goals for the Bara and Kaski eco-sites were developed in a participatory manner, involving breeders, socioeconomists, and farmers, to analyze the strengths and weaknesses of the landraces. In the process of selecting parents, farmers strongly felt that the preferred traits should be maintained even if inferior traits were the targets for improvement through PPB. Thus, the breeding strategy has a role to play in improving and conserving traits and characteristics that are *not* linked specifically with social, religious, or medicinal norms and beliefs or used in local recipes.

Adding benefits through nonbreeding and non-market methods

A number of participatory approaches have been used to date to increase local awareness about the importance of agro-biodiversity and to improve the flow of seed within and between communities (Rijal et al. 1999). Diversity fairs, diversity theaters, diversity songs, poetry journeys, community biodiversity registers (CBRs), and diversity blocks are some of the popular activities carried out to increase awareness and sensitize the community.

In the context of strengthening access to germplasm and information in the farming community, diversity fairs, diversity blocks, and community biodiversity registers have been identified as powerful options, which also enhance the farmers' capacity in managing their own crop genetic resources.

The diversity fair. Here, the term *diversity fair* refers to a tool used to demonstrate or display local crops along with the associated knowledge resources of an ecology, as defined by community-based organizations (CBOs). Traditionally, local seed markets and fairs constitute an important part of the informal seed exchange system in the villages. Local markets, *haat bazaar,* and "agricultural fairs" provide a good opportunity for the exchange of seeds and knowledge. In recent years, these informal systems have been threatened by outside intervention, particularly in the seed sector. As a result, indigenous knowledge associated with local genetic resources has begun to erode.

The community-organized diversity fair focuses on indigenous landraces. In Nepal, diversity fairs have been used as an entry point to raise the level of awareness about in situ crop conservation programs before more technical aspects of the project are implemented. By organizing competitions between groups of farmers, the project promote access to farmers and encourages farmers to maintain the maximum genetic diversity. The in situ project uses diversity fairs as a participatory research and development tool in Nepal. It aims at creating competitions between farmer groups on a regular basis in order to accomplish the following:

- to recognize farmers who maintain large amounts of genetic diversity and who possess a good deal of associated knowledge, to act as a source of information for others
- to locate areas of high diversity
- to identify and locate endangered landraces
- to prepare an inventory of crop genetics, along with a knowledge resource base
- to identify the main sources of the informal seed supply within the community
- to understand the value of diverse genetic resources in terms of use, economics, culture, religion, ecology, etc.
- to empower local communities to have control over their genetic resources
- to help develop a sense of ownership in the community

There are different ways of conducting diversity fairs. The in situ project aims at strengthening CBOs that conduct on-farm conservation activities with little input from outside. Initially, when CBOs were unfamiliar with the project's activities, project staff managed the fairs in partnership with them. Over time, as they have become better oriented, they organize the fair as an annual event. Sthapit and Jarvis (1999) have documented the concept and methods used, and the steps of the fair have been described by Rijal et al. (1999). There have already been five such fairs organized in Nepal, and as a result, the process has been refined over time. The fairs organized in Nepal have been successful in terms of the following:

- documenting local landraces and associated knowledge, as well as strengthening the farmer-to-farmer seed supply system
- linking outputs with research and development work
- locating the status of diversity and the custodians
- sensitizing farmers, along with the research and policy communities, on the importance of agrobiodiversity
- strengthening CBOs in on-farm conservation processes

The fairs organized through CBOs have documented equally good information, as well as increasing sample size and the number of crops. The information includes the special characteristics associated with the landraces, i.e., *huliya*, sociocultural values, ecology, and status at the community level. These sets of information can be very useful for a number of stakeholders, including breeders, ecologists, socioeconomists, and local promoters for their varied interests. The information may be shared among the farm communities and other interested parties. A very important aspect of the fair, observed in a recent fair in Begnas, Nepal, is the development of the sense of ownership in the community for the resources they have conserved for generations. Every CBO took back samples with the knowledge that they had to maintain them for future use.

The diversity block. A diversity block is a participatory research technique designed to characterize local landraces under farmers' management conditions. Landraces to be grown in the diversity block may be selected from materials from either the diversity fair or farmers' seed stocks. The crops are monitored by both farmers and scientist-promoters, and agromorphological characteristics are recorded. The diversity block has the value of enhancing public awareness at the grassroots level and making germplasm more accessible o the local community. In Nepal, the diversity block has been used to acquire farmers' indigenous knowledge about local varieties, to identify parents for breeding, and to study the population structure.

The community biodiversity register. A community biodiversity register is a record, kept on paper or in electronic form by community members. It is a register of local crop biodiversity and associated knowledge. The information maintained in the register includes landrace names, the farmers who store the seed, associated local knowledge and uses, and traditional and nontraditional passport data like agromorphological and agroecological characteristics and cultural significance. The register functions as a decentralized community gene bank (Sthapit and Jarvis 2000). CBRs have no implications for local seed exchange and storage systems; rather, it helps to improve access to information and seeds.

