Developing Local Organizational Capacity for Participatory Seed Management: Experiences from the Eastern Himalayas

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Abstract

This paper describes the objectives and goals of a participatory seed-management initiative that is presently being conducted in the Sankhuwasabha District of eastern Nepal as part of the Gender, Ethnicity and Agrobiodiversity Management" project. The long-term goal of the project is to develop local capacities to effectively manage existing genetic resources through the development of skills that enhance crop improvement. The research is based on an interactive methodology that emphasizes devolution through varying levels of farmer participation in the research process. Both men and women farmers are included in the project, with the requirement that they be involved in farming as a full-time subsistence activity. Specific problems faced by farmers in the area, such as out-migration of men looking for wage-work and a yearly period of food scarcity lasting as long as six months, are highlighted.

Introduction

Situated in the remote mountain regions of the eastern Himalayas, the "Gender, Ethnicity and Agrobiodiversity Management" project proposes to develop the research capabilities of selected local people in four sites: eastern Nepal, Sikkim, Bhutan, and Nagaland. The immediate objective of the project is to develop a local capacity to conduct research to better understand the causal links between ethnicity and gender and how these components affect and influence decisions related to management of agro biodiversity. However, the broader, long-term goal of the project is to develop local capacities to effectively manage existing genetic resources through the development of skills that enhance crop improvement. Within this latter context, a participatory seed management initiative is currently being implemented in one site (Nepal) with the objective of broadening the experiences gained from this process to other sites in the region.

The participatory seed management project is being conducted in three adjoining "village development committees" (VDCs), which are village-level administrative units of the Sankhuwasabha District of eastern Nepal. In broader terms, the project aims to enhance and develop new technologies for seed management in marginal mountain communities that lack access to new seed sources. The following hypotheses articulate the more specific objectives of the research project:

- The development and enhancement of seed-management technologies will occur most effectively through a process of interactive learning between indigenous and formal systems of agricultural development.
- Access to improved technologies can be most effectively sustained through community action. This necessitates the enhancement of existing technical skills for seed improvement, along with the organizational capacity of community-based organizations to ensure community access to these improved technologies.

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- Finally, the success of community action to manage development processes will depend fundamentally on the community's ability to control the processes of knowledge production, design, and implementation of actions.

The practical implications of this methodology can be summarized as the need to search for ways in which participatory research can be part of an ongoing process. Inherent to the process is the acknowledgment that power relations between researchers and the *researched* is problematic and that there is a need to develop a process of critical reflection that situates the production of knowledge and action within a specific context of a negotiated process, emphasizing community action (see also Koning and Martin 1996).

The setting

The major ethnic group inhabiting the research sites is an ethnically distinct but heterogeneous group of people known as the Rai. Together with a related group of people known as the Limbu, the Rai refer to themselves as *Kirats*, a term employed as much to unify all the various "tribes" and clans as it is a political statement employed to distinguish them from the dominant Hindu majority. Having until the recent past practiced a distinct system of communal land tenure known as *kipat*, the *Kirats* constitute one of the oldest ethnic components of the region. Yet in decades following their integration into Nepal after the "unification" in the mid-18th century, the *Kirats* have been confronted with numerous challenges to their traditional way of life. Dominant lowland influences have resulted in changes in sociocultural practices associated with traditional land-management practices and given rise to the ubiquitous rain-fed and irrigated terraces (*bari/khèt*) that suit wetland paddy and other lowland crops. In the process, engineered landscapes have replaced extensive areas of forest cover where traditional swidden (slash-and-burn clearing) was practiced.

Compounding the asymmetry of historically derived center/periphery relations are constraints imposed by the harsh mountain environment. Typical of the eastern Himalayan region (see Shrestha 1989), human settlements are situated in elevations ranging from 500–2000 meters, where land-distribution patterns combine with steep slopes and shallow soil depths to severely constrain agricultural activities. The land-distribution figures of Tamku VDC (table 1), where the research sites are located, demonstrate the environmental constraints that the inhabitants are confronted with. From the total available land, only 10.6% is suitable for agriculture, and from this total arable area, 54% has slopes of 40 degrees and soil depths of not more than 20 cm (Goldsmith, 1982).

