Livestock forms an important and integral part of the farming system and, among other things, provides a major source of nutrients (i.e., manure) for plants. Buffalo, cattle, goats, and chickens are the main kinds of livestock in the area, with an average livestock unit of 2.8 per household. The average livestock unit is highest among households in the rich and BCJ categories and lowest in poor and KDS households. This difference is significant across wealth ($p < .0001$) and ethnic ($p < .01$) categories. Similarly, the female-headed households have lower livestock units per household than the male-headed households, but this difference is not statistically significant. The resource analysis thus indicates that BCJ households have the most resources, followed by GMN households, while KDS households have the fewest resources. Similarly, female-headed households have comparatively fewer resources than male-headed households.

Access to information and technology

The access farmers have to improved maize varieties suitable to local environments and their own needs is quite limited (table 1). Only 13% of the farmers reported growing improved varieties of maize; however, they know the value of changing their old seeds. About 39% of the households reported exchanging their seeds during last five years with other farmers. The users' and gender analysis showed that access to new maize seeds is similar across all wealth categories. However, GMN and KDS households have a complete lack of access to new maize seeds, and a lower proportion of male-headed households reported cultivating improved varieties than did female-headed households. The proportion of households changing seeds over the last five years, however, is greater in the poor wealth category, suggesting that farmers in this category change seed more frequently than do the others. Since these households are also highly food deficit, they may be consuming the seed and, therefore, borrowing seeds from other farmers. The proportion of households changing maize seeds is, however, similar across ethnic categories and between male and female-headed households.

Similarly, farmers' access to technical services and information on technology is also poor. Only about 3% of the maize-growing households reported participating in agriculture-related training, and only 6% participated in educational tours. Likewise, about 15% of the households reported receiving information on improved technology for maize production. This reveals that external technical support to farmers in their attempts to develop better maize varieties is quite limited. The proportion of households participating in agricultural training and tours is lower in the average and poor households than in rich households. A chi-square analysis shows significant differences ($p < .05$) in access to information on improved technology for maize production across wealth categories. Similarly, only BCJ households reported having participated in agricultural training and tours or receiving information on improved maize production. The proportion of female-headed households participating in agricultural training and tours and receiving information on improved maize production is lower than male-headed households.

Maize varieties and their uses

Farmers have been found to grow about eight different types of maize varieties, which they broadly categorize into two maize types: one is a large type (*Thulo makai*) with tall plants, big cobs, large grains and long maturity, while the other is a small type (*Sano makai*) with short plants, small cobs and grains, and short maturity. A majority of the farmers grow large-type maize, and it covers about 87.7% of the total maize area. Among the large varieties, *Thulo pyanlo* alone covers about 80% of the area planted to this type, which reflects that, although farmers grow a large number of varieties, a large portion of the maize-growing area is covered by a relatively small number of varieties.

A majority of the households grow one to two varieties of maize (46.5% to 45.5%, respectively) in a season (table 2). Only about 8% of the total maize-growing households grow more than three varieties per season. The varietal diversity maintained at household level, therefore, is low (figure 1). The ANOVA result shows that the difference in the number of maize varieties grown at household level is significant ($p < .05$) across wealth categories but not significant across ethnic categories and between male- and female-headed households. A higher proportion of poor households grows one variety of maize, compared to rich and average households. This is contrary to the currently held view that small farmers maintain significant amounts of crop genetic diversity (Jarvis et al. 1997) and agrees with the findings of other studies (Rana and Kadayat 1999). Similarly, though not significant, a very high proportion of KDS households (90%) grows only one variety of maize.

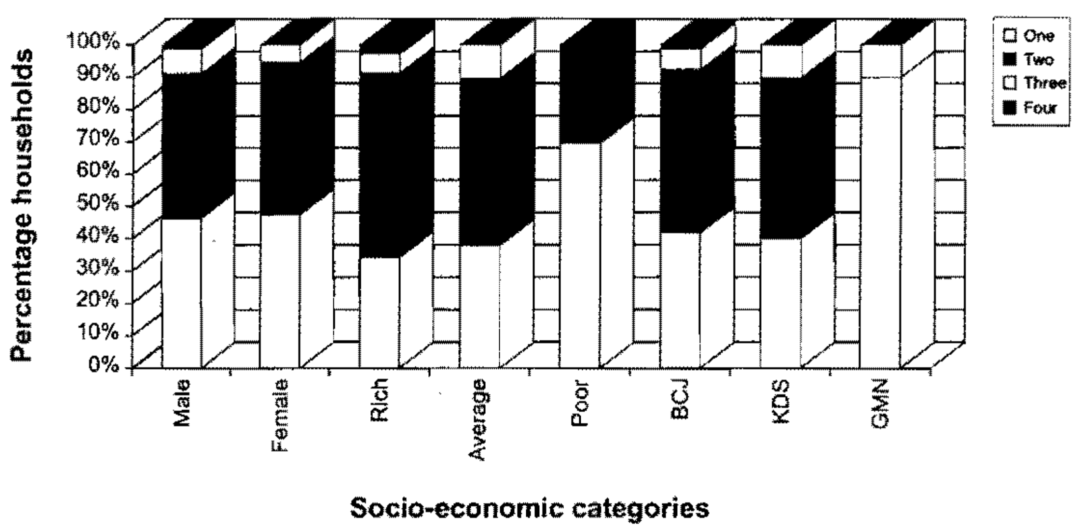

Figure 1. Number of maize varieties per household across gender, wealth and ethnic categories

