137.66	0.83	3.61**
GSL-61	94.58	4.21	82.10	17.41	2.26	-0.03	-0.23	7.73**	3.54**	143	0.69	2.92**
GSL-11	86.83	-2.95	85.71	17.91	2.58	0.54	0.74	0.30	1.27	136.58	1.96*	1.34*
K-332 (Popular variety)	102.58	6.11	82.03	18.08	-1.32	-0.52	2.14	7.34**	1.59*	144.66	1.52	7.75**
Farmers check	104.5	2.53	73.71	15.83	2.47	0.22	-1.00	0.59	2.71**	146.25	0.87	1.787**
Population mean		93.35			141.1			78.6		16.36		
SE(m)		0.86			0.9			1.41		0.41		
SE(b_i)		2.6			0.9			0.83		2.34		

Genotypes	Panicle length (cm)			Seeds panicle^{-1}			Biological yield plot^{-1} (Kg)			Grain yield plot^{-1} (Kg)		
	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i
K-08-73	13.3	1.93	0.32	89.75	-0.18	-6.58	1.81	0.33	-0.01	0.443	1.92	-0.02
K-08-63	15.74	1.27	-0.12	104.91	3.03	29.37**	2.00	0.45	-0.01	0.487	-5.35	0.00
K-08-69	13.83	0.97	1.44*	96.53	0.55	-4.43	2.28	0.49	-0.01	0.577	10.35*	-0.01
SKUA-524	15.40	1.28	-0.13	119.66	0.53	-4.81	2.18	0.13	-0.01	0.565	-10.77	0.01
SKUA-506	14.95	-0.21	1.06*	94.05	0.09	-5.73	1.58	1.14	0.04**	0.497	14.29*	-0.01
SKUA-402	11.91	1.16	-0.02	116.83	-0.25	-1.82	2.03	-0.67	-0.01	0.688	3.20	-0.01
GSL-61	11.68	0.92	-0.08	79.58	1.58	8.27	1.36	-0.14	0.00	0.620	6.39	0.00
GSL-11	11.86	0.49	1.11	11.26	3.45	122.57**	2.31	4.40*	0.02	0.662	-0.48	0.00
K-332 (popular variety)	11.5	1.62	0.38	103.78	-0.53	49.41	1.86	3.18*	0.01	0.611	-15.05*	0.00
Farmers check	10.9	0.56	0.36	73.73	1.72	3.39	1.84	0.69	-0.01	0.537	5.50	-0.01
Population mean		13.11			99.00						1.92	0.56
SE(m)		0.37			2.40						0.05	0.04
SE(b_i)		1.13			1.00						0.75	4.58

b_i = linear regression value and S^2d_i = deviation from linearity earliness, biological yield, long panicles with high number of grains, threshing and cooking quality traits are also needed to predict G x E.

Further the stability parameters such as mean ($\bar{x}$), regression coefficient (b_i) and deviation from regression (S^2d_i), as suggested by Eberhart and Russell (1966) were considered to explain and discuss the stability of 10 *japonica* rice genotypes including popular variety (K332) and farmer's variety as checks to make out the genotypes suitable across a range of environments and for a specific environment. An ideal genotype is defined as the one possessing high mean performance, with regression coefficient around unity (b_i = 1) and deviation from regression (S^2d_i) close to zero. GSL-11 and SKUA-402 were observed to be most stable across 6 test locations for days to 50% flowering viz- a- viz., earlier to flower. Similarly stable genotypes for days to maturity were SKUA-524 and SKUA-402; however GSL-11 proved inconsistent for maturity across the test locations (Table 6). Likewise for plant height and number of panicles plant^{-1}, GSL-11 was recognized as the most stable genotype. K-08-63 and SKUA-524 were reported to be highly adaptable across the locations for long panicle and number of seeds panicle^{-1} respectively. Further the promising genotype with respect to stability for biological yield was K-08-63, whereas, SKUA-402 and GSL-61 were found to possess wide adaptation for grain yield. For grain yield some genotypes were identified to be suitable to better and poor environments. The test genotypes K-08-69 and SKUA-506 were found suitable to better environment and popular variety K-332 for poor environments.

CONCLUSION

PRA gave feedback to breeders to breed such varieties for mountain irrigated agro-ecologies particularly for Kashmir valley as possess high biomass and grain yield with blast and cold resilience, high tillering, tall stature, medium threshing and medium bold seed with white milled grain color preferably with aroma. No aromatic genotype was used in the study because of their non-adaptability under such ecologies. The most preferred genotypes identified by the FGD through PVS were GSL-11 and SKUA-402. These genotypes need to be evaluated further by baby trial evaluation system on big plot size and over many more locations to corroborate the real performance and finally to recommend the varieties for up scaling through participatory seed production. The same genotypes were also identified as the most stable across all the test environments/locations for yield and other desirable traits put emphasis on the role of further evaluation both spatially and temporally so that the recommendation of genotypes can be suggested supported by data.

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REFERENCES

Anonymous (2012a). Area and production of field crops in India, www.indiastat.com.

