Table 3. Yield of Varieties Tested and Farmers' Ranking for Marketability

			Yield (Ton/Ha)							
			Marketable				Not marketable			
No	Accession No	Cultivar	I	II	III	X	I	II	III	X
1	W0131	Bon	0.56	0.14	1.94	0.88	1.81	1.67	0.83	1.44
2	W0194	Yaronambiri	5.83	12.5	8.47	8.93	2.36	1.39	2.92	2.22
3	W0116	Helalekue	7.08	7.08	7.22	7.13	2.92	1.11	1.94	1.99
4	W0113	Lemekuara	2.36	7.78	9.44	6.53	1.11	1.25	2.36	4.72
5	W0323	Womin	4.44	9.17	7.36	6.99	1.94	1.53	4.03	2.50
6	W0045	Poniai	5.00	6.39	6.25	5.88	2.08	2.36	1.67	2.04
7	W0061	Tinta kuning	6.81	3.61	5.00	5.14	0.14	0.69	0.97	0.60
8	W0049	Senggol	2.92	1.39	1.67	1.99	0.28	0.56	1.39	0.74
9	W0033	Sengkerengke	5.14	8.06	3.06	5.42	1.81	1.94	3.19	2.31
10	W0350	Iloka	11.11	12.22	7.50	10.28	1.11	1.25	0.97	1.11
11	W0104	Gelakue	2.36	3.61	0.28	2.08	2.08	1.39	1.67	1.71
12	W0158	Musanaken baru	15.14	10.28	2.50	9.31	5.42	3.19	3.19	3.93
13	W0220 B	Helalekue lama B	—	—	1.11	0.37	—	—	0.69	0.23
14	W0220 A	Helalekue lama A	1.25	4.44	3.47	3.05	0.14	—	0.28	0.14
15	W0008	Esipalek	—	—	0.83	0.28	—	—	0.28	0.09
16	W0124	Naulupe	5.83	11.39	5.14	7.45	2.22	0.83	1.94	1.67
17	W0204	Korwambi	—	0.69	—	0.23	0.42	—	0.14	0.19
18	W0181	Walegein	2.50	2.36	0.83	1.90	2.50	0.69	0.97	1.39
19	W0084	Kuruparambi	3.61	4.44	1.67	3.24	2.22	0.97	0.97	1.39
20	W0187	Mugulele	3.06	4.03	2.64	3.24	1.67	3.19	3.61	2.82
21	W0048	Giniagalo	7.78	5.14	3.06	5.33	1.39	0.56	0.56	0.84
22	W0139	Toweko	12.08	8.33	10.28	10.23	2.22	2.22	2.50	2.31
23	W0130	Siknimbi	4.58	7.92	1.25	4.58	0.83	0.97	1.11	0.97
24	W0197	Mukolele	5.56	4.31	3.89	4.59	1.94	2.78	2.64	2.45
25	W0223	Umakmbi	6.25	10.00	5.56	7.27	1.94	1.53	0.97	1.48
26	W0111	Umakmbi	8.19	3.33	6.25	5.92	2.22	2.22	1.81	2.08
27	W0316	Ketfelale	5.00	5.00	9.44	6.48	0.97	1.11	2.36	1.48
28	W0018	Mailongge	17.08	10.83	12.22	13.38	0.69	1.53	0.97	1.06
29	W0300	Musan	9.03	3.75	6.53	6.44	1.53	2.22	1.94	1.90
30	W0201	Gilikue	0.56	12.22	—	4.26	0.14	—	—	0.05
31	W0331	Kinta	13.19	12.22	8.61	11.34	1.67	2.22	1.81	1.90
32	W0339	Kuning	10.97	5.69	9.17	8.61	1.53	2.78	0.97	1.76
33	W0253	Yoban	4.58	4.72	5.28	4.86	1.39	2.22	1.67	1.76
34	W0041	Pusemangken	0.42	—	1.53	0.65	0.83	—	1.39	0.74

Table 3. Yield of Varieties Tested and Farmers' Ranking for Marketability (Continued)

			Yield (Ton/Ha)							
			Marketable				Not marketable			
No	Accession No	Cultivar	I	II	III	X	I	II	III	X
35	W0010	Musan	2.50	—	2.22	1.57	1.67	0.56	1.94	1.39
36	W0184	Lia-lia	8.19	9.17	7.36	8.24	2.08	2.50	2.92	2.50
37	W0125	Linggoara	4.31	1.67	1.67	2.55	0.56	1.39	0.83	0.93
38	W0241	Sahoma	11.25	8.33	10.28	9.95	1.25	1.81	0.69	1.25
39	W0280	Tuwembi	8.75	8.33	9.17	8.75	1.94	2.64	2.36	2.31
40	W0014	Kentang	7.36	8.89	4.31	6.85	1.53	1.53	1.67	1.58
41	W0141	Gelakue Putih	2.92	6.53	2.22	3.89	1.94	2.22	0.97	1.71
42	W0021	Kila	1.25	1.94	—	1.06	1.53	2.92	0.28	1.58
43	W0227	Kentang	0.83	2.50	0.97	1.43	1.11	0.56	0.97	0.88
44	W0109	Pipombi	3.06	3.47	0.28	2.27	2.92	0.97	0.69	1.53
45	W0109 B	Pipombi B	1.25	4.44	3.06	2.92	0.69	1.39	2.36	1.48
46	W0220	Helalekue Lama	5.69	9.86	5.14	6.90	4.17	2.78	1.53	2.83
47	W0134	Nasimbi	1.39	2.78	4.86	3.01	1.25	1.11	3.19	1.85
48	W0156	Soepak Baru	4.17	4.31	10.28	6.25	3.61	0.56	4.03	2.73
49	W0206 B	Andelan B	4.72	0.56	0.42	1.90	1.53	0.97	1.11	1.20
50	W0206 C	Andelan C	1.67	1.25	1.25	1.39	1.11	0.42	0.69	0.74
51	W0167	Anewun	0.83	—	—	0.28	0.56	0.28	0.42	0.42
52	W0108	Tabimbi	4.03	5.69	5.28	5.00	0.83	0.14	1.11	0.69
53	W0005	Hoboak	8.19	2.22	6.53	5.65	0.97	0.83	1.25	1.02
54	W0206 D	Andelan D	3.61	1.11	2.92	2.55	0.97	0.97	2.22	1.39
55	W0260	Mikmak	7.64	8.75	14.72	10.37	1.94	1.25	2.64	1.94
56	W0055	Mikmak	4.31	7.22	7.78	6.44	1.39	0.83	1.94	1.39
57	W0002	Mikmak	6.81	0.83	10.97	6.20	1.67	0.14	0.97	0.93
58	W0017	Wortel	6.81	4.86	1.53	4.40	1.81	0.97	1.94	1.57
59	W0039	Tinta Kuning	3.33	—	1.81	1.71	0.83	0.56	1.39	0.93
60		Bis 183	12.36	13.06	13.61	13.01	4.03	0.28	4.44	2.92
61		SQ 27	5.69	10.97	10.97	9.21	1.39	0.14	2.92	1.48
62		CIP-1	8.47	9.03	7.08	8.19	1.39	2.64	2.92	2.32
63		Jahe	1.94	9.31	9.31	6.85	1.81	2.22	1.25	1.76
64		Keleneng	2.78	4.17	8.19	5.05	1.25	1.39	4.58	2.41
65		Racik	6.11	0.42	8.33	4.95	5.42	4.58	3.33	4.44

