number of individual plants selected each season is limited, depending on farmers' capacity for seed handling and the land assigned as a breeding plot. Therefore, the genetic variation in farmers' selections is usually narrow. Only Group 1 farmers are involved in the selection process, while field operations are done with the help of other farmers in the community.

Observation test. Pure lines selected from the segregating materials are planted in observation test plots to check for adaptation and yield, with common local varieties used as local checks. Farmers compare the performance of new varieties/lines with the local check and select promising ones for further evaluation in yield trials by Group 2 farmers.

Monitoring. The Group 1 cooperating farmers take close field observations with technical assistance from breeders and agricultural extensionists. These farmers also keep records on field conditions and crop performance for later analysis in determining the suitability of the new crop varieties under selection.

Methods used for PVS

Participatory varietal selection involves the following steps and activities.

Need assessment and selection of cooperating farmers. As in PPB, community meetings are organized to identify farmers' problems and needs in relation to their current crop varieties. Farmers may want to improve their current varieties or change for promising new varieties. A separate group of farmers (Group 2 farmers), with good knowledge of and skills in seed selection and management, are also selected as cooperating farmers in consultation with the community. PVS activities are then formulated and decided upon with the cooperating farmers from both Group 1 and Group 2.

Provision of genetic materials and participatory selection. Three sources of genetic materials are used to obtain seeds for participatory selection of desired crop varieties:

- **PVS with improved local landraces.** The improvement of local landraces is done through mass as well as pure-line selection. Since the mass-selection method does not require very specialized skills, Group 2 farmers, after a simple orientation, have been able to undertake this selection. On the other hand, pure-line selection for crop improvement requires specialized skills and care on the part of the farmers. For this reason, only Group 1 farmers have been used to do pure-line selection, after adequate training and with intensive monitoring. The improved local landraces are then given to a large number of farmers within the community, as PVS materials, for their own testing and selection.
- **PVS with reintroduced local landraces.** PVS also reintroduces landraces from genebanks back to the community when local materials have been destroyed by disaster. Usually the collected local varieties from different locations within and outside of the community are evaluated in the community to give farmers more choices.
- **PVS with modern crop varieties.** Modern crop varieties from research institutions and finished products from PPB are also given to the cooperating farmers for testing their suitability under farmers' own management conditions and household requirements.

Yield trials of successful PVS varieties. The crop varieties preferred by farmers under the PVS program are then put into varietal yield trials in the community for farmers to observe directly and make selections of their choices. Common varieties in the community are used as local checks in these trials. Farmer field days are organized just before harvesting to bring farmers in the commu-

nity to the trial plots for a joint evaluation of the tested varieties. Desirable varieties (usually two to three varieties) are then selected for seed multiplication.

Seed multiplication. Varieties selected by farmers from yield trials are distributed to a group of farmers (Group 3 farmers), with considerable knowledge of and interest in seed production, to multiply large quantities of seeds for use by other farmers in the community. Seed multiplication fields are closely monitored and used as final checks for large-scale production.

Monitoring. Field visits and farmer field days are the most appropriate tools for participatory monitoring and evaluation of PVS activities. Breeders, field staff, extension workers, and farmers participate in such activities. Data collection depends on farmers' objectives and includes common traits such as growth duration, plant height, tillering capacity, grain yield and quality, and tolerance to insects and diseases.

Field experiences with rice

Participatory varietal selection (PVS)

Rice is the major food crop in the Mekong Delta. PVS activities on rice have been undertaken in different forms in the Mekong Delta starting as early as the 1970s. The most common of these activities was varietal yield trials. The main objectives of the varietal yield trials were to generate farmer-preferred crop varieties and faster dissemination of these varieties. Can Tho University has been a leading research institution in initiating and implementing on-farm research activities. In the beginning, breeders and researchers cooperated with advanced farmers individually throughout the Mekong Delta (De 1997).

During the period 1975–1995, hundreds of promising rice varieties were tested in farmers' fields, and a number of varieties were identified and released. Some of these rice varieties are IR36 (later named NN3A), HT6 (NN6A), MTL30 (NN7A), HT19 (NN2B), IR42 (NN4B), MTL58 IR13240-108-2-2-3), and MTL87 (IR50404-57-2-2-3). These varieties have made great contributions to the improvement of rice production in the Mekong Delta. Many farmers, such as Mr. Hai Huu (Long An province); Mr. Hai Chung, Mr. Tu Tai, Mr. Ba Chuong (Tien Giang province); Mr. Ba Cung (An Giang province); Mr. Muoi Tuoc, Mr. Muoi Than Nong (Vinh Long province); and some others, were known as the "rice-selection kings." Farmers were also found to use pure-line selection to improve the formally released varieties for grain quality and adaptation to specific conditions in their areas. This process has, in fact, strengthened on-farm conservation of crop diversity.