Anonymous (2012b). Statistical Digest (2012-2013). Directorate of economics and statistics, planning and development, Government of Jammu and Kashmir, Srinagar, pp. 109-113.

Bose LM, Nagaraju M, Singh OM (2012). Genotype x environment and stability analysis of lowland rice genotypes. *Journal of Agricultural Sciences* 57(1): 1-8.

De-Boef W,Thijssen M (2007). Participatory tools working with crops, varieties and seeds. *Wageningen International*, p. 83.

Deshpande VN, Dalvi VV, Adadoot GS, Desai SB (2003). Stability analysis in hybrid rice. *Journal of Maharastra Agricultural Universities*, 28 (28): 87-88.

Eberhart SA, Russell WA (1966). Stability parameters for comparing varieties. *Crop Sci.*6: 36-40.

Gyawali S, Sthapit BR, Bhandari B, Bajaracharya J, Shrestha PK, Upadhyay MP, Jarvis DI (2010). Participatory crop improvement and formal release of *Jethobudho* rice landrace in Nepal. *Euphytica* 24: 30-32

Hill J (1975). Genotype-environment interaction - A challenge for plant breeding. *Journal of Agricultural Sciences* 85: 477-493.

Joshi A,Witcombe JR (1996). Farmer participatory crop improvement. II. Participatory varietal selection, a case study in India. *Experimental Agriculture* 32(4): 461-477.

Joshi KD, Witcombe JR (2002). Participatory varietal selection in rice in Nepal in favourable agricultural environments- a comparison of two methods assessed by varietal adoption. *Euphytica* 17: 445-458.

Joshi KD, Sthapit B, Subedi M, Witcombe JR (2002). Participatory plant breeding in 10 rice in Nepal. In : *Farmers, Scientists and Plant Breeding: Integrating Knowledge and Practice* [Eds. D.A. Cleveland and D. Soleri]. Local Initiatives for Biodiversity, Research and Development (LI-BIRD), PO Box 324, Pokhara, Nepal, pp. 239-267.

Joshi KD, Devkota K, Musa A, Johansen C, Gyawali S,Witcombe JR (2005). An informal network in south Asia: the impact of new rice varieties in Nepal and Bangladesh developed using client-oriented breeding. *Aspects of Applied Biology* 75: 65-66.

Joshi KD. Musa AM, Johansen C, Gyawali S, Harris D,Witcombe JR(2007). Highly client oriented breeding using local preferences and selection, produces widely adapted rice varieties. *Field Crop Research* 10: 107-116.

Kadhem FA, Al-Nedawi(2011).Association between parametric and nonparametric meaures of phenotypic stability in rice genotypes (*Oryza sativa* L.) .*Agricultural Sciences-Journal*. 2(2): 20-33.

Kang MS, Gauch Jr H (1996).*Genotype-by-environment interaction*. CRC Press, New York, pp. 416.

Mosavi AA, Jelondar NB, Kazemitabor K (2013). Environmental responses and stability analysis for grain yield of some rice genotypes. *World Applied Sciences Journal* 21(1): 105-108.

Parray GA, Najeeb S, Bhat MA and Ashaq Hussain (2012). Rice research paradigms in Kashmir: Present status and future prospects. In: S.A. Wani, G.A. Parray and S. Najeeb, eds., *Rice research in Kashmir, a historical perspective*. SKUAST-Kashmir. pp.11-25.

Sambandon ST, Mehla BS, Singh R (2008). Stability in rice (*Oryza sativa* L.). *National Journal of Plant Improvement* 10(2): 154-158.

Sellammal R, Robin S (2013). Stability analysis of rice (*Oryza sativa* L.) genotypes under drought stress. *Indian Journal of Genetics and Biotechnology* 5(4): 236-240.

Sthapit BR, Joshi KD,Witcombe JR (1996). Farmer participatory crop improvement III. Participatory plant breeding, as case study for rice in Nepal. *Experimental Agriculture* 32: 479-496.

Swamy MN, Kumar BMD (2003). Stability analysis for grain yield and its component. *Karnatka Journal of Agricultural Sciences* 16(2): 222-227.

Virk DS, Singh DN, Kumar R, Prasad SC, Gangwar JS,Witcombe JR (2003). Collaborative and consultative participatory plant breeding on rice for the rainfed upland of eastern India. *Euphytica* 132: 95-108.

Witcombe JR, Joshi A, GoyalSN (2003). Participatory plant breeding in maize: a case study from Gujrat, India. *Euphytica* 130: 413-422.

Witcombe JR, Joshi KD, Gyawali S, Musa AM, Johansen C, Virk DS, Sthapit BR (2005). Participatory plant breeding is better described as highly client-oriented plant breeding. I. Four indicators of client-orientation in plant breeding. *Experimental Agriculture* 41(3): 299-319.

Yadavendra JP, Witcombe JR (2013). The impact of maize and rice varieties from client oriented breeding on the livelihoods of poor farmers in western India. *Journal of Breeding and Genetics* 45(1): 132-142.