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Farmers' preferences to varietal attributes as an indicator for acceptance and adoption of aromatic rice (*Oryza sativa*) varieties

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ABSTRACT

Indian Agricultural Research Institute is known for developing improved varieties of rice (*Oryza sativa* L.) which have spread to different corners of India. However, understanding farmers' preferences is important for successful adoption of improved varieties. The objective of this study was to find out the preferences of farmers for IARI developed varieties in the western Indo Gangetic Plains of India. For this data were collected from 69 respondent farmers sampled from four adopted villages under IARI transfer of technology programme. Nineteen important traits of crop varieties were identified by interviewing experts, extension scientists and identified farmers. The weighted score of all the nineteen traits was determined with the help of focused group discussion with the farmers. The preferences of the farmers were measured by using 'rice preference index (RPI)'. The farmers ranked improved varieties, in following order: i) Pusa Basmati 1509, ii) Pusa Basmati 1121, iii) Pusa Basmati 1, iv) Pusa 2511 and v) Pusa Rice Hybrid 10. Incorporation of farmers' preferences in development of rice varieties in breeding process would increase likelihood of adoption of the varieties.

Key words: Improved varieties, Preference, Rice varieties, Technology acceptance

There are 971 notified varieties of rice (*Oryza sativa* L.) in India. A lot of research has been conducted and still scientists are improving on the varietal traits to improve production and productivity of rice. However, farmers' perceptions of new varieties are particularly important in determining which variety they will adopt (Sall *et al.* 2000). Further, farmers' perceptions of the technology specific attributes of crop varieties are the major factors in determining adoption and use intensity (Adesina and Zinnah 1993). Farmers are more likely to assess a technology with criteria and objectives, which are different from the criteria that scientists prefer to consider. Complementary contributions of farmers and scientists are essential for effective research and technology development. Farmer evaluations help scientists to design, test and recommend new technologies in light of information about farmers' criteria for usefulness of the innovation (Ashby 1991). Participatory research allows identification and incorporation of farmers' criteria and priorities and definition of research agenda. Some authors (De Groote and Bellon 2000 and Sharma *et al.* 2010) emphasize that PRA, which involves local people in gathering and analyzing information, allows seeking of insights about local people and their actual conditions, and fosters dialogue between scientists and farmers. By integrating farmers' concerns and conditions into agricultural research, the developed technologies may get widely adopted, resulting in more productive, stable, equitable and sustainable agriculture. Further, understanding farmers' preferences is important for successful adoption of improved varieties.

The Indian Agricultural Research Institute (IARI) has contributed significantly to the attainment of higher yield and remunerative return to farmers through development and provisioning of quality seeds of high yielding varieties of rice, wheat, mustard, sorghum, fruits, vegetables and flowers. Improved varieties developed by the Institute are assessed, refined and disseminated through its outreach extension programme in selected villages in Haryana and Uttar Pradesh. A project was implemented for three years

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and many new improved varieties were assessed on farmers' fields. To improve the adoption of modern technologies, it is very important to study the farmers' own preferences of the traits. Thus a study was conducted to assess the preferences of the farmers for improved rice varieties introduced and demonstrated on their fields and to suggest changes to the breeders. The study forms a basis for formulating research strategies for improvement of rice varieties and scaling up of suitable varieties.

MATERIALS AND METHODS

The study was conducted among the farmers of four peri-urban Model villages adopted by ICAR-IARI, New Delhi. These villages were Badarpur Said, Rajpur and Dhani Kumbhavas (Haryana) and Soodna (Uttar Pradesh). The paddy farmers of these villages were demonstrated with the new seeds of different basmati rice namely Pusa Basmati 1, Pusa Basmati 1121 and Pusa Basmati 1509; as well as the non-basmati rice namely Pusa 2511 and Pusa Rice Hybrid 10 during the year 2010-14. Primary and secondary data sources were utilized to collect the data.

