PARTICIPATORY VARIETY SELECTION FOR SALT TOLERANT RICE

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ABSTRACT

Breeders are habituated to develop rice varieties on the centralized breeding approach. Varieties recommended in this method are popular to farmers at favorable rice production systems and often they are not suitable for stressed soil like saline prone land. To develop varieties suitable for saline prone areas, farmers' participation are directly involved to choice variety as they want. A large range of salt tolerant improve genotypes was grown in mother and baby system trials of participatory variety selection (PVS) at five coastal areas of Bangladesh. Experiments in farmers fields with farmers participation based on their needs has helped identify high yielding varieties for their lands. The success of PVS in the five coastal localities has convinced researchers and partner organizations to mirror the appreciation for this approach of rice variety development in risk prone environment. Among 234 genotypes the chosen five for both of Boro and T. Aman seasons of PVS were included in the national variety release system.

Key words: Participatory variety selection, salt tolerant, rice

INTRODUCTION

Rice is among the most important food crops of the world and it is the most consumed food in Asia. With the increasing human population in recent years, land scarcity, and high food demand to attain food security, marginal lands such as saline-prone areas should be exploited. Salinity is one of the most common abiotic stresses in rice growing areas of the world. About 400-950 million hectares of land around the world (Lin *et al*, 1998) and 0.83 million hectare in Bangladesh (Karim *et al*, 1990) are affected by different levels of salinity. The rice plant is one of the most suitable crops for saline soil, although it is considered to be moderately sensitive to salinity (Mori and Kinoshita, 1987).

Soil salinity is one of the major constraints to rice production in coastal areas of Bangladesh. To reduce salinity, major engineering structure and expensive soil amendments are needed. However, these amendments require large investments. Thus tailoring rice plants to adapt in salt stress prove to be practical and effective. In fact, a few varieties have been developed to cope with the varied soil and climatic conditions of the coastal areas. The urgent need therefore, for the development of saline tolerant varieties in the coastal areas of Bangladesh.

Breeders are used to develop rice varieties through on-station trials and farmers' participation is generally considered not so important. The bottlenecks of this approach could be realized by observing the popularity of a variety in one region but not in other regions. Moreover, the value for cultivar use of these varieties in marginal, risk prone and stress environments is limited. Therefore, evaluation of the genotypes at the real environment and participation of the end users in the process of variety development have been emphasized. In this study, Participatory Variety Selection (PVS) was initiated to develop high yielding rice varieties for the coastal saline areas of Bangladesh.

MATERIALS AND METHOD

Three sets of Bangladesh Rice Research Institute (BRRI) and International Rice Research Institute (IRRI) developed advance lines that can tolerate salt stress of EC 8-10 dSm^{-1} and with large range of plant characters composed of 72 for wet season (T. Aman), 76 for irrigated (Boro) and 86 for Upland were selected for evaluation in the "Mother and Baby" system trial of PVS. PVS trials were conducted in five sites at the saline prone coastal districts. In three years, 234 salt tolerant genotypes from IRRI and BRRI were placed in PVS mother trials at 5 coastal sites of Bangladesh.

The soil salinity status of the mother trial plots across the three crop seasons were shown in Table 1. All the trial plots had initial soil salinity above the critical level (>4.0dS/m) except Noakhali in the T. Aman season. The mean salinity level was highest in Boro followed by Upland and T. Aman plots. The mother trial for T. Aman was conducted at four sites viz. Char-Sonapur (Sonagazi), Char-Lawrence (Laxmipur), Char-Jabbar (Noakhali) and Benarpota (Satkhira) in 2001 followed by baby trials in 2002 and evaluation in farm walk farmer fields at three villages in 2003.

Table 1. Soil salinity of mother trial plots at five sites across rice crop seasons

Site	Plot location	Soil EC (dSm-1) in crop season		
		T. Aman	Boro	Upland
Sonagazi	Sonapur	5.9	--	6.2
Laxmipur	Char Lawrence	8.3	--	10.0
Noakhali	Char Jabbar	3.6	--	--
Satkhira	Benarpota	6.9	6.9	--
Kaliganj	Gobindapur	--	10.5	--
	Mean	**6.2**	**8.7**	**8.1**

Similarly, mother trial of Boro season was done at Benerpota (Satkhira) and Gobindopur (Kaliganj) sites in 2000-01 and also at Benarpota in 2001-02 followed by baby trials in 2001-02 and 2002-03 crop seasons. Farm-walks of farmers were organized for baby trials at seven villages.