Updated over time, the CBR allows communities to monitor the level of genetic diversity and prevent the extinction of rare varieties, which may then be preserved ex situ. CBRs can be a practical

tool to monitor genetic diversity at the village level, and if the capacity of the farming community is strengthened with institutional support, it could be a good way of developing various options to add benefits on a local or regional scale.

Strengthening seed and information networks was one of the concerns in this project, for which different strategic tools were explored. The community gene bank adopted by a few institutions, such as UBINIG in Bangladesh, was reviewed for its strengths and limitations. It was found to require additional structures to serve communities under situations of stress and risk, and may replace the local farmer-to-farmer seed-supply systems. CBR strengthens local systems was developed through review of functions complementary to in situ conservation.

Since CBR has only recently been developed, it still requires further refinement. However, it has multiple functions and is worth the effort because of its effectiveness at the grassroots level. This was discussed with farmers and CBO representatives, and their responses are summarized below:

- CBR provides an inventory of both valuable and worst crop resources.
- It strengthens sharing of information and crop seeds by improving access.
- It is useful for strengthening market and seed networks.
- It lists the status of all known crop resources, with reasons for decrease, increase, or loss.
- It is useful to R&D workers.
- It enhances the process of developing a sense of ownership for the resources held by CBOs.
- It provides descriptions of ecology and diversity with area-specific identities.

The records maintained in the CBR assists in understanding the farmer's decision-making processes as well. Thus, the CBR implemented in Nepal has guided communities in developing a sense of ownership for their resources. Whatever significance it has depends on the way it is developed and executed locally. Therefore, the potential benefits from CBR can only be realized when it is adopted with full consideration of the importance of (1) partnership with farmers, (2) periodic up-dating, (3) local control, (4) sharing information among the users/stakeholders, and (5) caution about providing access to the information to outsiders.

Both the CBR and diversity fair can be used for a number of purposes, from developing R&D bases to strengthening at the grassroots level in terms of improving access to seeds, using information in an effective manner, and assessing diversity. CBR records could provide a very useful basis for developing conservation strategies. Endangered species or landraces, for example, may be conserved ex situ. However, we are also equally concerned with the possible misuse of information, such as intellectual and farmers' rights. The community must be made aware of this kind of danger as well.

Adding benefits through market methods

The demand for materials or processed products may be increased by market methods (box 1). There are many examples of local crops (e.g., *Basmati* and *Jetho budho* rice) that have direct market value. There are many options to which farmers are not exposed. This applies to researchers, development workers, market networks, and consumers as well. Benefits can also be added to crop diversity by better processing, packaging, storage, and marketing.

Box 1. Options for Adding Benefits through Market Incentives

Adding benefits through market incentives

- Exploiting price incentives by better processing and marketing
- Creating consumer awareness of local products
- Linking market with food culture
- Linking market with eco-tourism and local cuisine
- Developing new food products using local landraces
- Adding benefits through participatory pest management (organic agriculture, green marketing)
- Improving farmers' skills on seed production of specific valuable landraces
- Appellation of local products through development of cook book of keystone crops across ethnic cultures
- Direct sale of genetic resources using IPR or contract (e.g., seed)

Source: Sthapit and Jarvis (1999).

Identifying local promoters and then linking them with local producers and markets are crucial processes. In Begnas, Nepal, a series of consultations was carried out to identify major local products that have market potential, assessing total production, price negotiations, quality control, and marketing outlets. In Nepal, the project identified local promoters like *Gunilo* and *Bandobasta* who played a catalytic role in establishing linkages between promoters and consumers with the farming community. NGOs have been involved in the project to facilitate networking. Associations of hotel and tourism, Pokhara chambers of commerce, hostels, and hospital networks have also been sensitized to use more domestic products. The impact of such networks is yet to be seen.

The project is keen to develop markets to enhance the value of local crop diversity through direct sales. Rice landraces, *Jethobudho*, aromatic sponge gourd, *Khari* in taro, and *Samdi kodo* in finger millet, are a few examples. To succeed, this initiative must also be supported by policy reforms.

Table 2. Strategic Options Employed for Adding Benefits to Local Crop Diversity through Market Methods, Case of Begnas

Crops	Varieties	Farmers' values	Indicators of assessment
Rice	*Anadi*	*Latte*, *khatte*, and *siroula* in festivals; Medicinal value	Research base recipes developed Number of grower farmers' increased Status of nutrition known Grain demand created and area under production increased Number of growers increased
	Bayami	Fine, medicinal and high quality; High quality and price	
Taro	*Khari*, *Khujure*, *Hattipow*	*Masaura*, *tandra*, corm quality; Gava	
Sponge gourd	*Basaune ghiroula*	Aroma and excellent eating quality	Quality seed produced and marketed widely
Finger millet	*Samdi kodo*	Special gruel; Possibly suitable for pizza making	Demand created locally that motivates farmers to grow

Source: Adopted from Rijal (1999).