Primary data were collected using a pre-tested interview schedule, key informants and focussed group discussions. The key informants included rice researchers, experienced farmers in the villages, local leaders and agricultural agents. A total of 69 farmers were selected randomly from the four project villages who have cultivated the rice varieties (both basmati and non-basmati type) developed by the IARI and disseminated to them through its outreach extension programme. As many as nineteen parameters were selected by reviewing the litreature and through consultation with experts, extension personnel and farmers for assessing the farmers' preferences. These parameters were related to nursery stage, plant growth stage, grain eating quality and upscaling potential. The weighted scores for each identified parameter were worked out based on the scoring given by farmers other than the respondents through focussed group discussions. The preferences of the farmers were measured by developing rice preference index (RPI). To calculate RPI, the respondents were asked to score from 1-5 for various quality parameters for each of the rice varieties. These scores of individual farmers were added together to arrive at the total score for a particular trait of a variety. Further, different traits of rice under the broad heads of nursery stage, transplanting stage, harvesting, organoleptic and economic parameters were identified for which distinct indicators were enlisted and their relative ranking according to importance were done by the rice breeders, agronomist and other experts and accordingly the weight for each indicator was obtained. Further, to calculate the weighted scores, each score was multiplied by the weight for each trait. Thus weighted scores were summed up to obtain an aggregate weighted score for each trait. The product of total score with the weighted scores for a particular trait for a variety was added to arrive at the grand weighted score. The grand weighted score were further divided by the number of farmers who responded to a particular variety to arrive at the preference ranking score. The varieties were finally ranked according to the rice preference index scores.

$$RPI = \frac{\Sigma^{m}_{k=1}\Sigma^{19}_{j=1}\Sigma^{n}_{i=1} wijXijk}{\Sigma^{m}_{k=1}}$$

where, RPI= Rice preference index, w_i= weight of the j^{th} characteristic of the i^{th} rice variety, X_{ijk}= farmers preference score assigned towards j^{th} characteristic of i^{th} rice variety by k^{th} farmer, i=rice variety ranging from 1 to n, j=characteristic of rice variety ranging from 1 to 19, k= number of respondent farmers ranging from 1 to m.

RESULTS AND DISCUSSION

Agro-ecosystem analysis

Socio-economic and bio-physical appraisal of the identified villages was conducted in participatory mode. Some of the selected Participatory Rural Appraisal techniques alongwith informal discussion and use of key informants were utilized to elicit the information about the four villages. The agro-economic situation of selected villages showed that the total cultivable land ranged between 120- 474 ha in these villages (Table 1). However, the average land holding is very less ranging between 0.33-0.94 ha/ family which reflected the high man to land ratio. The soil type also showed variation across the selected villages. Albeit, the available water quality was found suitable for irrigation purpose. Irrigation facility through tube well was also found adequate and for every 8 ha of land, the numbers of functional tube well recorded were 1 to 3. Similarly, the farm mechanization in the identified villages was also found good as indicated by number of working tractors for every 4 ha of land between 1 to as high as 13. The analysis, therefore, showed much strength prevailing in the identified villages.

Preference ranking of rice varieties by farmers

The farmers, the rice breeders and the extension specialists were asked to state the important traits of rice which have a bearing on the adoption of rice variety by the farmers. Nineteen such traits identified and were categorised in nursery stage and plant growth stage, grain and eating quality and potential for out scaling. Then weighted scores for each identified parameter were worked out on the rating given by fifteen rice researchers on the scale of 1-10, based on their perceived significance in quality parameter of rice variety for National Capital Region. These traits of rice were given weights to reflect their relative importance in defining the rice varieties. The traits having high significance for the adoption potential of rice variety were the crop duration, profitability, organoleptic traits. The traits having the least importance were disease vulnerability, threshing and germination vigour at nursery stage.