Asymmetrical center/periphery relations embedded in historical processes have contributed significantly to the present deteriorating state of local institutional capacities to negotiate and orient

Table 1. Land Classification of Tamku VDC

Agricultural lands	10.6%
Grazing lands	14.6%
Shrubs	7.8%
Deciduous forests	35.6%
Subtropical forests	10.8%
Rock ice	20.6%

Source: Khanal (1992).

development services to their benefit, especially to counter the period of food deficit that typically lasts for four to five months a year. Unable to support their subsistence needs through crop yields alone, many households have male family members migrating in increasing numbers to urban centers in search of employment, leaving women and children to manage and care for the farm. An additional outcome of prolonged periods of food deficit is the inability of households to save seeds from consumption in times of stress. This, along with deteriorating local knowledge about seed-management practices and the absence of organizational capacities to access external sources of improved seed technologies has profound implications for the long-term subsistence of households in the region. It also significantly determines the nature and type of research methodology to be adopted for particular sites.

The research process: An interactive methodology

The objectives of the project evolved in several stages of a diagnostic process that sought devolution by emphasizing community participation in increasing stages during the research process. In order to facilitate community control and ownership, the methodology was developed from the principles of problem posing, dialogue, and reflection based on the Freirean (1972, 1973, 1978) notion that community involvement in the development process can be generated through developing a critical awareness of the causes of problems. The diagnostic process involved the following steps:

1. A survey was conducted to establish the need for a participatory seed-management initiative, based on the following research themes:
   - assessing the capacity of local community-based organizations
   - determining existing patterns of food sufficiency
   - identifying appropriate crop(s) for enhancing improved seed-management strategies
   - determining factors for farmer participation through gender-differentiated varietal assessment of identified crop(s)
   - determining the source of germplasm, either in existing local varieties or through external means
2. Analysis was done through a critical examination of baseline data to determine how the problem of food deficit is contextualized by community members. That is, are problems of food deficit linked to just economic issues of subsistence or are they affected by social dynamics of decision-making? And to what extent are these embedded in the values and cultural constructs of the community? Conceptualized problems in this way necessitates posing the following questions:
   - Do the issues deal mainly with problems of subsistence, decision-making, or values?
   - Where will action most likely come from?
   - What will most effectively motivate people?
3. Problem-posing material was prepared through the development of codes, which are representations of existing problems in the form of stories, dramatized enactments, pictures, results of participatory rural appraisal (PRA), etc. Fundamental to the preparation of codes is the need to ensure that they present a scene showing a concrete experience of the problem, which is familiar to the participants.

4. Discussion was directed through an interactive workshop whereby community members participated in defining the problem of food deficit and searching for solutions. The primary objective of this process was to develop a critical awareness of the problem of food deficit through the search for potential solutions. Additionally, the process also creates a context for the community to provide comments on the research results and to define the direction of the process. The process begins with a description of codes, followed by a first analysis, which is then related to real life and followed by a deeper analysis, ending in self-reliant action planning.

Farmer participation in the research process

The degree and type of farmer participation depends principally on the objectives for participation, as well as the context, as determined by the particular stage of the process. Thus, the diagnostic phase, consisting of the survey, analysis, code preparation, and discussion, involved varying levels of farmer participation. In the survey, three members of the community and two project members comprised the research team. Clan elders and farmers selected on the basis their knowledge related to seed management were consulted about the relevance of the project. In addition, the executive body of community-based organizations were consulted to establish interest in developing a working partnership to conduct the project.

The survey was conducted to establish (1) a crop inventory, (2) to determine the needs and priorities of different groups, based on gender and wealth considerations, and (3) to identify crop for improving seed-management technology. At the same time, farmers were selected for consultation on the basis of their knowledge, financial status, and gender. The subsequent analysis of the data to develop appropriate codes was conducted in collaboration with local researchers and farmers.

The main objective of the workshop that followed was to present the codes to the larger community

Table 2. Types of Farmer Participation

	A	B	C	D
Survey		x		
Analysis		x		
Code preparation			x	
Discussion				x

Source: Adapted from Biggs (1989).
Note: A = contractual; B = consultative; C = collaborative; D = collegiate.

to understand the root causes and potential solutions to problems of food deficit in the region. The selection of community members was based on the criteria developed in prior consultation with local members of the research team. During this stage of the interface, farmers were more extensively involved in the direction of the discussion of research findings, as well as decision making to determine the level of participation in setting the agenda for future action.

User differentiation

The selection of participants was determined by the following criteria:

- demonstrated instances of innovation in seed management and knowledge of causal links between problems of food scarcity and gaps in existing seed-management practices
- gender-differentiated knowledge and gendered experiences
- farming for subsistence as a full-time subsistence activity

Innovation

The participants selected for participation in the research process demonstrated varying degrees of innovation in crop management. The type of innovations ranged from pre-harvest selection practices to post-harvest storage practices. In some instances, the practices were learned from experience gained externally, as in the case of selecting for desired traits of rice during the pre-harvest period or experimenting with new strategies as in the case of post-harvest storage of maize mixed with millet to reduce pest attack.