Farmers who grow more than one variety mentioned various reasons for this (table2): to prepare different food items, to harvest at different times, to suit different land types, to use as animal feed, and to meet fodder requirements. However, a majority of the farmers (67.9%) grow to suit different types of land, and this is true across all wealth and ethnic categories and between male- and female-headed households. The ANOVA result suggests that the number of maize varieties grown at household level is not significantly related to the size of the *bari* land but is highly significantly related to the number of parcels of *bari* land the farmer is planting to maize ($p < .0001$). This indicates that with the increase in the number of parcels of *bari* land, the number of maize varieties grown at household level also increases. This also confirms the PRA finding that farmers in the area grow large-type maize on more fertile land while small-type maize is grown on less fertile soil. The number of *bari* parcels, therefore, appears to be the strongest determining factor in deciding the number of maize varieties to be grown per season. It is, however, true that farmers use multiple criteria to select maize varieties for their household production.

The gender differences in the use of some criteria to choose maize varieties are striking. A large proportion of female-headed households (more than three times the number of male-headed households) mentioned growing more than one variety to meet fodder requirements for their livestock. This is also confirmed by the PRA findings. During the focus-group discussions, women farmers

Table 2. Maize Varieties and Their Uses as Reported by Farmers at Darwar Devisthan and Simichaur in Gulmi District, Nepal

Characteristics	All	Gender categories		Wealth categories			Ethnic categories		
		Male	Female	Rich	Medium	Poor	BCJ	GMN	KDS
No. of varieties grown per year (% households)									
One variety	46.5	46.3	47.4	34.3	38.0	66.0	42.0	40.0	90.0
Two varieties	45.5	45.0	47.4	57.7	52.0	29.0	51.0	50.0	0.0
Three varieties	7.1	7.5	5.3	5.7	10.3	6.0	6.3	10.0	10.0
Four varieties	1.0	1.3	0.0	2.9	0.0	0.0	1.3	0.0	0.0
Reasons for more varieties (% households)									
Prepare different food items	41.5	41.9	40.0	43.5	27.8	41.7	32.6	100.0	—
Harvest at different time	34.0	37.2	20.0	34.8	33.3	33.3	28.3	83.3	—
Suit different types of land	67.9	67.4	70.0	69.6	55.6	50.0	69.6	50.0	—
For use as animal feed	32.0	30.2	40.0	17.4	22.2	75.0	26.1	66.7	—
Meet fodder requirements	20.8	14.0	50.0	21.7	11.1	33.3	21.7	—	—
Usage of maize (% households)									
Grit (*makai ko bhat*)	76.6	76.2	78.6	73.7	78.5	81.0	76.3	81.3	72.0
Bread (*roti*)	2.3	2.3	2.4	2.5	1.6	2.6	2.4	0.6	4.4
Poridge (*dhindo*)	0.9	0.85	1.1	1.5	0.23	0.2	1.0	0.0	0.0
Roasted	13.5	13.2	15.0	13	15.0	13.3	13.2	17	10
Others	6.7	7.4	3.0	9.4	5.0	3.1	7.0	0.9	13.3

Note: Ethnicity is represented as BCJ = Brahmin/Chhetri/Jogi; GMN = Gurung/Magar/Newar; KDS = Kami/Damai/Sarki.

strongly expressed their preference for tall varieties of maize like their local varieties because taller varieties produce more fodder than short varieties. Women appear to be more concerned with this issue because managing livestock fodder is largely their responsibility. Similarly, women farmers are very particular about the suitability of maize varieties for intercropping, especially with legumes (cowpeas and beans), because these help them meet the vegetable and pulse requirements of their families. The latter sometimes leads to conflicts with their male counterparts because intercropping with cowpeas and beans makes maize plants vulnerable to lodging and can cause big losses in the maize yield.

Maize is the staple food for farming households in the study area. Different preparations of maize are made for household consumption, of which steamed grit (*makai ko bhat*) is the most common preparation, reported by 77% of total production (table 2). Farmers, therefore, prefer maize varieties that have high grit recovery. They perceive that yellow (colored) maize has higher grit recovery and, therefore, prefer colored varieties over the white ones. The food preparation of maize is similar across households of different wealth, ethnic, and gender categories, and a majority of households use it in grit form. Users' and gender differences in the choice of variety, therefore, do not appear to be influenced by differences in the use of maize.

The analysis discussed above indicates that farmers' choices for maize varieties are not greatly influenced by their differences in wealth, ethnicity, and gender, i.e., different categories of farmers have preferences for similar types of maize varieties. Farmers across all wealth, ethnic, and gender categories grow only one or two maize varieties per household and, therefore, their varietal needs are not very diverse. However, farmers use multiple criteria in selecting the varieties they grow. They prefer to have as many traits of their preference as possible in one to two maize varieties. In this way, they are able to maintain and manage the variety of their preference for a long duration. Since maize is an open-pollinated crop, a large number of varieties is difficult to maintain and manage. This analysis is also confirmed by the findings of the PRA conducted at the project research sites. The participatory breeding program, therefore, should focus on developing fewer maize varieties with multiple traits that reflect farmers' preferences. Priority should be given to the maize varieties that have higher grit recovery, grow well under different land conditions, produce high biomass for use as fodder, and allow good intercropping with legumes.

Gender roles in maize production and utilization

The information on gender roles in maize production and utilization is based on a participatory gender analysis done with 30 maize-growing households selected for that purpose. The results show that there are distinct gender roles for men, women, and children in the production and utilization of maize in the hills of Nepal.