Understanding Agroecological Domains: The Key to a Successful Participatory Plant Breeding Program

R.B. Rana, B.R. Sthapit, A. Subedi, D.K. Rijal, and P. Chaudhary

Abstract

Farmers have an intricate knowledge of their agroecological domains. The empirical evidences from Kachorwa (*terai*) and Begnas (mid-hill) sites in Nepal suggest that farmers distinguish domains for rice primarily on the basis of moisture and fertility. Farmers also differentiate the number, relative size, and specific characteristics of each domain within a given geographic area. Similarly, they allocate individual varieties/landraces to each domain, indicating that the competition between varieties/landraces occurs within the domain and that transgression of domain was rather limited. These deductions need to be verified at a wider level. A fuller understanding by researchers of specific agroecological domains is a prerequisite for them to contribute substantially in planning and executing effective participatory plant breeding (PPB) programs. Only with a sound knowledge of agroecological domains and the varietal distribution within domains can a program on diversity deployment and biodiversity conservation be effectively implemented. Likewise, justifying the cost-effectiveness of PPB, targeting research/extension activities, and measuring the contribution of PPB to food security demands a detailed understanding of agroecological domains. Simple and practical ways to illicit information on agroecological domains and associated varieties/landraces through farmers' group discussion at the village level have been suggested as a pre-project activity for PPB, which could enhance the success of PPB programs.

Introduction

The importance of agroecological domains can be found in earlier work on defining and delineating recommendation domains (RDs), which is closely associated with the farming systems research of the late 1970s (Wotowiec, Poats, and Hildebrand 1986). Initial work on RDs concentrated on a few relatively easily identifiable factors (biological variables), such as land and soil types, agro ecological zones, and crop types and management (Harrington and Tripp 1985). The exercise on RD was highly complex since the process was to identify farming households, based on the similarity in their practices, rather than farms. But the delineation of agroecological domains was much less cumbersome with rice because rice is very sensitive to changes in agroecological conditions and its adaptation is limited, as compared to some other crops such as maize. Moreover, rice is the most important cereal crop in the region, so farmers have an in-depth knowledge of rice-growing environments and varieties suitable to different agroecological domains.

The current endeavor on refining the definition of agroecological domains for rice in parts of Nepal is the case of "sharpening the focus" for better targeting of participatory plant breeding (PPB) work, including diversity deployment, conservation of landraces in different domains, and planning strategic crop management research. The methodology adopted is quite simple and can be replicated in other areas for wider use by the researchers and development workers.

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Farmers define and characterize agroecological domains

Field exercises for delineating agroecological domains have largely been influenced by the methodologies on RDs advocated by Collinson (1980), Franzel (1985), and Vaidya and Floyd (1997). They emphasized the use of secondary sources of information, followed by preliminary surveys supplemented later by a formal survey to refine the domains. However, later views on the subject hold that the refining process should take place only after researchers have a clear understanding of the variability inherent in the local farming systems (Cornick and Alberti 1985). The current study embodies the thoughts from both the methodologies for delineating domains and associated rice landraces/varieties.

In the process of delineating agroecological domains, two group meetings were organized in the Kachorwa and Begnas eco-sites. The first meeting was held with field-based staff; the second, with farmers from the project area. This was followed by a transect walk by researchers and farmer representatives to jointly validate farmers' statements. The exercise took about two days, including field visits in each site.

Interactions with field-based staff

Since field-based staff are stationed in villages, it was expected that they would have a fairly good understanding of the agroecological domains and the farming systems of their respective eco-sites. Hence, the first level of group discussions was organized in field offices, with the field officer, technical assistants, and motivators participating.

After discussions, the participants were able to come up with four major agroecological domains, mainly defined on the basis of water regimes. They also broadly classified the soil type and fertility status of soils from each domain, based on scientific knowledge of soil classification and characterization. Participants were also asked to estimate the size of each domain and place different landraces/varieties in their right domains. Estimating the relative size of each domain was straightforward because the *pokhari/man* occupied only a limited area within the eco-site. But placing each landrace/variety in its right domain proved more difficult. The team could place the majority of landraces/varieties in their domains, but the number of landraces/varieties per eco-site was too large for them to remember all the names and their right environments. The process was also complicated by the fact that some of the landraces/varieties are grown in more than one domain.

The whole process was reviewed by the participants, and once they were satisfied with the steps and outputs, the field officer was asked to facilitate the same process for the farmers' group discussion.

Group discussion with farmers

A group discussion was held with farmers with the specific objective of delineating agroecological domains. Field officers/site coordinators facilitated the discussion and the whole exercise was repeated with farmers' groups. Both female and male farmers participated in the discussion and put forward their opinions.

Farmers identified four agroecological domains within the eco-site (*ucha, samtal, nicha/khalar,* and *pokhari/man*), based on the major criteria of moisture regime and fertility status/gradient (tables 1 and 2). They could easily identify the relative size of each domain, but there were disagreements among about soil classification. Perhaps this reflected the variability of the soil types and soil fertility status in each domain. Placing landraces/variety in the domains initiated a lively

Table 1. Agroecological Domains at Kachorwa Eco-Site

Domain	Soil type	Production potential	Cultivated landraces/varieties
Ucha (bhadaiya rice cultivated on availability of water, good winter crops)	Balaute = sandy (ujar = whitish)	Low (III)	Mutmur, Sotwa, Sokan, Saro... No modern varieties grown.
Samtal (Good crop of bhadaiya rice and winter crops, aaghani rice can be grown)	Domat = Loam Balaute domat = sandy loam (whitish and brown)	High (I)	Lalka farm, Nakhi saro, Sathi, Bhadaiya Basmati, Khera, Aanga, Ujala faram, Sotwa, Sokan, Dudhi saro, Kamod, Madhumala, Basmati, Karma ... (China 4, Philips, Jiri, TV, Chandina, Sabetri...) – Modern varieties
Nicha/Khalar (Good crop of aaghani rice and medium winter crops)	Matiyar = Clay? (Piyar = Yellowish)	High (II)	Basmati, Lajhi, Mansara, Karma, Batsar, Rat rani, Faram, Kamod, Madhumala (Mansula, Sabetri, Pankaj, Nat masula, Jaya, K. Mansuli...) –Modern varieties
Pokhari/Man (can only grow aaghani rice)	Matiyar = Clay? (kalo/kariya = black)	Low (IV)	Bhati, Megraj, Silahout... No modern varieties grown.

Source: Chaudhary (2000).