While post-harvest selection practices were common for crops such as maize and millet, pre-harvest selection was practiced only on paddy. One farmer, selecting specifically for larger panicles, denser grain quality, and tall height in a landrace (*punche dhan*) was successful in producing a "variety" subsequently named after him (*changkhu dhan*, literally "Changkhu's rice"). This "variety" is currently widely adopted by other farmers in the community, with Changkhu presently selecting for early maturation to coincide with the planting of winter wheat.

In seed-storage technology, some innovative farmers experiment with the leaves of a locally available plant (*bojo*) to ward off pest attacks on maize seeds. Dried leaves of this plant are placed in the bottom of the seed container and alternately in several layers approximately every three to four inches, then the container is sealed by additional leaves at the top. Sealed in September or early October, the relatively airtight spaces and the toxic nature of leaves sufficiently wards off pest attacks.

In another example, one woman farmer, noticing that millet grains were free of pests that attacked maize seeds, began mixing a handful of millet grains in the container where maize seeds were stored. This relatively simple practice was based on her observation that millet seeds were free from the pests that attacked the maize seeds that were stored in close proximity to the millet.

Knowledge and gendered experiences

In varietal assessments of maize, conducted separately between women and men farmers during the initial research phase, women and men listed different categories of preferences based on their roles and experiences. Men listed four varieties of maize, mostly modern varieties that had been introduced into the community in the last several years. Women, on the other hand, listed eight varieties, mostly landraces whose use had been discontinued in the project site but existed in the women's natal villages. Women cited fodder quality, ease in grinding, and taste as the primary criteria for their preference of landraces. Men, on the other hand, cited high yields, early maturation, resistance to drought conditions, and market prices as important in their preference for modern varieties. An additional ranking of maize varieties among farmers revealed differential knowledge and preference priorities between women and men (table 3).

Farming for subsistence

That participating farmers be involved in farming as a full-time subsistence activity was an important criteria for selection for two reasons: the first was prompted by the project need for the uninterrupted involvement of participants for two production seasons (for most farmers in the area,

Table 3. Varietal Knowledge and Preference Ranking of Maize for Men and Women

Women	Men
1. bhote' paheli	1. manakamana-1 (MV)
2. paheli	2. dhude' seti
3. dudhe' seti	3. paheli
4. bhote' seti	
5. tamlunge' seti	
6. arun-2 (MV)	
7. manakamana-1 (MV)	
8. chepti seti	

food-scarcity periods necessitated involvement in off-farm activities for supplementing household incomes); the second was because those farmers who were involved in farming as a "full-time" activity showed a greater inclination to be relatively self-sufficient in food production, even during the scarcity period. Of the nine farmer participants in Tamku VDC who were included in the "innovative" category, all claimed sufficient food security during the year and could be counted upon by other community members for food loans during periods of food deficit.

Out-migration of men to urban centers in search of employment is one of the primary strategies employed to counter food deficits. In the past, it was common for men and women to become involved in reciprocal arrangements within the community during times of food shortage. Usually this involved providing labor for wealthier farmers in return for food provisions during times of scarcity. Increasingly, however, the present trend is for the majority of young men to migrate to urban centers to work as porters for trekking companies, perform menial jobs in restaurants and hotels, or migrate to the Middle East (*arab*) through the numerous employment agencies that have sprung up in Nepalese townships.

In addition to out-migration, people also forage for a variety of forest foods (*kandamul*), although a degree of social stigma surrounds foraging activities, principally through the perceived notion that it is part of the "primitive" past.

At the household level, food-preparation strategies also play an important role in "making it last longer." Grains are boiled with excess water, creating a porridge-like consistency to increase the quantity. "Visitors and guests" during the time of scarcity are actively discouraged from visiting, though some women participants cited visiting relatives (preferably the natal home, for married women) as an option to combat food shortages.

A seasonal calendar for food production reveals a period of severe food scarcity between the months beginning in late February and lasting till early July. The relationship between food production and out-migration, especially of males to urban centers in search of employment, is directly proportional to the increasing number of female-headed households as well as the additional, "gendered" burden of farming responsibilities that this trend implies. Moreover, there was a strong relationship between decreasing food production and poor access to seed sources and deteriorating seed-saving practices. Research suggested that the deterioration of seed saving was not necessarily related to loss of knowledge but was, rather, determined to a large extent by food scarcity and the additional burden of farm households to do "other things." Increasing trends in food scarcity over the last few generations have resulted in people consuming instead of saving seed material.

