

Table 3. Farmers' Assessment of Popular Traditional Varieties

Variety	Positive traits	Negative traits
Safri-17 (late maturing)	<ul style="list-style-type: none"> • stable yield every year • resistant to pests and diseases • drought tolerant • good for heavy-textured soil • good for <i>beushening</i> method of land preparation • tall (157 cm) and submergence tolerant • competes with weeds • requires less water and fertilizer • photosensitive • good taste and eating quality • good grain quality (slender, fine, shining) • commands high market price • high milling recovery • good quantity and quality of straw for making rope • matures near religious festival (<i>Diwali</i>) 	<ul style="list-style-type: none"> • has lower yields (2–3 t/ha) than Swarna and Kranti • susceptible to lodging due to height (157–168 cm) • can't be used to distinguish wild rice (<i>karaga</i>) • too much straw and less grain
Chepti gurnatia (medium duration)	<ul style="list-style-type: none"> • good grain yield (3 t/ha) • competes with weeds • tolerant to drought • ideal for light soil or <i>Matasi dorsa</i> • medium duration and can be harvested early, allowing <i>rabi</i> crop • purple pigmentation helps in eradicating wild rice • has good taste and eating quality • commands a high price in the market • good for other rice products (e.g., <i>basi</i> and <i>pulao</i>) • preferred as wage by agricultural laborers due to its bold, coarse grains: can last longer in the stomach 	<ul style="list-style-type: none"> • yields lesser than Swarna • susceptible to lodging because it is tall (137–142cm) • susceptible to bacterial blight and stemborer • has more straw than grain

qualities. *Chepti gurnatia*, for example, has purple pigmentation that helps farmers distinguish and eradicate wild rice (*karaga*).

Swarna and Mahamaya are two modern varieties that have the positive qualities present in the traditional varieties. Swarna is a high yielder, late maturing and semi-dwarf. Farmers perceive that these varieties can tolerate drought. Mahamaya, similar to Chepti gurnatia, also has the purple leaf sheath and purple auricle, which help to distinguish it from wild rice. It has potentially higher yields than the traditional varieties; however, the modern varieties are more susceptible to diseases (bacterial blight and gall midge). Mahamaya is also susceptible to lodging because of its short stature (table 4). Actually, Swarna was released in 1982 from Andhra Pradesh and was tested by the plant breeders. However, it was not recommended to farmers before 1992. The adoption of Swarna has been fast and it has replaced local varieties such as Safri and Dubraj and improved varieties such as Mashuri. However, since 1992, not a single variety with these positive combined characteristics could be released by the local breeders in IGAU.

Table 4. Farmers' Perceptions of Traits of Popular Modern Varieties

Variety	Positive traits	Negative traits
Swarna (late duration)	<ul style="list-style-type: none"> • high yield (4–5 t/ha), which is 1.5 tons higher than Safri • responsive to fertilizer • high number of medium-slender, fertile spikelets (150–200) • dark green color helps in distinguishing wild rice • can withstand drought • heavy tillering (8–10 tillers) • semi-dwarf (93 cm) and resistant to lodging • suitable to heavy-textured soils and retains moisture • requires low inputs • commands high price in the market • preferred for <i>basi</i> (leftover rice from dinner that is dipped in water and eaten the following day for breakfast or lunch) • good eating quality—remains soft after cooking for a long time compared to the other varieties • high milling recovery 	<ul style="list-style-type: none"> • susceptible to diseases (bacterial blight, gall midge) • susceptible to brown plant hopper • poor weed competition due to its short stature, which requires early weeding • duration too long when <i>rabi</i> crops need to be grown • requires more water to mature • low yields of straw • less yield than Mahamaya • not photosensitive
Mahamaya (medium duration)	<ul style="list-style-type: none"> • higher yield potential • resistant to diseases (gall midge) and pests (brown plant hopper) • dark green color helps distinguish wild rice • purple leaf sheath and purple auricle help identify wild rice • early to medium duration—can harvest sooner and grow <i>rabi</i> crops • commands high market price • has bold, heavy grains • good quantity and quality of straw • more fertile spikelets • resistant to lodging—intermediate height • responsive to fertilizer • preferred by millers and traders for beaten rice (unbroken <i>poja</i>) and for puffed rice (<i>murmura</i>) because it expands easily • preferred by poor farmers and agricultural laborers because it remains soft after cooking and makes them feel full even when consumed in small quantity 	<ul style="list-style-type: none"> • susceptible to stemborer • susceptible to sheath blight • not good eating quality • poor milling recovery—has more broken grains after milling