Table 2. Agroecological Domains at Begnas Eco-Site

Domains	Size of domain	Productivity	Cultivated landraces/varieties
Mule khet/Bhale khet/Khule khet	I	I	Kalo Jhinuwa, Pahenlo Jhinuwa, Jhinuwa, Lamcho Jhuluwa, Sato Jhinuwa, Masino Dhaba, Jhinuwa, Adhari Jhinuwa, Lahora Gurdi,Thulo Gurdi, Seto Gurdi, Sano Lahara, Kalo Gurdi, Sano Gurdi, Gurdi,Thulo Kalo Gurdi, Bayarni, Kalo Bayarni, Seto Bayarani, Gajale Bayarni, Juge Bayarni, Seto Anadi, Rato Anadi, Sano Anadi, Dudhe Anadi, Madhese Thulo Madhese, Sano Madhese, Naulo Madhese, Dhaba Jarneli, Ramani, Aapjhuta, Sano Aapjhunta, Gauwari Aakla, Sethobhudo, Rato Krishnabhog, Bhara Thapachine, Bale, Dhaba Gauwari, Masino Battisara, Kannasina, Pani Barmeli
Sim/Gaire khet	IV	II	Kalo Jhinuwa, Pahenlo Jhinuwa, Jhinuwa, Lamcho Jhinuwa, Seto Jhinuwa, Masino Jhinuwa, Tarkaya Jhinuwa, Jhugainiua, Masino Dhaba Jhinuwa, Adhani Jhinuwa, Lahara Gurdi, Thulo Gurdi, Seto Gurdi, Sano Lahara, Gajale Gurdi, Sano Gurdi, Gurdi, Thulo, Kalo Gurdi, Bayarni, Kalo Bayarni, Seto Bayarni, Gajele Bayarni, Juga Bayarni, Seto Anadi, Rato Anadi, Sano Anadi, Dudhe Anadi, Madhese Thulo Madhese, Sano Madhese, Naulo Madhese, Dhaba Jarneli, Ramni, Kartike Marsi, Pahenle Marsi, Sero Marsi, Chiniya Marsi, Aapjhuta, Sano Aapjhuta,Gauwari Aakla, Naithuma Brimphul, Basmati, Chobo, Palungtare, Jyagdikhole Rato, Krishnabhog, Thapa Chine, Bale, Makikhola, Dhaba Gauwari Barmali, Zadan Masino, Battisara, Karna Jira, Pani Barmeli
Tari/Kharkheri /Tapu	II	III	Eida Jhinuwa, Phaka Jhinuwa, Kanta Gurdi, Pakha Jarneli, Thuda, Pakha Thuda, Pakha Gaujari, Manamuri, Rato, Bhote, Makhi khola, Choto
Pakho tari	III	IV	Pakho Jhinuwa, Katna Gurdi, Mansara, Aagha

Source: PRA (2000).

debate among the members. However, they were able to agree upon the major domains for each landrace/variety. They also reported that some of the landraces/varieties were grown in more than one domain but the cases were limited.

In Kachorwa, of the four domains identified by the farmers, two—*ucha* and *pokhari/man*—were extreme cases (dry land and rainfed; wet-land conditions, respectively). No modern varieties were grown in these areas. Only landraces were found growing under such conditions, and the number of landraces (cultivars) was relatively small compared to other domains. *Samtal* and *nicha* represented better growing environments, with a greater number of landraces and modern varieties growing there. *Samtal* represented the major domain in terms of area. There was considerable area under *uccha* but not much area was under *nicha* and *pokahri*. Several landraces and modern varieties (MVs) were common to both *samtal* and *nicha*. These two domains were more productive in terms of crop production as well.

Similar results were found when the exercise was repeated in the Begnas eco-site under mid-hill conditions. However, the domain delineation was less clear-cut than it was in Kachorwa because several of the landraces and MVs were found in more than one domain. Here again, landraces/varieties were not repeated in more than two domains, and that in adjacent domains only. Jumping of domains by certain landraces/varieties was not observed in either of the exercises. Although several of the landraces and MVs were found in two domains, their performance was judged as best only in one domain. Based on the information generated from the discussion with farmers, it could be deduced that a landrace/variety fits best only in one domain. It exists in other domains because there is no competitive variety to replace it.

Transect walk with farmers for field verification

Having achieved a high degree of agreement between farmers and researchers in the definition of agroecological domains, it was decided to field-verify the definitions through a transect walk and to look for consistency in the field implementation. A representative group of farmers made a transect walk of the eco-site along with researchers. They identified domains and located landraces/varieties on different farms. The exercise helped in relating different agroecological domains and their characteristics with the landraces/varieties being grown there. Thus, this exercise needs to be conducted when the rice crop is mature or when the crop is standing in the field.

Development of conceptual model of agroecological domains for rice

Based on the analysis of the characteristics of different agroecological domains and the distribution of landraces/varieties within domains, an attempt to develop a conceptual model of agroecological domains for rice was made (figure 1). In the following subsections, the characteristic features of the domains have been explained. Nevertheless, the model needs verification in a larger context and further refinement for wider applicability.

Size and characteristics of domains

Local farmers can provide very reliable information on the agroecological domains for rice. Similarly, farmers can provide detailed features of each domain in terms of soil type, drainage, fertility status, production potential, cropping patterns, and so on.

The size of agroecological domains varies, with more extreme environments (domains) being relatively smaller as compared to more favorable ones. This follows normal distribution curve. How-