Women supersede men in their involvement in all three major functions of maize production and utilization: namely, (1) production, (2) household utilization and marketing, and (3) seed management (table 3). Their involvement is particularly high in the application of compost and farmyard manure to the maize field; seed processing, treatment, storage, and preparation for sowing in the next season; and intercropping of maize with beans, cowpeas, pumpkins, and other crops.

The results of the gender analysis show that women are also the prime decision makers in the family and their contribution to decision making in activities related to maize production and utilization is higher than that their male counterparts in the family (table 4). Their contribution to decisions is particularly high in the selection of crops for intercropping with maize, deciding on date and time of weeding and earthing-up in the maize fields, and in most of the activities related to utilization and

Table 3. Gender Roles in Maize Production and Utilization (Percentage Time Contribution)

Activities	Male	Female	Children
A. Maize production activities			
1. Seed preparation (shelling cobs, drying and storage)	24.8	61.1	14.1
2. Carry compost/FYM to the field	17.4	63.5	19.1
3. Land preparation	54.8	36.5	8.7
4. Seed sowing	11.7	42.8	45.5
5. Field supervision for seed germination	43.4	52.1	4.5
6. Weeding and earthing up maize crop (first)	34.1	49.4	16.5
7. Weeding and earthing up of maize crop (second)	41.0	54.5	4.5
8. Intercrop sowing of beans, cowpeas, pumpkin etc.	11.9	74.3	13.7
9. Relay transplanting of fingermillet in maize field	30.8	56.0	13.2
10. Field supervision of lodging of maize plants	41.3	52.1	6.6
11. Harvesting and transporting	35.9	50.3	13.8
12. Making bundles of maize stover and transporting	53.9	39.5	6.6
13. Processing (*khostyane/jhuto parne*) and storage of cobs	33.8	45.5	20.7
Total	**33.5**	**52.1**	**14.4**
B. Consumption and marketing activities			
1. Shelling cobs	24.2	57.1	18.7
2. Processing (cleaning and drying) grains for milling	15.3	76.6	8.1
3. Carrying grains to processing mills	27.2	52.0	20.7
4. Carrying grains to market for selling	49.7	50.3	—
5. Purchase	55.1	44.3	0.6
Total	**34.1**	**56.2**	**9.7**
C. seed management activities			
1. Selection of cobs for seed	37.3	57.1	5.6
2. Shelling grains from the selected cobs	31.1	52.4	16.5
3. Seed processing and treatment (cleaning, drying and treatment) and seed storage	21.7	74.4	3.9
4. Preparing storage pot/structure for seed storage	26.3	72.5	1.2
Total	**29.1**	**64.1**	**6.8**

marketing and seed management. The gender analysis thus suggests that women have important roles and a stake in the varietal-improvement programs designed to develop farmers' preferred varieties. Their participation in the whole process of variety development should be ensured and properly utilized.

Distribution of breeding knowledge

Participatory plant breeding seeks to use the knowledge and experiences farmers have accumulated over generations. It also creates an environment for mutual learning and sharing, which closes the knowledge gap and sets the stage for a working partnership between the farmers and researchers.

Table 4. Gender Differences in Decision Making in Maize Production and Utilization (Percentage Contribution in Decision Making)

Activities	Male	Female
A. Maize production activities		
1. Selection of maize variety for next season planting	49.2	50.8
2. Selection of land selection according to the variety	46.1	53.9
3. Date/time of sowing	51.5	48.5
4. Selection of crops for intercropping with maize	27.0	73.0
5. Date/time of weeding and earthing up of maize	36.2	63.8
6. Date/time of maize harvest	44.6	55.4
Total	**42.4**	**57.6**
B. Consumption and marketing activities		
1. When and how much grains to shell	30.6	69.4
2. Quantity of grits/flour to be milled at a time	23.2	76.8
3. When to carry maize grains to the mill (for milling)	27.6	72.4
4. Food items to be cooked daily	33.0	67.0
5. Whether to sale maize or not	44.8	55.2
6. Quantity of maize grains to sold	37.7	62.3
7. Whether to purchase maize or not	41.5	58.5
8. Quantity of maize grains to purchased	36.1	63.9
Total	**36.1**	**63.9**
C. Seed management activities		
1. Selection of maize varieties for next season	46.2	53.8
2. Quantity of seeds of different varieties for next season	39.9	60.1
3. Ways/methods of storing seed	35.3	64.7
4. Number of sun-drying of stored seeds and using other treatments	30.7	69.3
5. Whether to change old seeds or not	48.0	52.0
6. Type and quantity of seeds of new variety to be planted	48.8	51.2
7. Giving self-produced seeds to other farmers	36.1	63.9
Total	**36.3**	**63.7**

Facilitating and supporting farmers in their plant-breeding activities then becomes easy and smooth. Based on this understanding, farmers' breeding knowledge was assessed by surveying a sample of 113 households selected randomly. An analysis of the influence of gender, wealth, and ethnicity on the distribution of such knowledge was also done and is presented in table 5.