Mahamaya was only released in 1997. Both Swarna and Mahamaya were released for irrigated rice ecosystems, but because of their perceived ability to tolerate drought and their high market demand by traders, these two varieties have become very popular. Millers and traders prefer Mahamaya for making beaten rice and puffed rice. Poor farmers and agricultural laborers who are paid in terms of

rice prefer Mahamaya because they feel that it satisfies their hunger. Mahamaya has bold, coarse grains that they believe last longer in the stomach. Farmers also prefer Swarna for *basi* (leftover rice from dinner, dipped in water with a little salt and eaten the following day for breakfast or lunch).

Male and female farmers' criteria in selecting rice varieties

Despite the active involvement of women in rice production, post-harvest, and seed-management activities, scientists, who are mostly men, often talk with male farmers only. Ignoring women's knowledge and preferences for rice varieties may be an obstacle to adoption of improved varieties, particularly in areas with gender-specific tasks and in farm activities where women have considerable influence. For example, a released variety such as Pant-4 is high yielding but is rejected by women farmers because it is difficult to thresh by hand. In contrast, traditional varieties that are low yielders are still grown because of their desirable taste and their eating and cooking qualities that make them well-suited for rice products that women prepare. Knowing men's and women's criteria in rice varietal selection and access to and control of new seeds, information, etc., will lead to more efficient dissemination of improved rice varieties for rainfed conditions and their subsequent adoption. Thus, in 1998, a team of scientists from the Directorate of Extension, IGAU, conducted focused research in the same villages. Our objective was to test and develop a methodology for eliciting male and female farmers' criteria and to determine whether there are gender differences in these criteria in rice varietal choice.

The majority of the women farmers are illiterate and are less exposed to household surveys; therefore, we used a simple participatory method of eliciting their perceptions regarding the useful traits they consider when selecting rice varieties. Men and women were separately involved in this activity. This method, which is like a game of cards (see methodology section), gave the farmers more time to think as well as to enjoy the process. Tables 5 to 7 show the important traits that male and female farmers consider when selecting rice varieties according to land elevation and size of landholding. The results show that grain yield was the most important criterion for both men and women farmers in selecting rice varieties for all land types and sizes of landholding. Both men and women gave more value to eating quality (taste) and duration/maturity for rice varieties grown on upland fields. However, women were more concerned with market price, drought tolerance, pest and insect resistance, and competitiveness to weeds. On the other hand, men gave more importance to grain size and shape than women did. For midland conditions, women gave higher values to eating quality and market price, while men gave more importance to duration and maturity. For lowlands, eating quality and market price were considerations for both men and women. Women consistently gave higher values to the multiple use of straw for varieties grown in all land types.

We also assessed whether there were differences in criteria between men and women from marginal and large farms. Table 6 shows that there is not much difference between the criteria across size of landholding. Both men and women with large farms gave the highest value to grain yield. Aside from grain yield, both men and women from the same economic category gave more importance to eating quality and market price. Duration/maturity was more important to male farmers from large farms than to women of the same category, similar to marginal farmers. Women from both large and small farms gave a higher value to the multiple use of straw than men did.

In summary, the most important traits that both men and women value in selecting rice varieties are grain yield, eating quality (taste), market price, duration/maturity, drought tolerance, and resistance to pests and diseases. Women placed higher weights on multiple uses of straw across all land types and for both large and small landholdings. Men did not consider this as important, obviously

Table 5. Men's and Women's Perceptions of Useful Traits of Rice Varieties by Land Elevation, Raipur, Madhya Pradesh