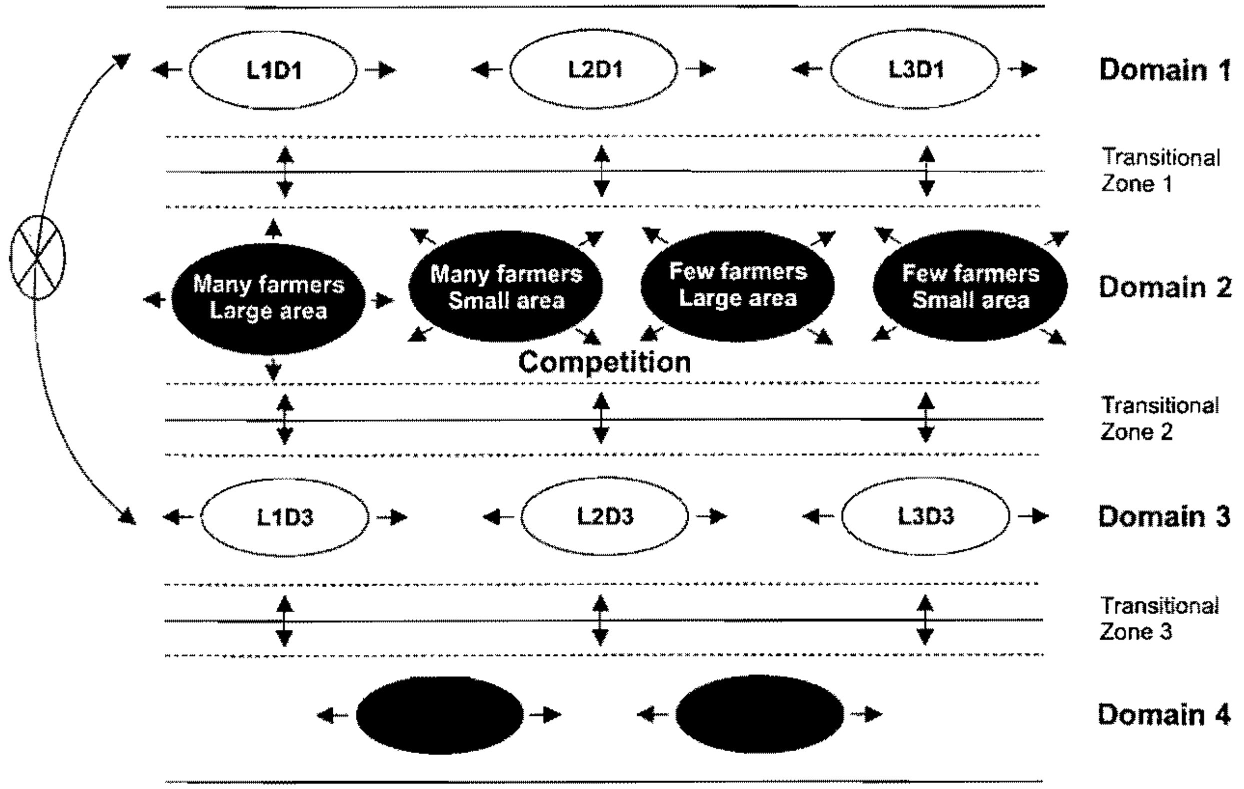

Figure 1. Conceptual model of agroecological domains

ever, depending upon the geographic location (high-potential production systems or marginal growing environments), the size of each domain will vary. For instance, in marginal environments for rice, the extreme domain will be relatively larger as compared to other domains; whereas, in favorable environments, the middle domains will be relatively larger.

Landraces/varieties distribution across domains

Until the distribution of landraces/varieties across domains, the features of domains, and the traits of cultivars are analyzed, one cannot appreciate the complexity of farmers' strategies to manage plant genetic resources to meet their multiple needs. From the analysis, it is apparent that one landrace/variety is best suited or most competitive in only one domain, though farmers might grow the same cultivar in more than one domain. This implies that the cultivar competes with other cultivars from within the domain, and that there is less competition between cultivars across domains, except when there is an overlap of cultivars. Overlap signifies the presence of transitional zones between domains, which explains the presence of landraces/varieties in two different but adjacent domains. Within domains, the area and number of households growing different landraces/varieties is explained by market forces, farmers' socioeconomic status, cultural factors, preferences for specific traits, and other abiotic and biotic factors.

Although landraces/varieties may overlap in adjacent domains, no case was registered where a landrace/variety was found in more than two domains. This suggests that landraces/varieties have very specific adaptations. In other words, it reinforces the idea that a cultivar is most competitive in only one domain.

Landraces/varieties falling within the same domain are more likely to be similar in their genetic composition as compared to landraces/varieties from dissimilar domains. The logic behind is that they have been put under similar management conditions have been selected over time for adaptation. However, this hypothesis needs to be proved from laboratory analysis of some of the samples from each domain. If it proves true, then there is a strong case, from a conservation point of view, for disaggregating genetic materials across agroecological domains. Nevertheless, this process still holds true where diversity deployment is the prime objective of the project.

Implications of agroecological domains for PPB

The distribution of landraces/varieties in different domains is the result of farmers' experimentation with those landraces/varieties over years. In other words, they are the "best fit" under farmers' management conditions. Therefore, researchers definitely need to know the characteristics of each domain, as well as the specific traits of the landraces/varieties in each domain and their distribution across domains in order to make any intervention in the present system. The analysis of agroecological domains is worth the money and time invested in collecting and analyzing the information.

Planning conservation strategies for landraces

Identifying landraces that are grown in small areas by a limited number of farmers and devising ways and means of conserving them might seem to be a straightforward task for conserving endangered landraces. Sometimes, weighted diversity, as well, might be computed for facilitating the decision-making process in choosing which landraces to focus on for conservation when there are numerous landraces falling in the endangered category. However, all these processes and steps consider the diversity of landraces at the aggregated/landscape (community) level and thus ignore the influence of agroecological domains in determining the position of landraces in different domains.

The need for micro-level analysis emerges from the fact that landraces are conditioned over years by their continued growth and selection over time in specific domains. As a result, they have developed adaptive traits, which are unique to landraces falling in that domain. Therefore, analysis of landrace diversity at the aggregated level fails to appreciate the position of landraces in specific domains, which in fact might be harboring genes of important traits. Selecting landraces from an aggregated list might exclude certain strategically important landraces from conservation.

PPB has been used as one means to conserve useful genes in landraces through crossing with modern varieties. However, there could be number of landraces within a domain that might require some form of conservation (through breeding and nonbreeding means). Understanding the features of domains and the distribution of landraces in them will facilitate decision making about selecting landraces for conservation. Failing to do this could result in selecting landraces with similar genetic traits for conservation (via PPB) from just one or two domains. This would lead to the neglect of some and overrepresentation of others.

Strategies for diversity deployment

Diversity deployment in simple term means "providing farmers with options of genetic materials to choose from." The introduction of new genetic material results in temporal disequilibrium because of competition between existing and new genetic material. The competition is for space in farmers' fields, for farm labor, for capital inputs, and so on. As time elapses, the new entrant finds its rightful

place in the given environment. This is the outcome of farmers constantly trying to maintain an equilibrium (meeting farmers' objectives) in terms of stabilizing yield and production over time.

The strategy for diversity deployment must begin by analyzing the distribution of landraces/varieties across agroecological domains. Once this is done, researchers would have a clear picture of each domain, along with the distribution of landraces/varieties, and the dominance of certain cultivars against others would become evident. Researchers would also come to know the reasons for this dominance. Only then could they develop their strategy for diversity deployment. In the absence of this information, new genetic materials might fit into domains where there is not much competition. It could also happen that new genetic materials compete with each other landraces/varieties in similar domains, resulting in limited impact of diversity deployment.

Justifying PPB

The conflict between breeding varieties for wide adaptability or for niche environments will perhaps go on. (*Wide adaptability* means the domain for which the suitability of the landrace/variety is large. *Niche environment* means the domain for the given landrace/variety is limited.) In the truest sense, *wide adaptability* should encompass the ability of a cultivar to be grown in several different domains and vice versa for the niche environment. However, such is not the case.

Whatever the case, the proponents of PPB must bear in mind that the approach has to prove its worth in terms of churning out farmer-acceptable varieties efficiently on such a scale that the economic return on investment is positive. But this is possible only when researchers have a clear knowledge of the size and characteristics of the domains the new variety will fit into. In addition, they also need to know the likely existing cultivar to be replaced. Without this information, it would be rather difficult to estimate the potential adoption ceiling of PPB varieties, which implies that the estimation of economic returns at the household level is difficult. This will become an increasingly important issue in the future, when enough time has elapsed between the development and adoption/dissemination of PPB varieties and the evaluation of their impact.

Another important issue that can be addressed by analyzing agroecological domains is orienting PPB programs towards "poverty alleviation" and food security at the household level. Since resource-poor farmers mainly own marginal land, there is limited varietal choice. By conducting PPB programs using landraces from marginal environments, the chances of providing greater options in such environments is increased, which would contribute to food security, particularly in resource-poor households. Targeting PPB for equity of benefits for the resource-poor can also be justified along similar lines.

Conclusion

Agroecological delineation using key informants/farmers from the given community can be reliably done. The identified domains and the associated varieties in each domain have to be verified through a transect walk with the key informants. This exercise helps prioritize landraces/varieties in each domain based on the number of households growing them and the area covered. Using this information, a selection of landraces/varieties for PPB work could be made. Diversity deployment and conservation of certain landraces/varieties could also be planned using this information. The arguments presented here clearly indicate the need to focus PPB initiatives on marginal environments for which there are no MVs, and where, at the same time, the majority of the resource-poor dwell. This exercise has to be conducted prior to initiating PPB work in a given area. Information

required to delineate agroecological domains and associated landraces/varieties can easily be gathered using key informants at the village level. It has been suggested that this exercise be incorporated as a component of PPB work.