The majority of the households (more than 90%) separate seed and grain in advance, but the seed selection is almost entirely done from the cobs, and generally right after the harvest. Farmers virtually do not practice seed selection on standing crops. The majority of the households select big, good-looking cobs with big, bold grains for seed. Similarly, almost all farmers follow the practice of discarding grains on the tips of the cob when the cobs are shelled for seed. Only about a quarter of the farmers are knowledgeable about the role of seed replacement in maintaining varietal purity and vigor. Farmers' knowledge on the more technical side of breeding, such as identification of male

Table 5. Distribution of Breeding Knowledge by Gender, Wealth and Ethnicity (% Households)

Characteristics	All	Gender categories		Wealth categories			Ethnic categories		
		Male	Female	Rich	Average	Poor	BCJ	GMN	KDS
Separate seed and grain in advance	96.2	97.0	93.9	97.7	94.1	94.1	97.2	90.0	91.7
Stage of seed selection									
a. On standing crop	0.1	10.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
b. Immediately after harvest	100.0	96.0	97.0	44.0	32.0	3.8	10.8	8.0	12.0
c. From stored cobs	0.8	1.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
Basis of cob selection for seed									
a. Cobs with big and bold grains	67.2	63.6	67.6	30.0	32.0	26.0	72.0	7.0	7.0
b. Big and good looking cobs	83.6	75.7	79.4	32.0	31.0	32.0	5.0	8.0	9.0
c. Matured cobs	36.0	30.3	47.0	18.0	10.0	8.0	43.0	1.0	2.0
d. Healthy cobs without insect and disease damage	35.2	32.3	38.2	17.0	12.0	14.0	37.0	4.0	4.0
d. Cobs not damaged by birds and rodents	1.6	1.0	2.9	0.0	2.0	0.0	2.0	—	—
f. Uniform grain colour	0.0	4.0	2.9	1.0	0.0	0.0	3.0	—	2.0
Practice of discard grains on either tips of the cob while selecting seeds	97.7	98.0	97.0	95.3	97.1	100.0	98.1	100	91.7
Knowledge about the need for seed replacement to maintain varietal purity and vigour	24.2	24.0	25.0	27.9	23.5	13.5	28.0	0.0	8.3
Knowledge about male and female maize flower									
a. Male flower	6.0	8.0	0.0	8.7	3.0	0.0	7.2	0.0	0.0
b. Female flower	6.0	8.0	0.0	8.7	3.0	0.0	7.2	0.0	0.0
Knowledge about the use of tassel and silk									
a. Tassel	12.0	13.1	9.0	17.1	6.7	5.7	12.6	0.0	16.7
b. Silk	9.0	11.1	3.0	11.4	6.7	0.0	9.0	0.0	16.7
Knowledge about the reason of varietal mixture	10.5	13.1	3.0	14.3	6.7	2.8	10.0	•1.0	16.7

Note: Ethnicity is represented as BCJ = Brahmin/Chhetri/Jogi; GMN = Gurung/Magar/Newar; KDS = Kami/Damai/Sarki.

and female plants and their functions, was found to be very poor. Similarly, a majority of the farmers also do not know the actual mechanism that causes new maize varieties to rapidly deteriorate, compared to other cereal crops like rice and wheat. The survey thus revealed that there is good scope and a need for sharing scientific breeding knowledge prior to the inception of a participatory plant breeding program in order to enhance farmers' confidence and thereby increase their interest and participation.

Incorporation of the users' perspective in the research process

Considerations made in the research process

The project on farmer-led participatory plant breeding of maize has just completed one season of work. A number of considerations have been made, as suggested by the analysis of the users' and gender perspective of maize production and utilization. These are briefly discussed below.

Breeding objective and selection of breeding materials

The breeding objective has been redefined to improve the production performance of a widely grown maize variety, *Thulo pyanlo,* rather than creating a large diversity of maize varieties in order to improve the productivity of the niche environment. This variety has all the traits preferred by the farmers except one, i.e., lodging resistance. Reducing lodging in this variety is now the main objective of the breeding program. In addition, the selection of improved maize varieties to be used as one of the parents for crossing with *Thulo pyanlo* was done in a way that ensured that they met most of the farmers' preferences for different traits. These included relatively taller, stout plant varieties like Ganesh 1 and 2, Rampur composit, Rampur 1, Khumal yellow, and Pop 22. This would help to combine good traits from a large number of varieties into a few farmers' preferred maize varieties. At the same time, attention has also been given to meeting the specific needs of the niche environment through a participatory variety-selection program, which provides farmers with a choice from a large number of maize varieties.

Selection of research farmers

Farmers have formed their own research committee at both the research sites to ensure their participation in and influence on the research process. These research committees are well represented by different categories of farmers and 41% of its members are women. The Farmers' Research Committee, in consultation with the farmers at large, decide the breeding objectives and the research process. They also select research farmers to participate in the farmer-led maize breeding programs implemented at the research sites. Since farmers themselves select research farmers, it is envisaged that this will lead to the development of maize varieties preferred by a large number of farmers. Similarly, under participatory variety-selection program, care is taken to distribute the seed of new maize varieties to different categories of farmers.

Selection of trainees and contents

Based on the findings of the survey on the distribution of maize-breeding knowledge among farmers, field-based training was provided to the research farmers in order to supplement farmers' knowledge with practical scientific breeding knowledge. Attention was given to representation of different categories of farmers, including women. Forty-five percent of the total trainees were women. This consideration will also be made in future farmers' training programs.

Collection and analysis of users' and gender-differentiated data

The initial survey indicated that farmers use multiple criteria for the selection of a particular maize variety. Farmers may give different weights to these criteria to suite their individual needs and resources. With this in mind, the collection and analysis of users' and gender-differentiated data have been built into the research process to ensure that users' and gender perspectives are incorporated into the participatory breeding program. Data are collected in a form that allows users' and gender-differentiated data to be analyzed, which will facilitate the drawing of inferences about whether users' and gender differences make a significant difference in the process and product of participatory plant breeding in open-pollinated crops like maize.