Though there were many reasons for food scarcity, research demonstrated a causal relationship between decreased crop yields and the inability to manage seed, in terms of both maintaining seed purity (*saadha biyu*) and poor seed storage practices. Moreover, access to the Agriculture Input Sector (AIC), a public-sector undertaking responsible for seed supplies was difficult, since it is situated in district headquarters a day's walk from the village and using it often proves to be a difficult bureaucratic process beyond the reach of individual farmers. The consequences of low yields, the inability to maintain seed purity, and lack of access to reliable sources of new germplasm all contribute to food scarcity in Tamku.

Lessons learned: Reconceptualizing participation and knowledge

In order to address the objective of developing improved seed technologies in marginal mountain environments while emphasizing community control of the management of the process, it becomes important to conceptualize farmer participation in the research process as an instrument of empowerment. One principle way forward in this direction is to situate farmer participation in the context of local knowledge. In doing so, however, it becomes important to view knowledge, or indigenous technical knowledge, beyond common representations of its being produced as a rational response to environmental contingencies (e.g., Mathias-Mundy et al. 1991; Howes and Chambers 1980; Brokensha, Warren, and Werner 1980). Instead, it becomes important to situate indigenous technical knowledge within cultural categories of meaning, which can then become an empowering base for participation in the interface with more powerful external categories of knowledge.

The workshop discussions revealed how empirical experiences cannot be separated from cultural experience, especially in the way Rai farmers talk about food scarcity and place the phenomenon in a mythic context. Local discourse of food scarcity finds expression both in the dominant Nepali language as well as the various dialects of the Rai group. The words to describe food scarcity range from *anikal* (food shortage), *bhokmari* (to kill hunger), *mahamari* (the great killer), and *sisawa* (famine) in the Kulung dialect of the Rai. It also finds expression through simple expressions such as "*khana ko abab hunu*" (to be short of edibles), "*dhayrai/chitto bhok lagnu*" (to experience hunger pangs sooner and more frequently than normal), "*chasum na hunu*" (to lack prosperity), as well as more abstract expressions, such as in this lament in the Kulung dialect "*Etenay sisawa udanai lay tay ho wumche*" (dear friends and brothers, . . .how do we survive the *sisawa* [food shortage] this year?) or the more common instructional verse admonishing people to save seeds to combat food shortages "*Almal ma jiyu bachhaunu, Anikal ma biyu bachhaunu*" (save oneself in times of confusion, [but] save seeds in times of [food] shortage) or "*Chha geda sabai mero Chhaina geda sabai tendo*" (having seeds, all is mine, [not] having seeds, all is not mine [i.e., lost]).

In the indigenous schema, food scarcity is a condition of cultural "disorder" that has its genesis in the curse that one warring ancestor castes upon another for perceived treachery. In cultural terms, the condition becomes inevitable and requires annual propitiation of the ancestor through ritual appeasement. The myth, consisting of ancestral deeds that include the settling of present territories, serves as a metaphor for the sacred relationship that exists between the Rai and the delimited territory they occupy. Traditional Kirati notions of ethnicity cannot be separated from this relationship and are symbolized by an ancestor stone that is situated in every village and propitiated in annual agricultural ceremonies (*ca:ri*).

What such a view of knowledge implies is that by granting legitimacy to cultural epistemologies, indigenous explanations for empirical categories are not subjugated by rationalist scientific explanations and thereby become an empowering element for farmer participation. Within such a context, the transfer of technical skills to enhance seed technology neither diminishes nor disempowers indigenous systems of meaning.

References

Biggs, S.D. 1989. *A multiple source of innovation model of agricultural research and technology promotion.* Agricultural Administration (Research and Extension) Network, Paper No. 6. London: ODI.

Brokensha, D., D.M. Warren, and O. Werner (Eds). 1980. *Indigenous knowledge systems and development.* Lanham, Maryland: University Press of America

Freire, P. 1972. *Pedagogy of the oppressed.* New York: Seabury.

Freire, P. 1973. *Education for critical consciousness.* New York: Seabury.

Freire, P. 1978. *Pedagogy in process.* New York: Seabury.

Goldsmith, P.F. 1982. *The land and soil resources of the KHARDEP area, Koshi Hill Area Rural Development Program.* Report no. 16. Kathmandu: Koshi Hill Area Rural Development Program.