Non-replicated mother trials and BRRI research managed on-farm experiments were done in cooperation with the participating farmers. BRRI research managed experiment was conducted under the direct supervision of Plant Breeder and follow the standard BRRI recommended management practices. Baby trials were conducted under farmers own management practices, breeders were monitored several times at the growing period of rice. The launching of the PVS was done at crop maturity. DAE and five NGO's (Gurpukur, Uttaran, Shushilan, Proshika and BRAC organized the 25-40 resource poor farmers (RPFs) including 0-15 women for the mother trials across the sites and crop seasons. A briefing was made on the importance of involving farmers in the progress of variety development through PVS. The participating farmers were divided into 3-4 groups (8-10 farmers per group), and a researcher led each group. Each farmer was given a simple PVS evaluation sheet asking them to choose one or two genotypes to grow as baby trials in their fields under their own management. After the field visit, PVS sheets were collected and two/ three farmers from each group were called immediately on a random basis to express their views and opinions on the selection made. A mother trial of upland ecosystem was done at Sonagazi BRRI farm in 2002 ands at Upakul Villa (Char-Lawrence, Laxmipur) in 2003.

All the PVS farmers were supplied with 500 g seeds of the chosen genotypes to be grown in their fields as baby trials. On the other hand, the farm walk farmers selected seeds from baby trial farmers' fields. Baby trials and the farm walk farmers were monitored using the household level questionnaire (HLQ).

RESULTS AND DISCUSSION

PVS is the selection of genotypes/ varieties done by farmers in target environment using their own selection criteria. In PVS, access and selection of breeding lines are decentralized, with farmers' participation. Plant materials, which have all the combination of characteristics are selected by the farmers for the appropriate plant type and yielding ability in their respective salt stressed farms instead of researchers themselves.

PVS in T. Aman season

87 farmers took part in PVS at four mother trial sites. The farmers selected 10 from the 72 lines and these genotypes were designated as PVS-T1 to PVS-T10 representing T. Aman (Table 2). There was great variation in the choice of PVS-T genotypes by the farmers across locations. The advance lines had site specific preference. BRRI dhan40 (PVS-T9) and BRRI dhan41 (PVS-T10) were chosen by majority of the farmers followed by PVS-T7 in all the sites. The farmers were listed down the criteria for choosing the genotypes due

to their lodging tolerance, high yield, freeness from diseases, uniformity in maturity and growth duration. The Chosen varieties by farmers were different for different location. This confirms the site specificity of varieties for complex environment like costal areas.

Table 2. Selected genotypes from the mother trial and the frequency of PVS farmers across the location (T. Aman)

Entry	Designation	Number of farmers				
		Sonagazi	Noakhali	Laxmipur	Satkhira	Total
PVS-T1	BR5778-156-1-3-HR1	5	2	--	16	23
PVS-T2	BR5778-156-1-3-HR14	15	8	--	28	51
PVS-T3	BR5778-156-1-3-HR15	16	4	--	16	36
PVS-T4	IR66401-2B-14-1-1	3	--	1	9	13
PVS-T5	BR5999-82-3-2-HR1	18	3	14	3	38
PVS-T6	BR5999-82-3-2-HR10	10	3	13	5	31
PVS-T7	BR5999-82-3-2-HR16	6	13	28	8	55
PVS-T8	BR5333-34-4-6	14	--	--	--	14
PVS-T9	BRRI dhan40	16	19	19	9	63
PVS-T10	BRRI dhan41	28	18	28	12	86

There is a considerable variation in yield and other agronomic characteristics of the 10 PVS-T genotypes (Table 3). Most of the farmers preferred varieties had growth duration of 135-145 days except for PVS-T4, with early growth duration and were chosen at Sonagazi and Satkhira for high lands and crop intensification. The PVS-T farmers grew their selected genotypes as baby trials in 2002, under their own management practices. Data from HLQ showed that 50% of the farmers are discouraged of the results due to water stagnation in the field, which ranged 30 to 50 cm from transplanting to maximum tillering stage. The farm walks for baby trials participated by 96 farmers were conducted at three villages where there is no high-level water stagnation. Five PVS-T genotypes showed promising results and were selected by farmers (Table 4). Two sister lines (PVS-T5 and PVS-T7) were selected at Sonapur while two sister lines (PVS-T1 and PVS-T2) and PVS-T4 were chosen at Satkhira and Kaliganj sites.