Conclusion

The users' and gender analysis indicates that the differences among maize-growing households in regard to wealth, ethnicity, and gender do not have any significant influence on their choices for different maize varieties. Similarly, farmers across all wealth, ethnic, and gender categories grow only one to two maize varieties per household; therefore, their varietal needs are not very diverse. This is contradictory to what has been found in the case of self-pollinated crops. This appears to be largely because a large number of varieties is difficult to maintain and manage in open-pollinated crops like maize. Farmers, however, use multiple criteria in selecting the maize varieties they grow and prefer to have as many traits of their preference as possible in one to two varieties. It is, therefore, important for the participatory breeding program to focus on developing fewer maize varieties with the multiple traits that farmers prefer. Women farmers have strong preferences about the quantity and quality of the fodder by-products of maize and the suitability of new maize varieties for intercropping with legumes. The research process should allow farmers of different categories to use their criteria in developing and selecting new maize varieties. Farmers of all categories generally lack adequate practical breeding knowledge, and they are specifically poor in scientific reasoning, regardless of whatever breeding knowledge they have. Supplementing farmers' knowledge with practical scientific breeding knowledge is, therefore, necessary to empower farmers to sustain their breeding initiatives.

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Understanding Farmers' Selection Criteria for Rice Varieties: A Case in Madhya Pradesh, Eastern India

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Abstract

This paper presents information from a participatory breeding project initiated in 1997 at the International Rice Research Institute (IRRI) in collaboration with plant breeders and social scientists from six national agricultural research institutions located in eastern India. The Indira Gandhi Agricultural University (IGAU) in Raipur, Madhya Pradesh, is one of the collaborating centers. The information given here is based on a sample survey of 75 rice-farming households in three villages of the Raipur district, Madhya Pradesh. Surveys were conducted to characterize farmers' cropping/farming systems, rice varietal diversity, degree of market orientation, gender roles, as well as socioeconomic differences, and to relate these to farmers' rice varietal preferences. The focus is on methodologies for improving understanding of farmers' (including women farmer's) criteria for selecting specific rice varieties and how these criteria are considered in participatory breeding strategies for rainfed lowland conditions in Madhya Pradesh, eastern India.

Introduction

Rice is the principal crop grown during the wet season (June-October) and is the staple food in Madhya Pradesh, eastern India. In this region, rice is cultivated on 5.35 million hectares, with an annual production of 6.46 million tons. This state contributes 9% to the national production from 12.8% of the national acreage. Eastern Madhya Pradesh, known as Chhattisgarh is considered the rice bowl of the state. Of the total rice area, 80% is rainfed, and drought, which occurs every two years, is a major constraint in increasing rice productivity in the region. The rice yield in the region is low (about 2.3 tons per hectare) and is below the national average. Because of the frequent droughts, the majority of farmers are not willing to risk investing in farm inputs to increase productivity. Sustainability and yield stability are the most important considerations of farmers in the management of their farming systems. Rural poverty still persists in this region, and about one-third of the total poor in Madhya Pradesh depend on rice production as the basic source of livelihood. Therefore, improving rice production and productivity could directly lead to a substantial reduction in the rural poverty in the region (Janiah et al. 2000).

For the last four decades, a total of 512 modern rice varieties have been released in India. However, hardly 10 to 20 of the released varieties are in the seed-production channel. For example, the average age of cultivars for which there is a demand for breeder seed is 11 years. The average age of cultivars in certified seed production ranges from 12 to 17 years in the states of Gujarat, Madhya Pradesh, and Rajasthan (Virk, Packwood, and Witcombe 1996). Only a few modern varieties have been successfully adopted in the irrigated ecosystem.

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One of the main reasons for low adoption of released varieties in the rainfed environments is that farmers have inadequate exposure to new cultivars. If adoption rates are to be improved, farmers need to try a wide range of novel cultivars in their fields in participatory varietal-selection (PVS) programs. The cultivars should include prereleased cultivars, advanced lines, and already released cultivars from other regions or countries (Whitcombe et al. 1996). This would give farmers a 'basket of choices' of varied genetic material (Chambers 1989). Another reason for low adoption of modern varieties is that the breeding process does not meet farmers' diverse needs. Released rice varieties are not suited to the complex and heterogeneous rainfed agroecological environment or to the diverse uses and needs of different socioeconomic groups of farmers. In Uttar Pradesh, India, Maurya et al. (1988) tested advanced lines of rice in villages and successfully identified superior material that was preferred by farmers. Understanding farmers' preferences and needs is crucial for successful adoption and dissemination of improved rice cultivars.

In 1997, a farmer participatory breeding project was initiated at the International Rice Research Institute (IRRI) and conducted in eastern India (Courtois et al. 2000). This is a collaborative project among plant breeders and social scientists from IRRI and six national agricultural research institutions located in eastern India. The Indira Gandhi Agricultural University (IGAU) in Raipur, Madhya Pradesh, is one of the collaborating centers. The main objectives for pursuing farmer participation in plant breeding are as follows:

- to test the hypothesis that farmer participation in rainfed rice breeding can help develop suitable varieties more efficiently
- to identify stages along the breeding process where farmers' participation has the most impact and to develop and test a methodology for effectively involving farmers in the breeding program
- to improve understanding of male and female criteria for selecting specific rice varieties
- to differentiate between the influence of farmer participation and decentralization of the breeding program
- to develop rice varieties suitable for heterogeneous rainfed environments and which meet farmers' preferences

This paper focuses on methodologies for improving our understanding of farmers' (including women farmers') criteria for selecting specific rice varieties and how these criteria were considered in participatory breeding strategies for rainfed lowland conditions in Madhya Pradesh, eastern India.