Later, since 1994, with the inception of the Community Biodiversity Development and Conservation (CBDC) project, PPB and PVS have been included in their current form in the crop-improvement program. There has been a shift from dealing with advanced, individual farmers to farmer groups and farming communities (CBDC 1998). As a result, more farmers have been involved, the degree of participation has improved, and more work has been organized at the grass-roots level by communities themselves with help from many local authorities. Four farming communities used as pioneers are Nhut Ninh community (Tan Tru district, Long An province), My Thanh community (Ba Tri district, Ben Tre province), Ke Sach community (Ke Sach district, Soc Trang province), and Long Thanh community (Vinh Loi district, Bac Lieu province). The results of PVS activities in these communities are presented in tables 1 and 2.

Table 1. Number of Rice Varieties Tested and Selected from PVS Activities at Four Communities in the Mekong Delta

Year		Nhut Ninh		My Thanh		Ke Sach		Long Thanh	
		Tested	Selected	Tested	Selected	Tested	Selected	Tested	Selected
1994	TR	252	8						
	DWR	20	6						
	MR	18	4						
	HYV	5	1			5	1	22	2
1995	TR	23	3						
	HYV		1	5	4	5	3	169	16
1996	TR		1						
	MR			22	1				
	HYV	9	9	34	9	89	—[1]	9	1
1997	TR	222	2						
	MR	7	Lost[2]	32	29			25	—[1]
	HYV			20	9	16	8	20	3
1998	MR	11						12	
	HYV	12	6	18	8	19	9	24	5

Source: CBDC (1998).
Note: TR= Traditional rice; DWR= Deep-water rice; MR= Medium rice; HYV= High-yielding rice (early).
1. No data available at the time of writing.
2. Due to a typhoon at the last stage of the trial, no result was possible.

Table 2. Common Varieties Selected from PVS Activities at Four Communities in the Mekong Delta

Rice varieties	Nhut Ninh	My Thanh	Ke Sach	Long Thanh
TR	Nep Thom, Tai Nguyen, Me Huong		Tai Nguyen	
MR		MTL83, MTL124		MTL83
HYV	IR49517, IR64, MTL156, 157, MTL159, 199	IR54883, S976B, MTL138, 205	MTL99, 101, MTL142, 157, MTL164, 190, MTL199, 201, MTL202	IR64, MTL138, MTL142, 147, MTL149, 150, MTL156, 157, MTL159, 199

Source: CBDC (1998).
Note: TR= Traditional rice; DWR= Deep-water rice; MR= Medium rice; HYV= High-yielding rice (early).

Participatory plant breeding (PPB)

In the 1996/97 dry season, the project decided to start providing segregating breeding materials from 63 F_2 populations of 12 crosses made by the Rice Research Department of Can Tho University for farmer selection in the four communities listed above (table 3). The names of these crosses are L245, L246, L247, L248, L249, L250, L251, L252, L253, L254, L255, and L256. Many farmers

Table 3. Number of Segregating Populations Distributed and Selected by Four Communities from PPB Activities in the Mekong Delta, by Year

Community	Number of populations selected by generation (F_2, F_3, F_4, F_5)				Farmers' selection
	F_2	F_3	F_4	F_5	
Nhut Ninh	13	13			
My Thanh	20	8	3	1	L246-10-1-B
Ke Sach	10	4	2	1	L246-7-3-B (SiC-1) L247-1-5-B (SiC-2)
Long Thanh	20	11			
Total	63	36	5	2	

were interested in selecting individual plants from segregating populations based on their own criteria and under their own management conditions. Some of the farmer-selected varieties are now stable lines and are being tested in yield trials.

L246-7-3-B, and L247-1-5-B, the two promising farmer selections and noted by farmers as SiC-1 (Soc Trang Selection, no. 1) and SiC-2 (Soc Trang Selection, no. 2) respectively, were purified by bulk selection method after F4. Farmers in Ke Sach community (Soc Trang province) are now multiplying it for distribution among themselves. Mr. Canh is the leader of this farmers' group who has led the selection activities in this community. Similarly, L246-10-1-B, a promising line selected by farmers in My Thanh community (Ba Tri district, Ben Tre province) is also now under yield test and seed multiplication.

Besides four communities the initially selected, the PPB and PVS programs were also expanded to include other advanced, individual farmers in the Mekong Delta. One of these was Mr. Hai Triem from An Giang province, who was well-known as "farmer of the era" and was awarded the Third Labour Medal by the central government for his contribution to rice improvement.