Table 3. Agronomic performance of the PVS genotypes (T. Aman) in mother trial across the locations

Entry	plant height (cm)	Yield (t/ha)					Duration (days)
		Sonagazi	Noakhali	Laxmipur	Satkhira	Mean	
PVS-T1	126	1.4	5.9	2.1	3.8	3.3	135
PVS-T2	120	1.2	4.7	2.1	3.7	3.0	135
PVS-T3	124	1.2	5.4	2.3	4.3	3.3	136
PVS-T4	106	2.0	2.9	1.5	3.0	2.3	126
PVS-T5	130	3.6	6.4	5.2	4.7	5.0	135
PVS-T6	130	3.5	5.4	4.5	4.7	4.5	136
PVS-T7	130	2.2	4.4	3.8	3.8	3.5	135
PVS-T8	112	2.9	5.4	4.1	4.8	4.1	146
PVS-T9	136	1.7	4.9	4.5	3.8	3.7	138
PVS-T10	138	2.8	4.4	4.2	3.7	3.7	144

PVS in Boro season

Mother trial composed of 76 salt tolerant (EC 8-10 dS/m) genotypes was conducted at Satkhira and Kaliganj site. Thirty-seven farmers took parts in the PVS activity at maturity in cooperation with DAE and three NGO's namely Gurpukur, Uttaran and Shushilan. Government officials, Block Supervisors (BS) of DAE field level workers of the said NGO's and local leaders (Chairman and members of the Union Council). The 24 genotypes selected by participating farmers were designated as PVS-B1 to PVS-B24 representing Boro season. In 2001-02, at Benarpota, 42 farmers including 15 women from Kaliganj, Tala and Satkhira, participated the PVS activity. The PVS farmers selected 12 genotypes as shown in Table 5. The performance of the PVS-B

genotypes was highly accepted by farmers especially in yielding ability and shorter growth duration. The farmers' criteria for the selection of PVS genotypes were short growth duration and yield contributing characters. The fields with initial soil salinity levels of 8-10 dSm^{-1} EC were reduced to 2-3 dSm^{-1} at transplanting. It gradually increased and exceeded the critical level (4.0 dS/m) from late April. Thus, farmers preferred short duration genotypes for saline condition because they noted that with longer growth duration, the crops were damaged by high soil and water salinity at the later growth phases which is the reproductive stage.

Table 4. Performance of the PVS genotypes in baby trial and number of farmers selected each genotype (T. Aman)

Genotypes	Plant height (cm)	Duration (days)	Preference of farmers	Yield (t/ha)			
				Tala	Kaliganj	Feni	Mean
PVS-T1	132	126	27	4.5	5.0	--	4.8
PVS-T2	133	126	28	5.0	5.1	--	5.1
PVS-T4	91	112	34	4.5	3.4	--	4.0
PVS-T5	140	141	29	--	--	5.0	5.0
PVS-T7	139	140	17	--	--	5.0	5.0

Table 5. Performance of the PVS genotypes in mother trial and frequency of participating farmers (Boro)

PVS #	Designation	Frequency of farmers	Plant height (cm)	Yield (t/ha)
PVS-B2	BR5778-156-1-3-HR1	4	99	6.7
PVS-B3	IR63307-4B-4-3	7	121	6.1
PVS-B4	IR64419-3B-4-3	2	94	5.6
PVS-B5	IR65192-4B-14-1	3	78	6.3
PVS-B6	AT309-1-Gaz	5	90	4.9
PVS-B7	IR10206-29-2-1	3	93	6.7
PVS-B8	BR5777-11-2-4-1-HR2	32	93	6.7
PVS-B9	IR63275-B-1-1-3-3-2	7	104	5.7
PVS-B12	IR72046-B-R-1-3-1	5	97	7.0
PVS-B13	IR72046-B-R-6-2-2	5	93	6.4
PVS-B19	IR66401-2B-14-1-1	27	96	6.2
PVS-B20	IR60483-2B-17-2-1-2	10	96	6.3

The PVS farmers were supplied with 500gm seeds of their selected PVS-B genotypes for growing as baby trials under their own management in 2002-2003 Boro crop season. Farm walks were conducted at seven villages and 211 farmer participants identified five genotypes for diffusion and placed in the variety release system (Table 6). Ten PVS farmers were involved in growing the five PVS-Boro genotypes together with check variety to obtain comparative data to serve as the basis for the nomination for the varietal release on the coastal wetlands of Bangladesh. Seed samples of these 5 PVS-B genotypes were submitted to Seed Certification Agency for completing Distinct, Uniformity, and stability (DUST) evaluation as a requirement for national varietals release.