Howes, M. and R. Chambers. 1980. Indigenous technical knowledge: Analysis, implications and issues. In *Indigenous Knowledge Systems and Development,* edited by D. Brokensha, D.M. Warren, and O. Werner. Lanham, Maryland: University Press of America

Khanal, N.R. 1992. *Study of geo-hydrology, landuse and population in the Makalu Barun Conservation Project area.* MBCP Working Paper Series 14. Kathmandu: Woodlands Mountain Institute.

Koning, K. de and M. Martin. (Eds). 1996. *Participatory research in health: Issues and experiences.* New Delhi: Vistaar Publications.

Mathias-Mundy, E., O. Muchena, G. McKierman, and P. Mundy. 1991. *Indigenous technical knowledge of private tree management.* Ames, Iowa: Iowa State University Press.

Shrestha, T.B. 1989. *Development ecology of the Arun River Basin.* Kathmandu: International Centre for Integrated Mountain Development.

Participatory Approaches to Crop Improvement at the Community Level in Vietnam

Nguyen Ngoc De

Abstract

Crop improvement has been one of the strong, continuous programs in the Mekong Delta for major crops, especially rice. However, most breeding programs have been set and designed by breeders, neglecting the role of users: farmers and farming communities. Farmers have been the passive users, receiving finished breeding lines/varieties for their production. The dissemination process of "technology transfer" has been very slow and costly for both breeders and farmers.

The use of participatory approaches in crop improvement have ensured the involvement of farmers in the whole process or, at least, in the evaluation process. This has resulted in a better understanding and acceptability of new crop varieties generated through the breeding program.

Can Tho University, as the leading research institution for adapting participatory approaches to rice improvement, started on-farm breeding programs as early as 1975, after the war, by sending out their staff and students to work closely with farmers on crop-improvement programs. In 1994, with the inception of the Community-Based Biodiversity Development and Conservation (CBDC) project, participatory plant- breeding (PPB) and participatory varietal-selection (PVS) approaches were introduced as methods to develop and identify crop varieties specific to niche environments and farmers' preferences.

These participatory approaches are also being used in one of the study sites, Tra Cu, of the global in situ conservation project implemented in Vietnam in collaboration with the International Plant Genetic Resources Institute (IPGRI). The result has been very positive, with many promising crop varieties selected from these programs and used in larger-scale production. Farmers have been successful in segregating material selection and many farmers have become well known through these activities.

Participatory approaches are very important for crop improvement at the community level in Vietnam. PPB and PVS approaches are the key tool for crop improvement. Successful results from farmer selections have strongly proven that these approaches are right. This experience has been very useful for national crop-improvement programs.

Introduction

Crop improvement has been one of the strong, continuous programs in the Mekong Delta for major crops, especially rice and beans. However, most breeding programs have been set and designed by breeders neglecting the role of users: farmers and farming communities. Breeders have set their own breeding objectives and conducted crop-improvement programs based on their own analysis of problems and on-station research findings (COWI 1999). At the end of their breeding programs, promising breeding materials are released to farmers as so-called "technology transfer." Farmers are passive users, receiving finished breeding lines/varieties for their production. In many cases, farmers, especially the poor, refuse to try new varieties because they do not want to take the risk. Resource-rich farmers are the first to try such varieties. Participation is limited to providing a piece of land to the breeders for on-farm trials. The dissemination process of "technology transfer" has been very slow and costly for both breeders and farmers. As a result, the adoption of recommended varieties, in many cases, has been very slow, doubtful, or has even failed. Local adoption of new technologies is dependent not only on technical suitability and economic viability but also on social

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acceptance. The use of participatory approaches in crop improvement assures farmers' involvement in the whole process or, at least, in the evaluation process. This has resulted in better understanding and greater acceptability of new crop varieties generated through breeding programs.

Can Tho University, as the leading research institution for adapting participatory approaches in rice improvement, started on-farm breeding programs as early as 1975, after the war, by sending out their staff and students to work closely with farmers on crop improvement programs (Xuan et al. 1993). In 1994, with the inception of the Community Biodiversity Development and Conservation (CBDC) project, participatory plant breeding (PPB) and participatory varietal selection (PVS) were introduced as methods to develop and identify crop varieties specific to niche environments and farmers' preferences (CBDC 1996, 1997).

Witcombe and Joshi (1996) defined PPB as involving farmers in selecting genotypes from genetically variable, segregating materials and PVS as involving the selection by farmers of nonsegregating materials, characterized as products from plant-breeding programs. However, they also agreed that PPB is a logical extension of PVS. In our view, PVS is only a lower level of PPB. PPB, therefore, should be understood in its broader meaning and implications as the involvement of farmers in the whole process of plant breeding, not only the selection of segregating and nonsegregating materials. Farmers can be involved at the very beginning, when strategies and objectives are set for plant breeding, in identifying parents, making crosses (of course with training from the formal sector), and selecting both segregating and nonsegregating materials. The experiences from the CBDC project in Southeast Asia have proven that point, especially in the Mekong Delta in Vietnam and in Bohol, Philippines, for rice (CBDC 1998).