Problems and lessons

Problems

- The low educational level of the farmers means they require more training and the adoption of PPB is slow.
- Few farmers are interested in working with breeding and selecting segregating materials. Farmers are more willing to multiply promising varieties than to select from segregating materials or make crosses.
- The number of farmers collaborating in PPB is limited, especially in pedigree selection and selection of segregating material because these are time-consuming activities.
- Agricultural policy is more favorable to commercial production than tp conserving diversity.
- Due to the fast turnover of rice varieties by farmers (every three to four seasons), it is difficult to keep their interest and get their cooperation for the entire process of selecting segregating lines, which takes time to get results.

Lessons

- Support from local authorities and organizations in term of organization, management, additional funds, and facilitation is very important.
- Cooperation with groups and communities on PPB and PVS gives better results than working only with individual farmers.
- Farmers' field schools and farmers' field days for PPB and PVS are good ways to motivate the farmers' participation at the community level.
- Farmers conserve and maintain the diversity of plant genetic resources to meet their own needs for home consumption, marketing, and adaptation to local environments and farm resources.
- Biodiversity development should be considered on a temporal and spatial basis at the level of species, crop, and agroecosystem. PPB and PVS increase plant genetic resources at the level of the gene pool and not at the level of specific varieties.
- In situ and ex situ conservation and development are complementary.
- Biodiversity in the Mekong Delta is currently under pressure but integrated farming systems and diversification of plant genetic resources could help to correct the situation.

Participatory approaches are very important for crop improvement at the community level in Vietnam and are efficient ways of achieving crop improvement at this level. PPB and PVS are the key tools for this. Successful results from farmers' selections have proven that these are the right approaches, providing a very useful lesson for national crop improvement programs.

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Using Farmer Knowledge for Participatory Sweet-Potato Variety Selection in Garut, West Java, Indonesia

Caecilia Afra Widyastuti and Minantyorini

Abstract

This paper describes trials using sweet-potato germplasm from Irian Jaya, where sweet potatoes are a staple food in the highlands. During the collection of sweet-potato germplasm, farmers' knowledge of those sweet potatoes has also been collected. Farmers' knowledge about sweet potatoes in Irian Jaya will be used as a basis for this project and includes information on yields, the use of sweet potatoes as human food or feed for livestock, and the condition of the environment.

Varieties are selected on the basis of farmers' criteria, including market orientation and table consumption: skin color, flesh color, uniformity, and other criteria. The project is also collecting information on farmers' cultivation practices, such as using high ridges in the rainy season and reducing the leaves during the growing period, as well as how to choose healthy cuttings.

Methodology

The objective of this research is not only to get a high-yielding sweet potato that is adaptable in Garut, but also to get new variety/ies with the agronomic characteristics required by different user groups (i.e., farmers, traders, consumers).

The study was set up in the village of Desakolot, Cilawu District, Garut Regency of West Java Province in a rainfed field that had been used for brick making six years before and had remained fallow for five years. The year before the trials took place, the field was planted with yambean. One week prior to planting, 150 sacks of manure were applied in order to improve the soil. This is always done in this area, especially for land has been used for brick making. This field is typical of places where sweet potatoes are grown. The nearest field to this site is planted with corn, sweet potatoes, and ginger. This neighboring field was also used for brick making, and the vigor of the plants grown on it is good. Prior to establishing the field trials, planting materials were multiplied in Cibadak, Pacet, about 3.5 hours away from Garut, since it was very dry in Garut.

A total of 64 cultivars, including five checks (BISI83, SQ27, CIP-1, Jahe, and Keleneng) were tested (the last two of the checks are well-known local cultivars in the area). There were 36 hills per plot. The date of planting was 26 February 1998.

The experimental design is a randomized complete block with three replications. The size of individual plots is 1.6 m x 3.0 m. Spacing is 80 cm between rows and 15 cm to 18 cm between hills. Harvesting is done according to the farmers' schedules.

During the harvest, we invited farmers, traders, and extensionists to select sweet potatoes based on their criteria. By using participatory tools such as flags, they walked around the trial field and chose what they liked. After that they ranked the selected varieties based on production, skin and flesh color, uniformity, skin smoothness, and general acceptance (table 1). Figure 1 shows participants ranking the selected varieties.