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Listening to Farmers' Perceptions through Participatory Rice Varietal Selection: A Case Study in Villages in Eastern Uttar Pradesh, India

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Abstract

This paper presents a case study based on the findings in two villages in eastern Uttar Pradesh, India, part of a project started in 1997 to develop, test, and refine methodologies of participatory research and gender analysis as they apply to the development of new technologies in germplasm and natural resource management. The two villages occupy different agroecological areas and also differ in sociocultural characteristics. Both male and female farmers were included in the study, and details of their preferences for the rice varieties studied are presented in this paper.

Introduction

Decisions about the adoption of technology are conditional to farmers' perceptions of the performance of a new technology relative to that of the technology currently being practiced. Farmers may assess a new technology, such as an improved variety, in terms of a range of attributes, such as grain quality, straw yield, and input requirements, in addition to grain yield (Traxler and Byerlee 1993). In Orissa, eastern India, farmers indicated preference not only for the visual appearance of rice grain, but also for attributes such as cooking quality, taste, keeping quality, and straw quality (Kshirsagar, Pandey, and Bellon 1997). If farmers perceive an improved variety to be inferior to traditional varieties in terms of one or more attributes, they are unlikely to adopt such a variety (Adesina and Zinnah 1993, as cited by Kshirsagar, Pandey, and Bellon 1997). Crop improvement could potentially benefit from farmers' assessments of the relative performance of different varieties under farmer management. Information on the traits desired by farmers and their knowledge of the production system could be invaluable in setting the goals of a breeding program, delineating the target environment, identifying the parents for breeding and defining the management treatment for breeding work (Sperling et al. 1996; Eyzaguirre and Iwanaga 1996).

Varietal preferences may differ, not only between socioeconomic groups but also by gender. In a farmer-participatory breeding (FPB) project on pearl millet in the Jodhpur district, Rajasthan, India, grain yield, early availability of grain, and the ease of harvesting by hand (lower panicle number and lower plant height) were the main considerations for making selections by women. For the men, yield and quality appeared to be a stronger concern (Weltzien, Whitaker, and Anders 1996). While women have traditionally been seed selectors and managers of germplasm in low-input farming systems, scientists have not given enough attention to their local knowledge, criteria for selection, and perceptions regarding new seeds until recently. For instance, the criteria for selecting seeds, practices of animal care and food processing, and the consequent preferences for different kinds of blending various food materials are useful starting points for building on women's

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perspectives in participatory research (Gupta et al. 1996). Another example is when high labor demands for manual threshing may create incentives for women to adopt varieties that are easier to thresh (Adesina and Forson 1995). Including women in the early evaluation of varieties ensures that new seeds can be adopted rapidly. Thus, men's and women's criteria and preferences for rice varieties should be well understood and considered in plant-breeding strategies.

In March 1997, a farmer-participatory plant-breeding program for rainfed rice was developed at the International Rice Research Institute (IRRI) in collaboration with the Indian Council of Agricultural Research (ICAR). This project includes six research sites representing different rice ecosystems in eastern India. The project is under the umbrella of the CGIAR's Systemwide Initiative on Participatory Research and Gender Analysis. The goal of this initiative is to develop, test, and refine methodologies of participatory research and gender analysis as they apply to the development of new technologies in germplasm and natural resource management. This FPB project aims to test the hypothesis that farmer participation in rainfed rice breeding can help develop suitable varieties more efficiently. It is also designed to identify the stages in a breeding program where farmer interfacing is optimal. The project has two components: the first is a plant-breeding component, which aims to develop and evaluate a methodology for participatory improvement of rice for heterogeneous environments, and to produce and improve adoption of material suiting farmers' needs. The second is a social-science component (including gender analysis) that aims (1) to characterize cropping systems, diversity of varieties grown, and the crop-management practices of rice farmers, (2) to analyze male and female farmers' selection criteria and their reactions to a range of cultivars and breeding lines, and (3) to enhance the capacities of national agricultural research systems (NARS) in participatory research and gender analysis in plant breeding and rice varietal selection (Courtois et al. 2000). This paper focuses on farmers' selection criteria and their reactions to a range of cultivars and breeding lines under participatory varietal selection conducted on farmers' fields.

Characteristics of the villages

The results of the socioeconomic and gender analysis in the FPB project includes only two villages (table 1): Mungeshpur in the Faizabad district and Basalatpur in the Siddathnagar district, eastern Uttar Pradesh. These sites are among the research sites under the FPB project. A similar study was conducted in the other FPB research sites in Orissa and Madhya Pradesh.

Basalatpur represents favorable (but submergence prone) lowland, rainfed areas. Mungeshpur represents shallow, submergence-prone areas that are favorably rainfed during years of low rainfall. Basalatpur and Mungeshpur have a higher proportion of lowland fields (70% and 60%, respectively) with heavier soil and good water-holding capacity. The flow of natural resources like rainwater (field hydrological conditions) throughout the season has also had a major impact on varietal selection in these villages. Farmers in Mungeshpur have more access to supplementary irrigation, which enables them to diversify into other crops, particularly vegetables and fodder crops. Only one diesel pump exists in Basalatpur and this limits crop diversification. The importance of livestock between the two villages also differs. Livestock in Mungeshpur is more important than in Basalatpur. In Mungeshpur, bullocks continue to be used for land preparation, and threshing is done manually. In contrast, land preparation and threshing in Basalatpur is mechanized with the use of tractors. The degree of market orientation is higher in Basalatpur (nearer the city) where more rice is sold.

Table 1. Village Characteristics, Basalatpur (Siddathnagar District) and Mungeshpur (Faizabad District), India, 1997

Agroecology	Basalatpur, Siddathnagar	Mungeshpur, Faizabad
	Favorable lowland	Shallow, submergence-prone, favorable rainfed during years of low rainfall
Total no. of households	140	133
Sample size for surveys	50	50
No. of male farmers	30	30
No. of female farmers	20	20
Land types (%)		
Lowland	70%	60%
Medium land	0	20%
Upland	30%	20%
Irrigation source (private pump)	1%	10%
Importance of livestock	Low	High
Degree of market orientation	High	Low

The socioeconomic characteristics of the sample households are shown in table 2. Households are classified by official social categories of caste. Muslims dominate in Basalatpur (55%), followed by scheduled and backward castes. In Mungeshpur, the backward and scheduled castes dominate (89%). The Yadavs, a subcaste of the backward caste in Mungeshpur, take care of milch animals. The majority of the farming households are owner-cultivators, and share cropping is of limited importance. Female labor participation in rice production is four times higher than that of males in Basalatpur and three-fourths in Mungesphur. There is wide disparity in terms of access to education between men and women. In general, females have lower literacy rates than men. The differences in resource endowments, socioeconomic status, importance of livestock, degree of market orientation, gender roles and responsibilities in rice production, and family size may determine the choice of rice varieties/cultivars and agronomic management practices.