Basmati grade varieties

The results of preferential ranking of basmati rice varieties are presented in the Table 2. The Total score and

Table 1 Agro-ecological situations in the project villages

Parameters	Villages (Districts, States)			
	Badarpur Said (Faridabad, Haryana)	Soodna (Hapur, Uttar Pradesh)	Kumbawas (Gurgaon, Haryana)	Rajpur (Sonipat, Haryana)
Total cultivable land	120 ha	474 ha.	200 ha.	440 ha
Total population	2800	5000	4000	6300
Male/Female	1500/1300	2350/2650	1900/2100	2980/3315
Number of households	370	916	470	950
No of households by size class				
Marginal (<2ha)	26	334	200	480
Small (2-4 ha)	55	118	150	265
Large (>4ha)	89	22	20	55
Average land holding	0.33 ha	0.52 ha	0.42 ha	0.94 ha
Soil type	Sandy loam	Sandy to Loam	Sandy loam	Sandy loam and loam
Water quality	Suitable for irrigation	Suitable for irrigation	Suitable for irrigation	Suitable for irrigation
Number of tube well/10 acre of land	1.6	1.58	0.5	0.5
Number of tractor/10 acre of land	1.6	0.58	13	1.4

Table 2 Preferential ranking of basmati rice varieties by farmers of model villages of IARI

Evaluation criteria/ Characteristic	Unit weighted score	Total score of basmati grade rice varieties			Weighted scores of basmati grade rice varieties		
		PB-1121	PB-1509	PB-1	PB-1121	PB-1509	PB-1
During nursery stage							
Germination	0.048	182.4	096.0	33.6	8.7552	4.6080	1.6128
Disease	0.037	153.6	081.6	38.4	5.6832	3.0192	1.4208
Plant health	0.053	120.0	096.0	43.2	6.3600	5.0880	2.2896
After transplanting							
No. of tillers	0.053	159.8	070.5	32.9	8.4694	3.7365	1.7437
Dose of fertilizer	0.050	132.0	076.0	24.0	6.6000	3.8000	1.2000
Disease/pest	0.053	135.0	094.5	27.0	7.1550	5.0085	1.4310
Irrigation	0.050	124.0	084.0	24.0	6.2000	4.2000	1.2000
Threshing	0.045	152.0	072.0	40.0	6.8400	3.2400	1.8000
Labour	0.050	152.0	100.0	40.0	7.6000	5.0000	2.0000
Crop duration	0.051	130.5	108.0	36.0	6.6555	5.5080	1.8360
Yield	0.060	159.8	112.8	47.0	9.5880	6.7680	2.8200
Grain size	0.050	165.0	125.0	40.0	8.2500	6.2500	2.0000
Grain eating quality							
Aroma	0.057	162.0	090.0	40.5	9.2340	5.1300	2.3085
Taste	0.060	166.5	103.5	40.5	9.9900	6.2100	2.4300
After cooking quality	0.060	162.0	103.5	40.5	9.7200	6.2100	2.4300
Outscaling potential							
Seed availability	0.053	190.0	125.0	50.0	10.070	6.6250	2.6500
Profit	0.060	185.0	125.0	50.0	11.100	7.5000	3.0000
Market demand	0.057	195.0	125.0	50.0	11.115	7.1250	2.8500
Change in area under cultivation	0.053	152.0	100.0	40.0	8.0560	5.3000	2.1200
Total		2978.6	1888.4	737.6	157.4413	100.3262	39.1424
Number of respondents					24	15	6
RPI					6.560054	6.688413	6.523733
Ranking					II	I	III

Weighted score of different characteristics was highest for Pusa Basmati -1121 (2978.6 and 157.44), followed by Pusa Basmati-1509 with a Total score and weighted score of 1888.4 and 100.32. The RPI Index of variety Pusa Basmati 1509 (RPI -6.69) ranked highest and was followed by Pusa Basmati 1121 (RPI -6.56) and Pusa Basmati 1 (RPI -6.52). This reveals farmers preferred Pusa Basmati-1509 most among all other variant of basmati varieties.