These participatory approaches are also being used at one of the study sites, Tra Cu, of the global in situ conservation project implemented in Vietnam in collaboration with the International Plant Genetic Resources Institute (IPGRI).

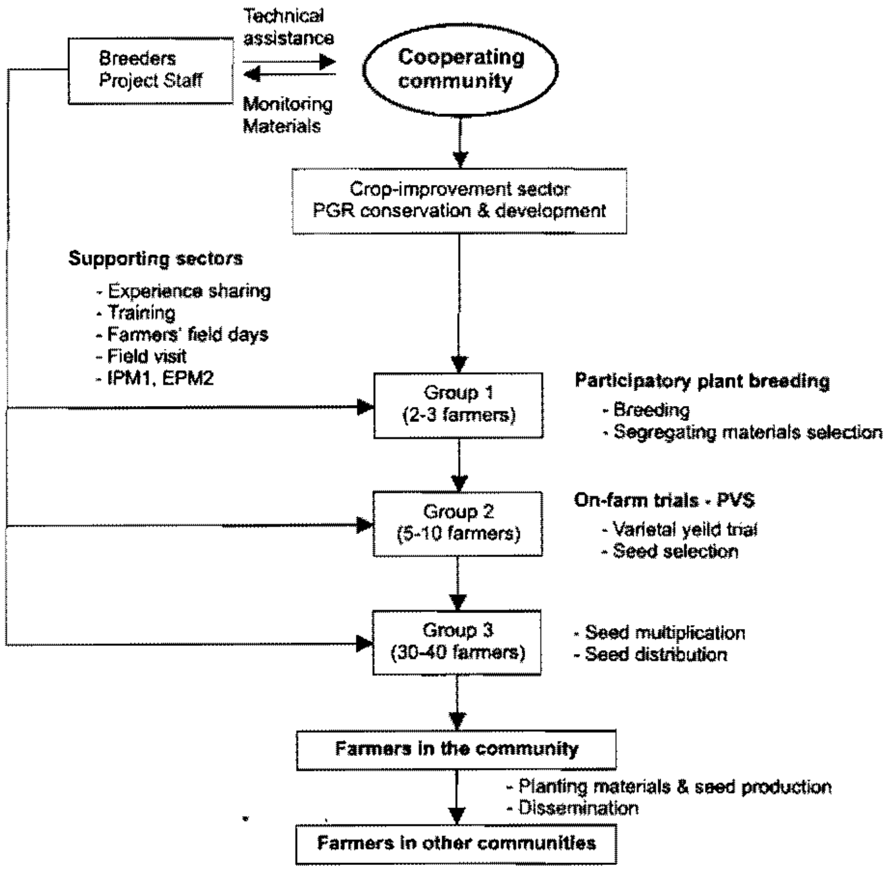
Methods used in participatory crop improvement

The participatory crop-improvement program uses PVS and/or PPB approaches, depending on farmers' varietal needs and their breeding knowledge and technical skills. The PVS approach has been used to improve local landraces and to evaluate the finished breeding materials, obtained from research institutions, on farmers' field. When varietal options available to farmers through PVS are limited or exhausted, PPB is initiated (CBDC 1998). Farmers with knowledge of and interest in breeding are involved in PPB activities, i.e., activities from crossing desired parent lines to selecting and evaluating the segregating genetic materials (De and Tin 1998). A flow diagram showing the methods used in participatory crop improvement is presented in figure 1. The methods used in implementing PPB and PVS are discussed below.

Methods used for PPB

Participatory plant breeding involves the following steps and activities.

Need assessment and selection of cooperating farmers. Community meetings are organized to identify farmers' problems and needs and to come up with suitable crop-improvement strategies and plans. A group of farmers (Group 1 farmers), with knowledge of and interest in breeding, are selected as cooperating farmers in consultation with the community. Breeding activities are then formulated and decided upon with these cooperating farmers.



Note: Group 1=Advanced farmers with good knowledge and skill in breeding.
Group 2=Farmers with good knowledge and skill in seed selection.
Group 3=Farmers with good knowledge and skill in seed production.