Cropping systems

Rice followed by wheat + mustard is the predominant cropping pattern in all villages. In Basalatpur, wheat and oilseed are grown mainly for domestic use, but rice is grown for consumption as well as marketing. On the other hand, in Mungeshpur, rice is mainly grown for consumption because of low yields and low marketable surplus. Rice is followed by wheat + mustard, which are grown for both domestic consumption and sale. Land preparation for rice is started in June after the arrival of the monsoon. Transplanting and broadcasting are done in July; weeding, in August; and harvesting and threshing, in October to December. During the *rabi* (dry) season from November to April, crops such as wheat + mustard, peas, grams, lentils, *berseem* as green fodder, and vegetables are grown. A few farmers, who have their own irrigation sources, grow crops like mung, maize, vegetables, and green fodder during the *zaid* season (late April to June) in Mungeshpur. Growing crops during the *rabi* and *zaid* seasons is not common in Basalatpur because of the lack of irrigation facilities.

Table 2. Socioeconomic Characteristics of Sample Households, 1997

Characteristics	Basalatpur, Siddathnagar	Mungeshpur, Faizabad
Caste composition (% of households)		
Upper caste	6%	9%
Backward caste	18%	49%
Scheduled caste	21%	42%
Minority	55%	0
Area by tenure (% of households))		
Share-in	3%	0
Share-out	0	1%
Owner-cultivated	97%	99%
Labor inputs in rice (days/ha)		
Male farmers	25 days/ha (19)	45 days/ha (25)
Female farmers	105 days/ha (81)	130 days/ha (75)
Categories of farmers (%)		
Marginal (<1 ha)	68%	80%
Small (1–2 ha)	24%	16%
Large (>2 ha)	8%	4%
Ave. operational size	1.00 ha	0.70 ha
Literacy rates (%)		
Male head	72%	51%
Female head	40%	14%
Average family size	7	7

Note: Figures in parentheses are percentages of total male and female labor inputs in rice production.

The gender division of labor in rice production

The majority of the respondents belong to the lower social class, with small-sized landholdings. Females are younger and have lower literacy rates, compared to males, and have over 20 years of farming experience. The extent of female participation in rice production is high in both villages. Some tasks in rice production and postharvest operations are gender specific. Land preparation and the application of chemicals are men's responsibilities in both villages (10% of fertilizer application is done by women in Basalatpur). In Mungeshpur, women from the lower social status dominate in the work of pulling seedlings (100%), transplanting (70%), weeding (80%), applying farmyard manure (60%), harvesting (82%), and threshing (82%). In Basalatpur, more men than women participate in pulling seedlings and harvesting. Women do the transplanting of seedlings (100%) and most of the weeding (75%), with men doing most of the spraying (90%). Women are also mainly responsible for postharvest activities such as cleaning and selecting the seeds for the next season, storage, and processing rice into other food products for home consumption and for sale. They are the primary end-users of rice byproducts and biomass for livestock and other farm use. A village study in eastern India revealed that women from the lower castes provided 60% to 80% of the total labor input in rice production (Paris et al. 1996). Aside from their significant contributions in rice production, women also provide labor in non-rice crops, collect green animal

fodder, and feed and tend livestock. Thus, men's and women's preferences for specific traits in rice varieties may differ, based on gender-specific roles and responsibilities. With increasing male migration to cities, women are taking on more responsibilities as farm managers, aside from their normal household and childcare responsibilities (Paris et al. 1996).

Rice varieties

Varieties grown by farmers

The rice varieties currently grown by farmers are shown in table 3. Traditional varieties are more common in Basalatpur than in Mungeshpur. Although modern varieties (MVs) show higher adoption rates in Mungeshpur, these varieties often suffer from submergence, drought, and stress at reproductive and ripening phases when the crop is planted late. Most farmers felt that traditional varieties are more tolerant to drought, submergence, pests, and diseases, while MVs performed well under irrigated conditions. The majority of the farmers indicated that they felt that MVs needed better management than traditional varieties. Modern varieties need more labor, higher levels of fertilizer, and more irrigation, but more farmers prefer to grow MVs because of their higher yields.

Table 3. Popular Rice Varieties Grown by Farmers According to Land Type

Land type	Variety	Basalatpur	Mungeshpur
Upland/midland	Traditional	Bengalia, Sarya, Kuwari Mashuri, Oriswa, Malwa	Ari, Bagri, Balbagra, Chaini
	Improved	NDR-97, Sarju-52, PNR-381	Saket-4, NDR-80, 97, 118 NDR-359, Pant-4, Pant-10, Pant-12, Sarju-52
Shallow lowland/lowland	Traditional	Kalamanak, Motibaddam, Malwa, Malasia	Bilaspuri, Indrasan
	Improved	Mashuri, Rajshree, Sambha Mashuri	Mashuri, Madhu, BKP-246, Dwarf Mashuri

Topographical adaptations

Farmers generally match varieties with their environment. For rainfed rice, this means an adaptation to the hydrological conditions of their fields. Each field position in the topo-sequence corresponds to a risk of drought or submergence. The drought risk increases from the bottom to the top of the topo-sequence, while submergence risk decreases along the same path, associated with progressively lower water depths and earlier recession of the water. This translates into different ideotypes for the different situations. Table 4 shows varietal diversity according to land type/topography. In Basalatpur, varieties such as *Bengalia, Sarya, Oriswa, Kuwari Mashuri, Malwa,* and *Ghanbhanan* are the major traditional rice cultivars grown in the uplands, and *Kalamanak, Malasia, Motibaddam,* and *Malwa* are the major varieties grown in the lowlands. Improved varieties, such as NDR-97, PNR-381, and Sarju 52 are grown in the uplands by a few farmers, but the improved variety, Mashuri, occupied more area in the lowlands. In Mungeshpur, the common local varieties grown on upland fields are *Ari, Bagri,* 90 days, *Sonia, Lalmati, Punjab, Lalbagra, Ashwani, Indrasan,* and *Bilaspuri.* The improved varieties are Saket-4, NDR-80, and NDR-118 in upland and medium fields and Sarju 52, Mashuri, and dwarf Mashuri mostly in lowland fields.

Table 4. Farmers' Perceptions of Useful Traits in Selecting Rice Varieties According to Land Type

	Mungeshpur							
	Upland		Lowland		Upland		Lowland	
Traits	Male	Female	Male	Female	Male	Female	Male	Female
Grain yield	36.67	39.50	48.67	49.67	41.67	35.96	42.06	40.45
Duration	25.83	34.50	0.67	1.00	20.56	25.84	20.56	15.00
Grain price	0.00	0.00	15.67	16.00	1.67	2.81	2.97	1.82
Resistance to abiotic stress	8.33	6.70	0.67	0.33	6.10	6.18	5.10	5.00
Biomass quality	3.33	2.50	5.33	4.67	5.00	2.25	5.52	8.64
Taste	1.67	0.50	10.33	12.33	2.78	2.81	2.12	3.18
Bold and pure grain	7.67	1.50	1.67	0.00	4.44	4.49	3.40	5.00
Adaptation to specific soil type	3.33	3.00	2.33	0.67	5.00	4.49	5.52	6.36
Postharvest quality	0.83	3.00	6.67	7.67	0.00	5.06	0.00	2.27
Resistance to biotic stress	4.17	2.50	1.00	1.33	3.89	1.69	4.25	3.18
Cooking characteristics	0.83	1.00	1.67	2.00	3.89	3.92	3.40	5.00
Response to fertilizer	2.50	1.00	2.67	1.33	5.00	2.25	4.25	1.82
Competitiveness with weeds	0.00	0.00	0.00	2.33	0.00	2.25	0.00	2.27
Resistance to lodging	1.67	0.00	2.65	0.67	0.00	0.00	0.85	0.00
Adaptation to several preparations	2.34	4.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Traits are listed in order of importance. Grain yield includes tillering, panicle length, and number of grains. Resistance to biotic stress includes resistance to pests and blast. Resistance to abiotic stress includes resistance to zinc deficiency and drought. Biomass quality includes height and quality and quantity of straw. Postharvest quality includes ease of hulling and milling recovery. Cooking characteristics include cooking time, elongation ability, aspect after cooking, and impression in the stomach.