Traits	Uplands		Midlands		Lowlands	
	Men	Women	Men	Women	Men	Women
Grain yield	19	19	27	25	30	27
Eating quality (taste)	16	11	6	17	11	19
Market price	3	10	8	13	9	13
Duration/maturity	13	10	13	6	7	3
Drought tolerance	6	11	5	3	3	1
Pest/insect resistance	6	10	8	6	6	4
Multiple use of straw	0	8	5	11	6	11
Grain size and shape	16	0	2	2	4	3
Milling recovery	9	0	2	2	4	4
Lodging resistance	3	0	3	4	2	3
Fertilizer responsiveness	6	3	5	3	4	2
Weed competitiveness	7	7	3	1	2	2
Submergence tolerance	5	5	1	2	2	2
Good for rice products	0	0	2	2	1	0.5
Disease resistance	0	0	3	<0.5	3	0.5
Adaptation to soils	3	0.5	2	1	2	1
Adaptation to land level	0	0.5	2	1	0.5	1
Storage quality	0	2	1	<0.5	2	1
Fullness in stomach	0		1	<0.5	1	1
Cooking time	0	3	1	1	0.5	
	100	100	100	100	100	100

Note: Values have been rounded off. Values were computed by weighted-ranking method.

because women are more responsible than men in caring for the livestock. Rice straw is used as feed for the livestock and also mixed with cowdung to make a cake for household fuel. Thus, women consider both grain yield and rice biomass in selecting rice varieties according to their specific environments. A rice variety that has high grain yields but low quantity and quality of rice straw has a lower chance of adoption by women farmers. Men gave more importance to grain size and shape for varieties grown on the uplands. Men owning small farms considered adaptation of the variety to specific soil conditions as being extremely important (second to yield) but were the only group to rank this highly. This may be because poorer farmers cultivate more marginal land (explaining the need for adaptation of the variety to soil type). Women did not rank this characteristic highly, probably because of their role in production (men tend to choose the varieties and clear the land).

Logically, drought tolerance was more important for upland and midland areas than for lowland areas. Women weighted this more highly than men.

While the participatory ranking method was useful in assessing the trade-offs between traits valued by farmers, this method could be improved by including traits mentioned in the open-ended

Table 6. Perceptions of Useful Traits of Rice Varieties, by Size of Landholding and Gender, Raipur, Madhya Pradesh

Traits	Large farmers		Marginal farmers	
	Men	Women	Men	Women
Grain yield	36	34	19	21
Eating quality (taste)	13	12	9	18
Market price	8	12	6	13
Duration/maturity	10	3	7	8
Multiple use of straw	4	7	3	10
Drought tolerance	4	8	4	4
Pest/insect resistance	7	5	6	7
Grain size and shape	8	<0.5	5	2
Milling recovery	1	2	9	6
Lodging resistance	3	2	4	2
Fertilizer responsiveness	3	2	7	3
Weed competitiveness	1	2	2	1
Submergence tolerance	1	5	1	1
Good for rice products	1	<0.5	1	1
Disease resistance		1	2	<0.5
Adaptation to soils		1	12	<0.5
Adaptation to land level		1	1	<0.5
Storage quality		1	1	1
Fullness in stomach		0	1	<0.5
Cooking time		2	1	2
		100	100	100

questionnaires. The cards shown by the researcher limited the choice of desired traits—other traits based on specific cultural practices, such as a preference for purple-colored rice varieties or for varieties suited to the *beushening* method of land preparation, were not mentioned at all. Moreover, other social considerations, such as a preference for late and medium varieties to coincide with a religious festival such as *Diwali* were not captured. Farmers usually harvest rice only after the *Diwali* festival. During this festival, families give special rice as gifts to relatives.

Participatory varietal selection

Although scientists accept that farmers are careful managers and possess a wealth of knowledge about their production systems, this knowledge is not sufficiently used in the formal breeding process (Kshirsager et al. 1998). Several strategies were used to involve farmers in PVS. Farmers volunteered to grow 16 early- to medium-duration group varieties and late-duration varieties on their own fields for three consecutive years. The early/medium-duration group varieties were tested at Tarpongi village on two farmers' fields that have light soils. The late-duration varieties were tested on two farmers' fields at Saguni village under heavy soils. The new varieties had some of the preferred criteria mentioned by farmers obtained in the interview and participatory-ranking activities. Farmers and breeders ranked the rice lines on the station and on farmers' fields in the research sites.