1. IPM=Integrated pest management.
2. EPM=Ecological pest management.

Figure 1.Community-based networking diagram for PPB and PVS

Setting breeding objectives and identifying donor parents. Breeders work closely with farmers to agree on breeding objectives. Farmers have been found to use both quantitative and qualitative criteria to determine these breeding objectives. Some of the examples of such criteria are high yield, short duration, resistance to major pests and diseases, stickiness of cooked rice, and so on. Based on the breeding objectives, breeders then assist farmers in searching for suitable donor parents for crossing. These donors may be found among the available genetic materials at the local level or from research institutions and are made available to the cooperating farmers.

Making crosses and selecting segregating materials. The Group 1 farmers are given additional training on crossing techniques and assisted in making the desired crosses. In other cases, breeders provide seeds of segregating lines at very early generations (F_2, F_3, and F_4) to the farmers for selection of desired lines based on their own criteria. Farmers have been found to handle segregating materials from generations as early as F_2. In the process, farmers apply their own crop-management practices. Based on breeding objectives, farmers observe, evaluate, and harvest the selected plants individually. This process is repeated until stable lines are obtained. For management reasons, the

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

		Nhut Ninh		My Thanh		Ke Sach		Long Thanh	
Year		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.

References

CBDC. 1996. *Annual CBDC project report of 1996.* Can Tho, Vietnam: Community Biodiversity Development and Conservation Project.

CBDC. 1997. *Annual CBDC project report of 1997.* Can Tho, Vietnam: Community Biodiversity Development and Conservation Project.

CBDC. 1998. *Annual CBDC project report of 1998.* Can Tho, Vietnam: Community Biodiversity Development and Conservation Project.

COWI. 1999. *Seed sector study, Vietnam. Volume 1: Findings, Conclusions and Recommendations.* Danida/MARD draft report. March 1999. Hanoi, Vietnam: Danida.

De, N.N. 1997. Data collection and analysis in the Mekong Delta Community Biodiversity Development and Conservation Project of Vietnam. Paper presented at the 2nd IPGRI meeting, Rome, Italy, 25-29 August 1997.

De, N.N. and H.Q. Tin. 1998. *Participatory plant breeding in Vietnam CBDC project.* Technical report to CBDC Regional Coordination Unit. Quezon City, Philippines: South East Asia Regional Institute for Community Education.

Xuan, V.T. and N.N. De. 1993. Present status of agricultural extension in Vietnam. Paper presented at the first Southeast Asia workshop on formulation of project proposals on technology transfer for major food crop production, FAO and UAF, Ho Chi Minh City, 6-9 Dec. 1993.

Witcombe, J. and A. Joshi. 1996. Farmer participatory approaches for varietal breeding and selection and linkages to the formal seed sector. In *Participatory plant breeding: Proceedings of a workshop, 26–29 July 1995, Wageningen, Netherlands*, edited by P. Eyzaguirre and M. Iwanaga. Rome: International Plant Genetic Resources Institute.

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.

References

Schneider, J., C.A. Widyastuti, and M. Djazuli. 1993. *Sweetpotato in the Baliem Valley area, Irian Jaya.* Bogor. Indonesia: International Potato Center (CIP)—ESEAP Region.

Widyastuti, C.A. 1994. Women role of Dani tribe to maintain the sustainability of sweetpotato as staple food in Jayawijaya Regency, Irian Jaya. In *Proceedings of application sweetpotato production technology and post harvesting to support agro industry*. Malang, Indonesia: Research Institute for Legume and Tuber Crops.

Widyastuti, C.A. 1995. The collection of associated knowledge during short germplasm collections: Field experiences in Java and Irian Jaya. In *Indigenous knowledge in conservation of crop genetic resources*, edited by J. Schneider. Bogor, Indonesia: International Potato Center (CIP)—ESEAP Region and Central Research Institute for Food Crops.

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 Jameli, 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-