Medium-duration fields are grown mostly in medium land. Varieties such as Sarju-52, Ashwani, NDR-359, Pant-4, -10, and -12, and Indrasan are grown on the fields that are located in between upper and lower levels of land type. Farmers of Mungeshpur prefer to grow these varieties on the these land types on the belief that they need optimum moisture during the growth period. Fields differ in agrohydrological characteristics in Basalatpur; therefore, some farmers prefer to grow medium varieties on upland fields also.

Farmers' perceptions of useful traits in varietal adoption

To determine whether there are gender differences in perceptions of useful traits in varietal adoption, we used graphic illustrations of traits. We first showed cards that illustrate useful traits in selecting rice varieties. We then asked each farmer what traits he or she consider in selecting rice varieties for specific land types—upland and lowland fields. To assess how farmers valued each trait, we asked the question, "If you had 100 *paisa*, how much would you pay for each trait? The value in *paisa* allocated to a particular trait corresponded to the importance given by the farmer. Because many traits are interrelated, we reclassified them in consultation with a plant breeder. For example, we grouped traits such as ease in hulling and milling recovery under postharvest quality. Table 2 shows the selection criteria of male and female farmers for different land types and villages.

Favorable rainfed lowlands (Basalatpur, Siddathnagar district)

In the lowland areas in Basalatpur, yield and duration are the most important traits male and female farmers consider in selection rice varieties.

In this village, the popular traditional varieties are *Bengalia, Oriswa,* and *Kuwari mashuri.* These are short-duration (90–110 days), medium-height varieties. The average yields are 2.5 tons per hectare. Farmers prefer short-duration rice varieties in the uplands because of the importance of growing early winter crops such as oilseed, linseed, pulses, peas, and potatoes. They prefer to parboil *Bengalia*; otherwise, its grains break easily. Women in Basalatpur use traditional rice varieties for making puffed rice and *churra,* beaten rice like cornflakes.. For women who continue to use the traditional method of hand-pounding rice, postharvest qualities such as ease of hulling and high milling recovery are additional useful traits. The men did not mention these. The finding that women are more concerned than men with postharvest traits and milling recovery are similar to the findings in a participatory breeding project in the high altitudes in Nepal. Sthapit, Joshi, and Witcombe (1996) also observed that women farmers are particularly skillful in assessing postharvest traits, such as milling recovery, and the cooking and eating quality of rice. They found that the evaluation scores between male and female farmers in Chhomrong village showed significant agreement. Women farmers reported that they would like to decide on variety selection after the postharvest evaluation. Consumers preferred white-grained rice to red-pericarped rice because it saves women time in milling.

In Basalatpur, both male and female farmers agreed upon the important traits for lowland rice varieties. Grain price is an important consideration for farmers here because they sell traditional varieties in the market. These, like *Kalamanak,* command a higher price because of their good taste and aroma. *Kalamanak* gives low yields of 1.5 to 2 tons per hectare. In contrast, grain price is not an important consideration in Mungeshpur because rice is mainly used for home consumption and is seldom sold in the market.

Shallow, submergence-prone uplands (Mungeshpur, Faizabad district)

In Mungeshpur, both male and female farmers agreed upon important traits in selecting varieties for the uplands. Women gave more importance to postharvest qualities and grain quality such as bold and pure grains. For the lowlands, both males and females cited better grain yield, medium duration (125-135 days), biomass, and resistance to abiotic stress as their selection criteria for lowland rice varieties. Women gave greater weight to better adaptation to specific soil types and to grain quality. Women mentioned additional useful traits for varieties in the uplands and lowlands that were not mentioned by men: competitiveness with weeds and postharvest quality. Weeds are the major problem in the uplands, particularly when rice is direct-seeded. In the lowlands, weeds are more prevalent during drought. These additional traits are related to the roles and responsibilities of female family members (e.g., hand weeding and feeding rice straw to livestock).

Farmers' evaluation of new rice genotypes grown in farmers' fields

During the 1999 monsoon season, two farmers from each of the villages of Mungeshpur and Sariyawan (rainfed neighboring village) of the Faizabad district and from Basalatpur were selected to check the performance of rice genotypes in their fields. The genotypes were (1) advanced lines from a shuttle breeding project from Uttar Pradesh, (2) released varieties, and (3) the most common local varieties. Of the 14 genotypes screened in Basalatpur, two are scented varieties (*Kamini,*

which flowers in 136 days, and *Sugandha*, which flowers in 124 days). Scientists distributed the seeds through the FPB project. In this approach, breeders select the most promising lines with farmers, and farmers are given a "basket of choices," growing several genotypes in their specific environments.

Ten farmers (five women and five men) visited the individual plots and ranked the rice genotypes grown on farmers' fields past the maturity stage. Farmers were asked to rank the rice lines from 1 (excellent) to 14 or 16 (worst) on the basis of visual assessment. The rankings of the new cultivars by the farmers generated an n x k matrix, where n equals the lines being evaluated and k equals the farmers evaluating the crop performance. Kendall's Coefficient of Concordance (W) was used to measure the agreement in rankings among male farmers and among female farmers, and the correlation between male and female farmers' rankings. High and significant correlation values indicate close agreement on the ranking of the rice genotypes by men and women in the sample.

Tables 5a to 5d show that in the two villages, male and female evaluators were in close agreement in the ranking of the lines. The *W*s were highly significant, revealing that farmers' and breeders' rankings are often acceptable. Table 6 shows the summary of the ranking of male farmers, female farmers, and plant breeders indicating their choices. Of the 14 and 16 varieties ranked in Basalatpur and Mungeshpur, PVS 1, PVS3, PVS7, PVS9, PVS10, and PVS15 came out as the farmers' and breeders' choices in 1999. The traits of these lines are shown on table 7. During the crop season in 2000, several of these lines were compared with local check through PVS. Twenty-three farmers in two villages in Faizabad grew three rice lines, while 50 farmers in six villages in Siddathnagar grew six rice lines obtained from PVS trials.