Table 7. Comparison between Ranks Attributed by Farmers and Breeders at Different Growth Stages in the PVS Trials, Raipur Villages, Eastern India, and IGAU Station, 1997–99

Trial location	Year	Trial code ²	Stage ¹	No var.	No F.	No B.	Agreement among farmers	Agreement among breeders	Correlation between farmers' & breeders' rankings	
							W	W	r	
Station	97	1	F	16	8	1	0.34**	–	–0.20	
	97	1	M	16	8	1	0.51**	–	0.11	
Tarpongi	97	1	F	16	5	–	0.51**	–	–	
	97	1	M	16	4	2	0.55**	0.47	0.13	
Saguni	97	2	F	16	5	–	0.50**	–	–	
	97	2	M	16	7	2	0.34**	0.53	–0.03	
	97	1	F	16	7	–	0.30**	–	–	
	97	1	M	16	6	2	0.44**	0.30	–0.18	
	97	2	F	16	5	–	0.79**	–	–	
	97	2	M	16	5	2	0.54**	0.56	–0.06	
Station	98	1(M)	F	16	8	2	0.32**	0.77	0.16	
	98	1(M)	M	16	6	2	0.26	0.60	0.50*	
	98	2 (L)	F	16	8	2	0.31**	0.54	–0.04	
	98	2 (L)	M	16	6	2	0.67**	0.70	0.28	
Tarpongi	98	1(M)	F	16	5	1	0.55**	–	0.46	
	98	1(M)	M	16	4	1	0.30***	–	0.20	
	98	1(M)	CROP FAILURE							
Saguni	98	2 (L)	F	16	4	1	0.56**	–	0.07	
	98	2 (L)	M	16	4	1	0.59**	–	0.02	
Khairkhutt	98	2 (L)	F	16	6	1	0.38**	–	0.51*	
	98	2 (L)	M	16	4	1	0.44*	–	–0.01	
Station	99	1 M)	M	16	7	3	0.49**	0.91**	0.33	
Station	99	2 M)	M	16	7	3	0.65**	0.89**	0.62*	
Tarpongi 1	99	1 M)	M	16	6	3	0.65**	0.94**	0.61*	
Tarpongi 2	99	2 M)	M	16	5	3	0.62**	0.84**	0.46	
Station	99	1 (L)	M	16	7	3	0.53**	0.81**	0.15	
Station	99	2 (L)	M	16	7	3	0.34**	0.76**	0.11	
Saguni 1	99	1 (L)	M	16	7	3	0.50**	0.93**	0.66**	
Saguni 2	99	2 (L)	M	16	6	3	0.66**	0.91**	0.64**	
Station	99	1	V	20	5	3	0.98**	0.94**	0.90**	
Station	99	1	F	20	5	3	0.98**	0.98**	0.91**	
Station	99	1	M	20	5	3	0.96**	0.97**	0.89**	
Khairkhut	99	2	V	20	5	3	0.98**	0.95**	0.87**	
Khairkhut	99	2	F	20	5	3	0.94**	0.99**	0.92**	
Khairkhut	99	2	M	20	5	3	0.90**	0.97**	0.41**	

Note: – = not tested. W = Kendall's coefficient of concordance. r = Spearman's coefficient of correlation. F = farmers. B = breeders.

1. Stage: V = vegetative stage, F = flowering, M = maturity.

2. Trial code: L = late, M = medium.

Farmers' rankings were compared with breeders' rankings during different stages of crop growth (vegetative, flowering, and maturity) as shown in table 7.

Correlation between breeders and farmers at all sites and in all the years was consistently low. Very few of the trials showed significant or highly significant agreement between farmers and breeders (trials that showed any significant agreement were mainly in 1999). In general, agreement was insignificant or even negative (although not strongly so). It was impossible to make an assessment of agreement between farmers and breeders in 1997 and 1998. However, in 1999, although there was high agreement in varietal ranking among farmers and among breeders, there was generally low agreement between farmers and breeders, which may indicate that farmers and breeders consider different criteria. Farmers' rankings are not correlated with yield, indicating that farmers consider other criteria in their rankings.

Assessment of late-duration varieties included in PVS in Saguni, Raipur

The breeders' top five favorite late-duration varieties in the 1999 trials included Swarna, BKP-232, R650-1817, R304-34, and R738-1-64-2-2 (all modern varieties). These varieties also ranked in the top five in yield. The farmers' top five favorite varieties included Swarna, Safri-17, R738-1-64-2-2, Mahsuri, and R650-1817. These were not always the highest yielding varieties—in fact, Mashuri gave one of the lowest yields and Safri-17 (a traditional variety) was somewhere in the middle. These varieties were likely selected for other reasons than yield. Varieties preferred by both groups (ranking on average in the top 5) included Swarna (first choice of both farmers and breeders, and also high yielding), R650-1817, and R738-1-64-2-2. These are all modern varieties, and are also the three varieties that had the highest yields in the trials (table 8).