PVS in saline prone upland areas

The mother trial for 85 short duration (120-130 d) IR genotypes was conducted at BRRI farm in Sonagazi. The prevailing crop growing conditions in the upland coastal wetlands were the following: 1) dry direct seeded in dibbling method, 2) drought spell plus salinity (6-8 dS/m) stress from seedling to tillering stages, 3) water stagnation of 20-50 cm at tillering through maturity stages depending on the elevation and 4) harvesting of the upland rice on or before mid August for the transplanting of main rice crop (T. Aman). Considering the above mentioned diversified and difficult conditions, the mother trial was set at the BRRI Sonagazi station.

Table 6. Performance of the PVS genotypes in Baby trial and frequency of participating farmers (Boro)

Genotypes	Plant height (cm)	Growth duration (days)	No. of farmers	Yield (t/ha)							
				L1	L2	L3	L4	L5	L6	L7	Mean
PVS-B3	96	149	25	--	--	--	--	--	6.0	--	6.0
PVS-B8	91	153	36	6.0	6.2	6.0	6.0	--	--	--	6.05
PVS-B9	97	154	57	6.2	6.4	--	6.5	--	--	6.4	6.38
PVS-B13	93	145	27	--	--	--	--	6.0	--	--	6.00
PVS-B19	99	152	108	6.5	6.1	6.8	6.8	--	--	--	6.48

L1= Satkhira sadar, L2= Ashashuni, L3= Kaliganj, L4= Sakdah, L5= Uttaran, L6= Benarpota, L7= Kashipur

PVS activity was conducted in collaboration with DAE and two NGO's (Proshika and BRAC) of Sonagazi at crop maturity. Twenty-nine farmers including two women joined the PVS activity and 12 salt tolerant genotypes with good yielding ability were selected. The performance of the farmers selected varieties demonstrated higher yield than the BRRI dhan27 and shorter plant height.

A mother trial was composed of 22 genotypes including 12 PVS-A, was set up at Upakul Villa under Char Alexander of Laxmipur. Proshika, BRAC and DAE organized 31 farmers including five women to join the PVS activity. The male farmers visited the trial and selected four PVS-A genotypes (Table 7). Seeds of the PVS genotypes (500 g) were supplied to the PVS farmers for baby trials to be conducted in their own farms for next season.

Table 7. Performance of the PVS genotypes in mother trial and frequency of participating farmers (Aus)

Entry	Designation	Plant height (cm)	Growth duration (days)	Yield (t/ha)	No. of farmers
PVS-A2	IR72046-B-R-6-3-1	85	117	3.0	7
PVS-A6	IR63307-4B-4-3	103	120	3.1	11
PVS-A9	IR64419-3B-4-3	91	104	2.7	16
PVS-A10	BRRI dhan27	123	100	2.2	10

With PVS in the RPFs fields, and involvement of relevant NGOS, local government and extension scientists, and varieties were evaluated, selected, and distributed to farmers in the coastal wetlands of Bangladesh. After 6 seasons of PVS, at least 500 RPF were using the farmers selected varieties for Boro season. NGO like Gorpukur at Sathkira are conducting their own PVS in a techno demo using the 5 PVS-B materials in 3 villages involving 53 farmers. Five genotypes each for T. Aman and Boro seasons identified by farmers through PVS showed good potentials for diffusion, and were included in the national variety release system of Bangladesh.

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REFERENCES

Karim, Z., S. G. Hussain and M. Ahmed. 1990. Salinity problem and crop intensification in the costal region of Bangladesh. BARC Soil Publication. No. 33. P. 63.

Lin, H.X., S. Yanagihara, J.Y. Zhuang, T. Senboku, K.L Zheng and S. Yashima .1998. Identification of QTL for salt tolerance in rice via molecular markers. Chinese J. Rice Sci. 12(2):72-78.

Mori, I. and T. Kinoshita .1987. Salt tolerance of rice callus clones. Rice Genet. Newsl. 4:112-113.