Methodology

This study is based on a sample survey of 75 rice-farming households in three villages of the Raipur district, Madhya Pradesh. Surveys were conducted to characterize farmers' cropping/farming systems, rice varietal diversity, degree of market orientation, gender roles, as well as socioeconomic differences, and to relate these to farmers' rice varietal preferences. Farmers were interviewed in regard to the positive and negative attributes of the traditional and improved varieties they grow and other seed-related information. A method of participatory weighted ranking was used to elicit male and female farmers' criteria for selecting rice varieties according to specific land elevations and information on how they trade off between traits. Basic information (name, age, sex, caste, size

of landholding, elevation of rice plots, etc.) was collected from male and female heads of separate households who are actively involved in rice farming. Twenty cards that illustrate traits of rice cultivars were shown and explained to the farmers. Referring to a particular land elevation (*upland*, for example), each farmer was asked what traits he/she considered when selecting rice varieties for that elevation. The traits that the farmer did not consider important were discarded. With the remaining cards representing the chosen traits, the farmer was then asked how much weight he/she gave to each trait out of 16 ana (16 ana=100 paise, 100 paise = 1 Rs). For this process, a total of 16 pieces of stone were provided to the respondent to assign the weights according to his/her choice. An average weight was then computed by getting the sum of all the values assigned per trait, divided by the number of respondents, after which the proportion of each trait to all traits was calculated. This methodology in eliciting farmers' perceptions also provides room for trading off between traits (Sharma et al.1998; Paris et al. 1999)

Farmer participatory approaches for the identification or breeding of improved crop cultivars can be usefully categorized into participatory varietal selection (PVS) and participatory plant breeding (PPB). PVS is a more rapid and cost-effective way of identifying farmer-preferred cultivars, if a suitable choice of cultivars exists. A successful PVS program has four phases: (1) a means of identifying farmers' needs in a cultivar, (2) a search for suitable material to test with farmers, (3) experimentation on its acceptability in farmers' fields, and (4) wider dissemination of farmer-preferred cultivars (Whitcombe et al. 1996). In all of these phases, understanding farmers' local knowledge, perceptions, and criteria for varietal selection is important in improving rice varieties for rainfed ecosystems.

Two approaches were used to strengthen farmers' involvement in the project: (1) farmers were invited to the research station to view a broad range of genetic materials, and (2) farmers were asked to grow a set of diverse materials in their own fields using their own level of management and inputs. Two farmers in each village volunteered to evaluate 16 rice genotypes on their fields using their own labor and level of management. Two sets of medium-duration rice genotypes were planted in two farmers' fields in Tarpongi, which has comparatively lighter soils. One set each of late-duration varieties was planted in Saguni and Khairkut villages, which have heavy-textured soils. The set of rice genotypes include prereleased genotypes (F7-F8), advanced lines from the Shuttle Breeding Project, and a local check. During specific phenotypic stages of rice production, farmers and plant breeders, using a visual method, evaluated and ranked the same set of rice genotypes on the station and on farmers' fields. Kendall's coefficient of agreement was used to measure the agreement among farmers, among plant breeders, and between farmers and breeders. Farmers recorded the reasons for their ranking in their diaries. This was done for consecutive years from 1997 to 1999. In 2000, the number of rice genotypes was reduced to five choices (plant breeder, farmer, one common, and a local check). These genotypes will be evaluated before harvesting, both at the station and on farmers' fields by plant breeders and farmers.

Results and discussion

Characteristics of the research sites and the farm households

This research is being conducted in three villages in the Raipur district located on the Chhattisgarh plains of Madhya Pradesh. On the Chhatisgarh plains, rice is grown mostly in the lowlands in a drought-prone ecosystem. Drought is a major climatic constraint for rice crops in this region. The general climate of the region is dry sub-humid, where annual potential evapotranspirational losses

are higher than the annual rainfall, which is about 1300 mm. Over 90% of the rainfall is received during the period from June to October. The monsoon sets in by 15 June and withdraws around 15 September. Winter conditions set in by mid-November, when the average minimum temperature reaches around 15°C. Hence, the rice crop should mature before this time. Sometimes winter conditions set in early—by the third week of October—and this results in increased sterility and, thereby, low productivity. Under such fragile conditions, the identification of suitable genotypes should be based both on climatic and edaphic characteristics (IRRI-IGAU 2000).

The research sites are located in three villages: Tarpongi, Saguni, and Khairkut in the Raipur district. Tarpongi is 29 km in the north of Raipur; Saguni and Kharkut are 5 km to the west of Tarpongi. These villages are located within 50 km of IGAU. There are 200 to 250 households in each village. More than 90% of the farming households in these villages belong to the other backward caste with small and marginal landholdings (owning less than a hectare), of which the majority are Hindus. Male heads of households have an average of four years in school, while the majority of the women have lower levels of education and did not go to school. All of the farmers interviewed owned their own land. In each village, 25 farmers were interviewed with regards to their farming and cropping systems, rice diversity, and their criteria for varietal selection. The survey was conducted in 1997 and 1998.

The areas for rice production in these representative villages are heterogeneous. Farmers in these villages classify their land according to the topography/slope, such as upland, midland, and lowland. The light soils in the uplands are classified by farmers as *bhata* (entisols), while the sandy loam in the midlands are referred to *matasi* (inceptisols). The heavy-textured soils in the lowlands are referred to as *kanhar* (vertisols). Most of the drought-prone areas have light-textured soils, whereas the more favorable areas have heavy-structured soils. Tarpongi has light-textured soils while the other two villages have heavy-structured soils. The length of the rice-growing season is primarily dependent on moisture availability, which is dependent on slope and soil type.