Table 8. Assessment of Late-Maturing Varieties Included in PVS, Saguni, Raipur, Madhya Pradesh, Eastern India

Variety	Ranking
Swarna (check)	Favorite of both farmers and breeders Consistently ranked highly in the top 5 by both groups in the field sites and on-station
Safri-17 (check)	Always ranked in the top 5 by farmers, but not so well ranked by breeders
R738-64	This is ranked in the top 5 by farmers and breeders in the farmers' fields, but less well ranked in on-station trials.
R304-34	Ranked first by breeders, but not liked by farmers, even though yield is quite good (5 t/ha) Ranked low by both groups in field sites Bold grains, not susceptible to disease, commands high market price
Mahsuri	On-station, ranked within top 5 by farmers, on station and in one farm site, although yield is consistently low Ranked consistently low by breeders
IR54896	On-station, ranked highly by breeders Yield is good, but farmers don't like it (one of their least favorites) Ranked low by all in farm trials

Assessment of medium-duration varieties in Tarpongi, Raipur, Madhya Pradesh

In Tarpongi, the top ranking medium-duration varieties for breeders were R574-11, IR42342, Chepti gurmatia, BG380-2, R703-1-52-1, and OR1158-261. All of these were also the top six

yielding varieties. All are modern varieties except for Chepti gurmaia. For farmers, the top ranking varieties included BG380-2, OR1158-261, R714-2-9-3-3, IR63429, and R574-11. These are all modern varieties, but not always top yielding. R714-2-9-3-3 gave medium yields, while IR63429 gave relatively low yields when compared with the other varieties. Farmers and breeders agreed only on R574-11, BG380-2, and OR1158-261 as their favorite varieties (table 9).

Table 9. Assessment of Medium-Duration Varieties Included in PVS, Raipur, Madhya Pradesh

Variety	Ranking
R714-2-9-3-3	Ranked highly by farmers on farmers' fields and in 2 nd on-station replication, and is among the farmers' favorites Consistently marked low by breeders
R574-11	Top ranked by farmers and by breeders in station trials. Also, highest yield On-farm, is still in top 1-2 for breeders but drops to 8-10th rank for farmers Yield on farm is less (4th and 6th rank)
OR1158-26	Ranked about 5-6 (on average) in all sites except in one field, where it was #1 among farmers Yield ranges from 3-8 t/ha Among the top varieties for farmers and breeders
IR63429	Ranked well by farmers in all sites but consistently ranked low by breeders Lower-yielding variety compared to others, but farmers seem to like it in any case Early, long grain, intermediate height
IR42324	Consistently highly ranked by breeders, but given low rank by farmers in all sites except station replication #1 Consistently high yield, but even with highest yield on farm, farmers don't like it
Chepti gurmaia (local check)	Consistently ranked well by breeders, also one of the top 5 yielding varieties However, it ranks in the middle with farmers
BG380-2	Ranked highly by breeders and farmers in field and on-station Generally has good yield

During the *kharif* season 2000, the medium-duration varieties that were further evaluated on-station and on farmers' fields were IR4234 (breeders' choice), R574-11 (farmers' choice), BG380-2 (common choice), and Chepti gurmaia (best local choice). The late-duration varieties were BKP-232 (farmers' choice), R304-34 (breeder's choice), R650-1817 (common choice), and Swarna (local check).

The challenge facing plant breeders in IGAU and IRRI is to develop new cultivars that are better than Swarna and Mahamaya, while also meeting the other requirements and criteria that farmers have for their given rice environments. While it is impossible to combine all the requirements in one single variety, giving farmers (both men and women) an opportunity to test the performance of different rice genotypes on their own fields and to evaluate their cooking and eating qualities can lead to more efficient rice varietal improvement in the Chhattisgarh region in Madhya Pradesh.

Conclusions

This paper focused on methodologies for improving our understanding of the criteria used by farmers (both men and women) in selecting specific rice varieties and of how these criteria are considered in participatory breeding strategies in the rainfed lowland environments of the Chhattisgarh region in Madhya Pradesh, eastern India. Different methods for understanding farmers' criteria in