Table 5a. Summary Ranking of Rice Genotypes in Basalatpur, Siddathnagar District, 1999

Field 1		Males(5)		Females(5)		Breeders (3)	
No.	Lines	Ave. Score	Rank	Ave. score	Rank	Ave. score	Rank
PVS1	**NDR-40032**	**2.4**	**3**	**2.6**	**2**	**3.0**	**2**
PVS2	**Kamini**	**8.4**	**8**	**8.8**	**6**	**11.3**	**12**
PVS3	**NDR-9730004**	**5.8**	**5**	**7.0**	**5**	**4.0**	**3**
PVS4	Bindili	6.4	6	8.8	6	10.3	11
PVS5	NDR-9830103	10.6	10	13.2	11	9.3	10
PVS6	Sugandha	10.8	10	7.0	5	12.0	13
PVS7	**NDR-96005**	**6.8**	**7**	**7.6**	**7**	**6.3**	**5**
PVS8	4113	14.0	11	12.4	10	14.0	14
PVS9	**NDR-9730015**	**3.0**	**2**	**1.8**	**1**	**5.3**	**4**
PVS10	**NDR-9730020**	**2.0**	**1**	**4.0**	**3**	**2.0**	**1**
PVS11	**Malasia**	**9.6**	**9**	**5.2**	**4**	**8.7**	**9**
PVS12	RAU-1308-10-11-3-1-2-4-3	8.6	11	7.4	5	6.7	6
PVS13	CN-1035-61	4.8	4	10.0	9	8.0	8
PVS14	RAU-1411-10	10.4	10	9.2	8	7.0	7
		w=.73**		w=.63**		w=.70**	

**Significant at 0.5 and .10 per cent level.

Table 5b. Summary Ranking of Rice Genotypes in Basalatpur, Siddathnagar District, 1999

Field 2		Males (5)		Females (5)		Breeders (3)	
No.	Lines	Ave. score	Rank	Ave. score	Rank	Ave. score	Rank
PVS1	**NDR-40032**	**2.2**	**2**	**3.8**	**3**	**3.3**	**4**
PVS2	**Kamini**	**7.2**	**6**	**7.8**	**7**	**10.7**	**10**
PVS3	**NDR-9730004**	**8.2**	**7**	**5.4**	**5**	**2.7**	**2**
PVS4	Bindili	5.6	4	2.6	2	11.7	11
PVS5	NDR-9830103	8.0	7	9.2	8	9.7	9
PVS6	Sugandha	6.4	5	6.2	5	9.3	8
PVS7	**NDR-96005**	**4.6**	**3**	**6.4**	**5**	**5.3**	**5**
PVS8	4113	11.0	9	12.2	10	13.3	12
PVS9	NDR-9730015	1.8	1	1.8	1	1.3	1
PVS10	**NDR-9730020**	**2.4**	**2**	**5.0**	**4**	**3.0**	**3**
PVS11	**Malasia**	**12.6**	**10**	**7.2**	**6**	**9.3**	**8**
PVS12	RAU-1308-10-11-3-1-2-4-3	13.6	11	12.2	10	7.7	7
PVS13	CN-1035-61	8.6	8	12.2	10	6.0	6
PVS14	RAU-1411-10	12.8	10	11.0	9	11.7	11
		w=.90**		w=.72**		w=31**	

**Significant at 0.5 and .10 percent level.

Table 5c. Summary Ranking of Rice Genotypes in Mungeshpur, Faizabad District, 1999

Field 1		Males (5)		Females (5)		Breeders (3)	
No.	Lines	Ave scores	Rank	Ave scores	Rank	Ave scores	Rank
PVS1	NDR-40032	3.2	3	2.6	2	1.7	1
PVS2	Kamini	15.8	16	15.2	14	15.3	16
PVS3	**NDR-9730004**	**6.6**	**6**	**6.0**	**4**	**3.0**	**2**
PVS4	NDR-9730003	10.4	13	7.2	7	3.7	3
PVS5	RAU-1308-9-3-1-10-3-4-3	8.4	8	9.0	8	13.0	13
PVS6	PSRM-1-16-48-1	13.8	15	14.8	13	14.0	13
PVS7	**NDR-9830102**	**2.9**	**1**	**1.8**	**1**	**5.7**	**5**
PVS8	NDR-9730002	9.2	10	12.6	10	7.0	8
PVS9	**NDR-9730015**	**8.0**	**7**	**6.6**	**5**	**5.0**	**4**
PVS10	**NDR-9730020**	**5.4**	**4**	**7.0**	**6**	**6.0**	**6**
PVS11	**Mashuri**	**6.6**	**5**	**10.6**	**9**	**9.7**	**10**
PVS12	RAU-1308-10-11-3-1-4-3	10.2	11	13.0	11	12.0	12
PVS13	NDR-96012	9.0	9	8.8	8	8.0	9
PVS14	RAU-1411-10	10.4	12	6.0	4	10.0	11
PVS15	NDR-9830103	3.0	2	3.4	3	6.7	7
PVS16	RAU-1400-13-200-4-6	14.0	14	13.2	12	13.3	140
			w=71**		w=.81**		w=0.79**

**Significant at 0.5 and .10 per cent level.

Table 5d. Summary Ranking of Rice Genotypes in Mungeshpur, Faizabad District, 1999

Field 2		Males (5)		Females (5)		Breeders (4)	
No	Lines	Ave scores	Rank	Ave scores	Rank	Ave scores	Rank
PVS1	NDR-40032	4.2	3	3.4	3	2.3	1
PVS2	Kamini	11.4	12	14.4	14	14.7	11
PVS3	NDR-973004	8.0	7	6.2	4	4.7	2
PVS4	NDR-973003	8.6	9	8.0	8	8.0	6
PVS5	RAU-1308-9-3-1-10-3-4-3	14	12.0	12	14.3	10	10
PVS6	PSRM-1-16-48-1	12.8	13	11.8	11	12.3	8
PVS7	NDR-9830102	3.6	2	2.4	2	7.0	5
PVS8	NDR-9730002	8.0	7	10.0	9	8.7	7
PVS9	NDR-9730015	5.6	5	6.4	5	5.0	2
PVS10	NDR-9730020	5.2	4	7.0	6	6.0	4
PVS11	Mashuri	10.6	10	13.6	13	7.0	4
PVS12	RAU-1308-10-11-3-1-4-3	8	10.2	10	12.7	9	9
PVS13	NDR-96012	10.8	11	7.2	7	9.3	7
PVS14	RAU-1411-10	7.0	6	10.0	9	9.0	7
PVS15	**NDR-9830103**	**1.6**	**1**	**1.4**	**1**	**5.3**	**3**
PVS16	RAU-1400-13-20	15.0	15	10.0	9	9.7	6
			w=.65**		w=.65**		w=.60**

**Significant at 0.5 and .10 per cent level.

Table 6. Summary Ranking of Preferred Lines by Male and Female Farmers and Plant Breeders, 1999

	Male farmers		Female farmers		Plant breeders	
	Field 1	Field 2	Field 1	Field 2	Field 1	Field 2
Basalatpur						
PVS1	3	2	2	3	2	4
PVS3	5	7	5	5	3	3
PVS7	7	3	7	5	5	5
PVS9	2	1	1	1	4	1
PVS10	1	2	3	4	1	3
Mungeshpur						
PVS1	3	3	2	3	1	1
PVS3	6	7	4	4	2	2
PVS7	1	2	1	2	5	5
PVS9	8	5	5	5	4	2
PVS10	4	4	6	6	6	4
PVS15	3	1	3	1	7	6