Farmers' preference for different characteristics was worked out with the help of weighted scores on different characteristics for basmati grade rice varieties, i.e. Pusa Basmati 1 (released in 1989), Pusa Basmati 1121 (released in 2005), Pusa Basmati 1509 (released in 2013). Data in Table 6 revealed that farmers preferred Pusa Basmati-1 majorly for its economic traits like profitability, market demand and seed availability (WS 50 each). Yield wise preference was ranked at no II and plant health at no III with corresponding weighted score as 47 and 43.2, respectively. This may be the reason for the popularity of variety Pusa Basmati 1. The preference criteria for Pusa Basmati 1121 is its market demand (WS 195), seed availability (WS 190) and profitability (WS 185). The other preferred criteria's for this variety were its germination vigor and other organoleptic traits like taste and after cooking qualities. Although Pusa Basmati 1509 is relatively new variety but farmers preferred it more for economic traits like profitability, market demand, seed availability and grain size pertaining to weighted score 125 each. The yield potential and crop duration were ranked at II, III place with weighted score of 112.8 and 108 respectively. Ghimire *et al.* (2015) also had shown in their study that technology specific variables (e.g. yield potential and acceptability) are significant for explaining adoption behavior, implying that it is important to take farmers' preferences to varietal characteristics into consideration in the design of a research and development program.

The analyses of acceptable and non acceptable identified traits were classified for the selected basmati rice varieties presented in Table 3. For the farmers the acceptance of basmati variety depends on the market demand. Seed availability for adoption and outscaling is an important criteria as observed for the rice varieties Pusa Basmati 1 and Pusa Basmati 1509. Farmers as producers are least concerned about organoleptic traits like aroma, taste and post cooking quality. Although these traits were rated high by the rice breeders, other economic parameters like labour and area expansion are least important characteristics for the farmers.

Table 3 Ranking of traits of basmati rice varieties

Relative ranks of the traits	Identified traits		
	PB 1 (Very old)	PB-1121 (Relatively recent)	PB-1509 (very recent)
Most preferred (RANK I)	Profit, Availability, Demand,	Demand	Grain size, Demand, Availability, Profit
Preferred (RANK II)	Yield	Availability,	Yield
Slightly preferred (RANK III)	Plant health	Profit	Crop duration
Less preferred (RANK IV)	Aroma, Taste, Post cooking quality	Germination	Taste, Post cooking quality
Least preferred traits (RANK V)	Labour saving, Change in area and Grain size	Taste	Labour saving, Change in area

Non-Basmati grade varieties

The results of preferential ranking of non-basmati rice varieties are presented in the Table 4. The Total score and weighted score of different characteristics was highest for Pusa 2511 (1460.9 and 76.80), followed by Pusa Rice Hybrid 10 with a Total score and weighted score of 1346.6 and 71.03. The RPI Index of variety Pusa 2511 ranked higher (RPI -6.39) and was followed by Pusa Rice Hybrid 10 (RPI -5.91). This reveals farmers preferred Pusa 2511 more than Pusa Rice Hybrid 10.

Similar pattern of ranking of preferred traits also observed in non-basmati rice varieties as seed availability and market demand are preferred traits at Rank I and Rank

Table 4 Preferential ranking of non-basmati rice varieties by farmers of model villages of IARI