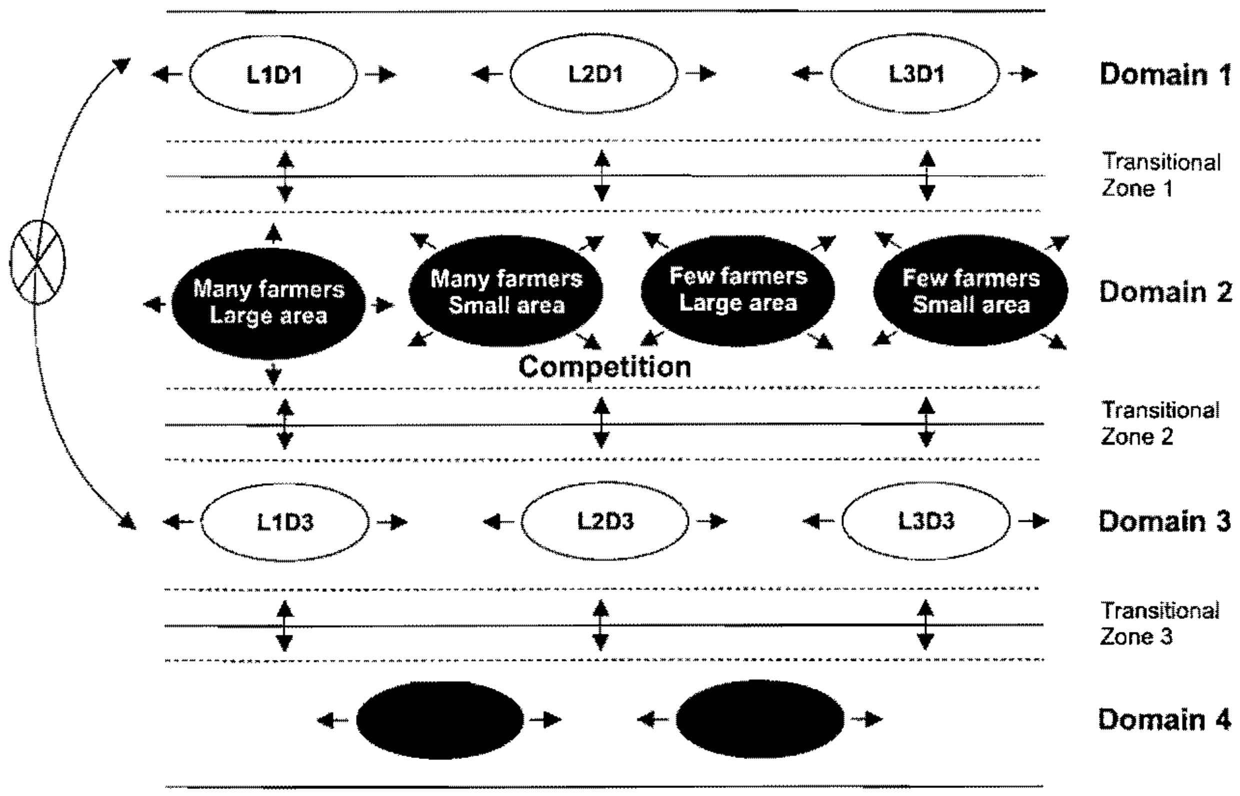

Figure 1. Conceptual model of agroecological domains

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.

References

Chaudhary, P. 2000. *Progress updates, Kachorwa, Bara, Nepal (March 1998–December 1999). Strengthening the scientific basis of in situ conservation of agricultural biodiversity on-farm.* A project jointly implemented by NARC/LI-BIRD/IPGRI.

Collinson, M.P. 1980. *A farming systems contribution to improved relevancy in agricultural research: Concepts and procedures and their promotion by CIMMYT in Eastern Africa.* Nairobi: Centro Internacional de Mejoramiento de Maíz y Trigo, East African Economics Program.

Cornick, T. and A. Alberti. 1985. Recommendation domain reconsidered. Paper presented at the 1985 Farming Systems Research and Methodology Symposium, Manhattan, Kansas. Manhattan, Kansas: Kansas State University.

Franzel, S. 1985. Evaluating a method for defining recommendation domains: A case study from Kenya. Paper presented at the 1985 Farming Systems Research and Methodology Symposium, Manhattan, Kansas. Manhattan, Kansas: Kansas State University.

Harrington, L.W.,and R. Tripp. 1985. *Recommendation domains: A framework for on-farm research.* Working Paper 02/84. Mexico, DF: Centro Internacional de Mejoramiento de Maíz y Trigo.

PRA. 2000. *Participatory Rural Appraisal on Intensive Data Plots Exercise at Begnas, Kaski.* Field Report. Pokhara, Nepal: Local Initiatives for Biodiversity Research and Development.

Vaidya, A.K. and C.N. Floyd. 1997. *From recommendation domains to providing a basis for research prioritisation and locating representative sites for technology generation and verification in the hills of Nepal.* LARC Occasional Paper No. 97/3. Kaski, Nepal: Lumle Agricultural Research Centre.

Wotowiec, P. Jr., S. Poats, and P.E. Hildebrand. 1986. Research, recommendation, and diffusion domains: A farming systems approach to targeting. Paper submitted to the 1986 conference on Gender Issues in Farming Systems Research and Extension.

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.