Rice is grown mainly in the rainy season (*kharif*) in a *biasi* system. Land preparation is done by bullocks and rice is dry-seeded at the beginning of the rainy season in June. When enough rain has accumulated in the field, 25- to 30-day-old seedlings are wet-plowed, laddered, and redistributed. This traditional practice, called *beushening* or *biasi,* is common in many rainfed areas of eastern India, particularly in Madhya Pradesh. Farmers continue this practice with the belief that it helps to control weeds and stimulate root growth (Fujisaka et al. 1993; Singh, Singh, and Singh 1994). Farmers grow purple-colored rice varieties as a strategy to identify and eradicate wild rice (which is prevalent in this region) at an early stage of crop growth.

Family members provide the major source of labor for rice cultivation. While male family members do most of the land preparation, rice broadcasting, and application of chemicals, females are predominantly responsible for weeding, applying farmyard manure, harvesting, threshing by hand, winnowing, and managing seeds for storage. Seed selection is done by both husband and wife. Other post-harvest activities, such sun drying, dehusking, and parboiling are exclusively done by women. Caring for livestock and, consequently, daily collection of green fodder for the livestock is done mostly by women (Sharma et al. 1997). Thus, women's criteria for rice varietal choices may be influenced by their roles and responsibilities in farming and their social and religious obligations, and may differ from those of men. The majority of the farmers obtain new seeds from their neighbors and from extension workers. Only 24% obtain new seeds from IGAU. This indicates a lack of awareness among farmers about the new technologies developed at the university. Weeds are prevalent in farmers' fields, and roguing the rice fields to protect the purity of seeds is not

commonly practiced in these villages. Rice mixtures and weed seeds are commonly found in the seed stocked for the next season.

The cropping intensity in these villages is low because of the lack of supplementary irrigation water during the *rabi* season. The cropping systems in the villages are rice-fallow, rice-lathyrus, or rice-chickpea (table 1). The chickpea and lathyrus crops are grown as relay crops (locally called *utera* in rice).

Table 1. Characteristics of the Rice Land in the Research Sites in Raipur, Madhya Pradesh, Eastern India

Slope	Upland (ndulating)	Midland (gently undulating)	Lowland (leveled and gently undulating and terraced fields)	Lowland (leveled)	Lowland (low lying)
Soils	*Bhata* (entisols)	*Matasi* (inceptisols)	*Dorsa* (alfisols)	*Kanhar* (vertisols)	*Nala* (vertisols)
Texture	Gravely course loamy to sandy	Sandy loam	Silty clay	Clayey	Clayey
Depth (cm)	Very shallow (5–30)	Moderate (30–80)	Moderate to deep (80–150)	Deep (>150)	Deep (>150)
Internal drainage	Rapid	Moderate	Moderate to slow	Slow	Slow (surface flooding)
Mechanical composition (%)					
a. Sand	60–80	30–50	25–35	20–30	20–30
b. Silt	15–22	30–40	25–30	20–30	20–30
c. Clay	9–20	20–33	33–45	>45	>45
Cropping patterns	Rice-Fallow	Rice-Fallow	Rice-Lathyrus or Chickpea	Rice-Lathyrus; Dikes are planted with pigeon pea	Rice-Lathyrus
Duration of rice varieties suited to these land	Short (90–110 days)	Intermediate (110–130 days)	Long (130–145 days)	Long (> 145 days)	Long (> 145 days)

Adoption of rice varieties

A high diversity of rice varieties exists in these villages. The names of the varieties grown by farmers in these villages are shown in table 2. Of the total area grown to rice in the lowlands of Tarpongi, 73% is grown with traditional varieties, while the rest (27%) has modern varieties. Twenty years ago, there were about 20 traditional varieties; however, this number has declined. In contrast, in the uplands of Saguni and Kharkut, the adoption of modern varieties is slightly higher than thethe adoption of traditional ones. Traditional varieties such as Safri-17 and Chepti gurmatia are popular in the lowlands. The main reason for adoption of traditional varieties in the lowlands with heavy soils is because all the traditional varieties are tall and can sustain even late *biasi* operations.

According to the rainfall pattern and soil types of Chhattisgarh, farmers grow varieties according to the land elevation, hydrology, and soils. Rice varieties with a growth duration of less than 110 days are grown on the upper (undulating) portion of uplands with loamy to sandy soil *bhata* (entisols). Rice varieties with a growth duration of 110 to 130 days are allocated mainly to the midland (gently undulating) sandy loam *matasi* (inceptisols). Varieties with a growth duration of up to 140 days are best suited for light soils, such as those found in Tarpongi village. Late-maturing varieties (140 to 155 days) are ideal for low-lying, heavy-textured *dorasa* and *kanhar* soil types, such as those found

Table 2. Area (Hectares) Planted to Modern and Traditional Rice Varieties by Sample Farming Households, Elevation of Rice Land, and Village, Raipur, Madhya Pradesh