Evaluation criteria/ Characteristic	Unit weighted score	Total score of non-basmati rice varieties		Weighted score of non-basmati rice	
		P 2511	PRH 10	P 2511	PRH 10
During nursery stage					
Germination	0.048	76.8	72.0	3.6864	3.4560
Disease	0.037	91.2	67.2	3.3744	2.4864
Plant health	0.053	48.0	72.0	2.5440	3.8160
After transplanting					
No. of tillers	0.053	84.6	79.9	4.4838	4.2347
Dose of fertilizer	0.050	64.0	76.0	3.2000	3.8000
Disease/pest	0.053	81.0	76.5	4.2930	4.0545
Irrigation	0.050	60.0	56.0	3.0000	2.8000
Threshing	0.045	68.0	60.0	3.0600	2.7000
Labour	0.050	72.0	72.0	3.6000	3.6000
Crop duration	0.051	85.5	54.0	4.3605	2.7540
Yield	0.060	89.3	70.5	5.3580	4.2300
Grain size	0.050	90.0	75.0	4.5000	3.7500
Grain eating quality					
Aroma	0.057	58.5	63.0	3.3345	3.5910
Taste	0.060	63.0	67.5	3.7800	4.050
After cooking quality	0.060	63.0	63.0	3.7800	3.7800
Outscaling potential					
Seed availability	0.053	100	90.0	5.3000	4.7700
Profit	0.060	95.0	75.0	5.7000	4.5000
Market demand	0.057	95.0	85.0	5.4150	4.8450
Change in area under cultivation	0.053	76.0	72.0	4.0280	3.8160
Total		1460.9	1346.6	76.7976	71.0336
Number of respondents				12	12
RPI				6.3998	5.919467
Ranking				I	II

Table 5 Ranking of traits in non-basmati rice varieties

Relative ranks of the traits	Identified traits	
	P-2511	PRH-10
Most preferred (RANK I)	Availability	Availability
Preferred (RANK II)	Demand, Profit	Demand
Slightly preferred (RANK III)	Disease	No. of tillers
Less preferred (RANK IV)	Crop duration	Disease pest
Least preferred traits (RANK V)	Yield	Profit, Grain size

II in both the selected varieties (Table 5). Disease resistance and short duration are important characteristics of Pusa 2511 but given least preference by the respondents.

Overall preference score for rice varieties by respondents for 19 broad features under various sub-areas was compared for all varieties (Table 6). The inter-grade ranking of RPI shows that basmati rice varieties were more preferred in comparison to non-basmati varieties. RPI of PB 1509 (377.6) was highest followed by PB 1121 (372.3), PB 1(368.8), P 2511 (365.2) and PRH 10 (338.8). A pattern was also observed in preference scores at different stages in basmati and non-basmati rice varieties. A similar pattern was observed since post transplanting and economic traits are important attributes for farmers' choice of rice varieties. Organoleptic traits were more preferred than characters at nursery stage in basmati varieties and preference was reversed in non-basmati varieties.

The study identified the preferences of farmers for different traits of rice varieties assessed on farmers' fields by using rice preference index for both basmati and non-basmati grade rice varieties. Findings may be useful to form the basis for formulation of farmer-oriented extension and research programme. Incorporation of farmers' preferences in development of rice varieties in breeding process would increase likelihood of adoption of the varieties. Whereas breeding cannot incorporate all the desired attributes, the key attributes should be included in particular varieties and many varieties should be bred focusing the demands of farmers.

Table 6 Overall preference score for rice varieties by farmers of model village for 19 broad features under various sub-areas

Crop stages	Basmati grade rice			Non-basmati grade rice	
	PB 1121	PB 1509	PB 1	PRH 10	P 2511
Nursery stage	57.0 (iv)	54.7 (iv)	57.6 (iv)	52.8 (iii)	54.0 (iii)
Post trans-planting	144.7 (i)	148.5 (i)	135.4 (i)	136.9 (i)	155.6 (i)
Organoleptic traits	61.3 (iii)	59.4 (iii)	60.7 (iii)	48.3 (iv)	46.1 (iv)
Economic traits	109.2 (ii)	115.0 (ii)	115.0 (ii)	98.5 (ii)	109.5 (ii)
Total number of respondents	24	15	6	12	12
RPI	372.3	377.6	368.8	338.8	365.20
Inter-grade ranking of RPI	II	I	III	V	IV
Intra-grade ranking of RPI	II	I	III	II	I

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