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Table 1. Selection Criteria and Rank of Sweet-Potato Varieties

Rank of selection	Criteria of selection	Results (in order)
I	Production	Kinta, Toweko, Lemekuara, Umakmbi, Pipombi
II	Skin color	Toweko, Pipombi, Lemekuara, Umakmbi, Kinta
III	Root shape	Umakmbi,Toweko, Kinta, Pipombi, Lemekuara
IV	Flesh color	Toweko, Umakmbi, Lemekuara, Kinta, Pipombi
V	Uniformity (shape and size)	Umakmbi, Toweko, Pipombi, Lemekuara, Kinta
VI	Skin smoothness	Toweko, Pipombi, Lemekuara, Kinta, Umakmbi
VII	General acceptance	Toweko, Umakmbi, Lemekuara, Pipombi, Kinta

Figure 1. Farmers, traders, and extensionists ranking selected sweet potatoes

Results and discussion

The experimental field was harvested on 22 August 1998, according to the farmers' schedule. No check varieties were select by farmers—not even Racik, the most popular local cultivar. Five new cultivars, i.e., W0139 (Toweko), W0331 (Kinta), W0111 (Umakmbi), W0113 (Lemekuara), and W0109B (Pipombi), were selected by the farmers, traders, and consumers (table 2). Toweko appears to be the most preferred cultivar in this area.

Farmers in Desakolot plant sweet potatoes for commercial purposes. They have several requirements, such as high yield, smoothness of skin, skin and flesh color, uniformity in shape and size, and root shape.

High yield is one important requirement for commercial purposes. The idea of "high yield" includes early maturation. Farmers prefer to plant sweet potatoes that with a high yield but they also require other criteria such as smooth skin, good skin and flesh color, etc. Table 2 shows that *Kinta,*

Table 2. Farmers' Selections from the Irian Jaya Sweet-Potato Trial

No	Accession No.	Local name	Production	Skin color	Root shape	Flesh color	Uniformity (shape and size)	Skin smoothness	General acceptance
1	W0139	Toweko	****	*****	****	*****	****	*****	*****
2	W0331	Kinta	*****	*	***	**	*	**	*
3	W0111	Umakmbi	**	**	*****	****	*****	*	****
4	W0113	Lemekuwara	***	***	*	***	**	***	***
5	W0109B	Pipombi	*	****	**	*	***	****	**

Note: Ranking is indicated on a scale from 1 to 5, where ***** indicates highly acceptable and * indicates low acceptability.

which had the highest yield was given low acceptance overall because it did not have acceptable skin color, uniformity, or skin smoothness.

Smooth skin color refers to skin that has not been damaged by weevils or nematodes and that exhibits no cracking. Skin should be thick enough to withstand peeling during transportation and to be resistant to weevils or nematodes. The smoothness of the skin has a considerable effect on the price of sweet potatoes.

Farmers always refer to good-tasting sweet potatoes as *ubi ketan* (sticky sweet potatoes) if they see a sweet potato with purple flesh. According to them, these sweet potatoes get a good price.

Toweko (W0139) was given eight flags because it meets the criteria of high yield, good skin color, uniformity in shape and size, good flesh color (dark yellow), and is suitable for fresh consumption and for snack food (*keremes*). According to farmers, the minimum price for Toweko should not be less than Rp 500. After tasting the raw *Toweko*, the farmers predicted that this cultivar would be well received in the market. The participating farmer wanted to plant Toweko 30% in the first season and increase it to 50% for the next season. They said they would plant 100% if the market could absorb that much. Two participating farmers, Haji Sumarna and Amin, will be responsible for multiplying this sweet potato as a source of planting material.

Umakmbi (W0111) was chosen with four flags because the skin is very smooth and thick, meaning it could resist weevil attacks. The flesh color is dark purple, meaning it will taste good (*ubi ketan*—sticky sweet potato), and the roots are very uniform in shape and size. With these criteria, the farmers predicted that this sweet potato would command a good price in the market. According to the farmers, they can increase the production of this variety. Farmer Unang will be responsible for multiplying this sweet potato as a source of planting material.

Kinta (W0331) was given six flags because of its high yield and purple flesh, meaning it will taste good (*ubi ketan*—sticky sweet potato). The skin is very smooth, with no evidence of nematode attack. Farmer Agus will be responsible for multiplying this sweet potato as a source of planting material.

Lemekuwara (W0113) was chosen with two flags because of its rounded shape and smooth, red skin, which mean it will be easier to sell in the market. Farmers chose this from replication III, which indicated high production. Farmer Eman will be responsible for multiplying this sweet potato as a source of planting material.

Pipombi (W0109B) was chosen with eight flags because the size is uniform, it has smooth skin color, and it can be sold fresh. Farmer Encek will be responsible for multiplying this sweet potato as a source of planting material.

Conclusions

Based on our experiences with this trial, we have formed the following conclusions:

- Using farmers' knowledge about sweet potatoes from Irian Jaya will help researchers to do preliminary selections for the trial.
- The participation of farmers in the area where the trial was set up will help in selecting sweet potatoes based on farmers' criteria, such as marketability and table consumption.
- Farmers selected sweet potatoes based on their marketability and farmers' own criteria.

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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-