Varieties	Tarpongi (n = 25)		Saguni (n=50)		Khairkut (n=50)		
Modern	**Upland**	**Lowland**	**Upland**	**Lowland**	**Upland**	**Lowland**	**Duration (days)**
Swarna	0.8	7.82	27.64	9.86	38.66	5.0	Late (150)
Mahamaya		2.6	2.22	1.4	6.6	1.0	Medium (130)
Kranti	6.8	6.9	8.8	1.8	4.9		Medium (130)
262	7.5	2.1		0.1	0.8		Medium, (125)
H.M.T.					0.4		Medium (130)
Purnima	2.4	0.4					Late (145)
IR36						0.6	Early (120)
Culture		0.8	1.86	1.2			Medium (130)
Others				0.7			
Total MVs	17.5	20.62	40.52	15.06	51.36	6.6	
Traditional							
Safri-BD	2.9	**28.4**	7.7	4.04	**40.62**	5.2	Late (150)
Safri-17	1.2	**10.7**	12.3	3.64	0.44		Late (155)
Chepti gurmatia	**10.8**	7.0	3.2	3.8	0.64	5.0	Medium (130)
Ranikajar	1.8	1.4	6.3	1.84	5.68	0.4	Medium (130)
Bhata safri	4.44	7.8		0.4	2.12	1.6	Medium (130)
Anjan safri	0.5	0.1					Late (145)
Ganga safri	0.3						Late (145)
Nankershar	0.2						Late (135)
Dubraj		1.6					
Chepti				4.7			Medium (130)
Total Traditional	20.14	57.0	29.5	18.82	49.50	12.2	
Total of all varieties	37.64	77.62	70.02	33.88	100.86	18.8	
%MV	**46.49**	**26.57**	**57.87**	**44.45**	**50.92**	**35.11**	
%Traditional	**53.51**	**73.43**	**42.13**	**55.55**	**49.08**	**64.89**	

Note: Modern = semi-dwarf, high-yielding varieties. Traditional = tall in stature whether improved or not improved by selection. Upland = no bunds between plots.

in Saguni and Khairkut. Crops are grown chronologically with the lowland fields planted first and the upland fields planted last. Lowland fields are submergence-prone and need to be sown early so that seedlings are already established before the fields are flooded.

Farmers' perceptions of traditional and modern rice varieties

After identifying the modern and traditional varieties farmers grew, questions were asked about positive and negative attributes. These questions were open-ended and no attempt was made to impose *a priori* categories of answers. Table 3 shows the list of positive traits of popular traditional varieties such as Safri-17 (late duration) and Chepti gurmatia (medium duration). Although these traditional varieties have lower yields, farmers prefer them because of their combined positive

Table 3. Farmers' Assessment of Popular Traditional Varieties

Variety	Positive traits	Negative traits
Safri-17 (late maturing)	• stable yield every year • resistant to pests and diseases • drought tolerant • good for heavy-textured soil • good for *beushening* 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 (*Diwali*)	• 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 (*karaga*) • too much straw and less grain
Chepti gurmatia (medium duration)	• good grain yield (3 t/ha) • competes with weeds • tolerant to drought • ideal for light soil or *Matasi dorsa* • medium duration and can be harvested early, allowing *rabi* 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., *basi* and *pulao*) • preferred as wage by agricultural laborers due to its bold, coarse grains: can last longer in the stomach	• 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 gurmatia*, 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 gurmatia, 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)	• 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 *basi* (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	• 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 *rabi* crops need to be grown • requires more water to mature • low yields of straw • less yield than Mahamaya • not photosensitive
Mahamaya (medium duration)	• 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 *rabi* 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 *poja*) and for puffed rice (*murmura*) 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	• 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	013
	97	2	F	16	5	–	0.50**	–	–
	97	2	M	16	7	2	0.34**	0.53	–0.03
Saguni	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 gurmatia. 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 2nd 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 gurmatia (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 gurmatia (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 Chhatisgarh region in Madhya Pradesh, eastern India. Different methods for understanding farmers' criteria in

selecting rice varieties were used. These methods were (1) a questionnaire with open-ended questions eliciting positive and negative attributes of the most popular modern and traditional varieties, (2) a participatory weighted-ranking method, disaggregating the perceptions of men and women by land types and size of landholdings, and (3) participatory varietal selection, where farmers evaluated several prereleased and local varieties on their fields as well as on-station. The results of the study highlight the importance farmers attach to characteristics other than grain yield: eating quality (taste), market price, duration/maturity, drought tolerance, and pest and insect resistance.

Both men and women have similar criteria in choosing rice varieties. However, straw quality for multiple uses is an important consideration for women farmers but not for men. Farmers, particularly women who do most of the weeding, prefer rice varieties that are inherently dark green or purple to distinguish them from wild rice and enable the farmer to eradicate the wild rice at an early stage of crop growth. Wild rice is a prevalent pest and a constraint to high rice productivity in the Chhattisgarh region. The attributes considered by men and women farmers, however, are not generally used as screening criteria in most formal breeding programs, where the emphasis is mainly on grain yield. Quality attributes should be emphasized more than they have been in the past in breeding programs for rainfed areas. Because of the proximity of the villages to the market, farmers prefer to grow varieties that not only meet their own consumption needs but also those of consumers, including millers and traders. Therefore, farmers maintain their rice diversity and grow both traditional and modern varieties that meet their varied interests and needs. Using approaches like farmer participatory breeding and varietal selection from many rice lines provides an opportunity to farmers to choose varieties suitable to their environment and needs as well as access to new seeds.

Breeding lines R574-11, BG308-2, and IR42342 performed well over the three years of the project in the medium-duration group and showed tolerance to drought. Breeding lines R304-34 and IET-14444 (R738-1-64) also proved promising. A large quantity of seeds have been multiplied by one of the farmers of Saguni village where blight is a problem.

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