Discussion of strategic choices for PGR conservation

The role of local crop varieties in securing food at the household level is apparent, but diversity has also been enhanced for socioeconomic reasons (Rana et al. 1999). Nepali farmers use local rice landraces for at least six specific purposes (Rijal et al. 1997). On the one hand, these deserve special value and there is less competition, so a nonbreeding strategy is appropriate. On the other hand, breeding strategies are employed to make local crops competitive with other options, particularly those that have value and benefits in terms of ecology or physical indices like yield, disease resistance, etc. For example, the best quality of *Jethobudho* is grown with cold water, as is *Phewa* and *Kundahar* of the Pokhara valley, and always fetches a higher market price than when grown in an irrigated field. The strategies employed for adding values are presented in table 3.

In niche- or ecology-specific areas where food security is the main concern, as in Jumla, farmers always go for increased yield. Low yield is associated with rice blasts, poor response, and cold injury, for which the only way of addressing the problem is through breeding methods.

Table 3. Strategic Options for Adding Benefits to Local Crop Diversity

Values	In situ strategies employed for on-farm conservation			
	Breeding	Market	Awareness	Improved access
Ecology (e.g., JB)	✔	✔	✔	✔
Genetic (yield, height, disease, etc.)	✔	✂	✔	✔
Medicinal, cultural, religious	✂	✔	✔	✔
Traditional recipes	✂	✔	✔	✔

Conclusion

Developing an in-depth understanding of the value of landraces through appropriate methods is the prime need prior to deciding on any conservation strategies. Local crop diversity can be desegregated into broad categories by value—genetic, sociocultural, medicinal, or religious—to strengthen conservation of crops in situ by the farm community. Three broader categories include market, non-market, and policy perspectives for improving direct and indirect benefits. No single strategy is perfect for addressing the goal of conservation; a combination is required.

Of the many innovative tools available, the diversity fair and community biodiversity register have been most effective in terms of documentation and sensitizing communities of farmers, researchers, promoters, and policymakers. Furthermore, these two tools are very useful in monitoring diversity along with status. Values documented through these tools can be used for R&D purposes, where researchers, promoters, and planners may benefit. They also provide a basis for breeding work in the short term as well as the longer term.

For local crop diversity with socioreligious, cultural, or economic value, strategies that strengthen information, seed, and market networks are particularly important if CGR and their products are to be promoted *per se*. The diversity of these sets of crops will be maintained as long as the local culture associated with them continues. On the other hand, for crop diversity associated with ecological and genetic traits, the breeding strategy is the right choice. Thus, for effective conservation of

CGR on-farm, a number of strategies are essential. We argue that valuable genes can be captured and conserved only when they are utilized locally for both breeding and non-breeding purposes and when there is effective local conservation.

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Appendix

Appendix 1. Comparative Value of Local Diversity of Rice, Taro, Finger Millet, and Sponge Gourds at Different Eco-Sites of Nepal

Crop/Varieties	Location/habitat	Direct value
1. Landraces with ecological benefits		
Jumli marshi in rice	Jumla (2200m)	Cold tolerance, taste, and *aadilopan*
Naltumme	Kaski (670–1400m)	Adapted to shaded areas
Mansara, Aanga, Kathe gurdi	Kaski (670–1400m)	Adapted to entirely rain-fed, low-input ecosystems
Taro: *Khari pindalu*	Kaski (670–1400m)	Compatible for intercropping with maize, etc.
Bhati, Silhat, Laltangar, Aamaghauj, Sakhar	Bara (85m)	*Dhab* (swampy land)
Nakhisaro, Rango, Sokan, Mutmur, Sotwa	Bara (85m)	*Ucha/Bhith* (upland, rain-fed)
Batsar, Lajhi	Bara (85m)	*Nicha* (low land)
2. Socioeconomic values related to specific use		
Jetho budho	Kaski (670–850m)	High quality; High price
Panhele	Kaski (670–850m)	Fine, aroma; High price
Gurdi	Kaski (670–1400m)	*Sel roti* (Nepal donut)
Anadi	Kaski (670–1100m)	Special recipe for local festivals; Not accepted for religious ceremonies
Basmati	Bara (85m)	Aroma and eating quality
3. Medicinal, cultural, food, and religious values		
Basmati, Sathi, Aanga, Lajh, Sotwa, Sokani	Bara (85m)	Religious (guest, feast, recipe)
Khera	Bara (85m)	Religious (local diets, *Karik maharaj*)
Bayarni, Anadi	Kaski (670-1900)	Medicinal (back pain, taste, recipe)
Sponge gourds: *Basaune*	Kaski (670-11200)	Aroma, taste, eating quality
Khari pindalu	Kaski (670-1400)	Special recipes: *Masaura tandra, Gava* and cormels
Dudhe	Kaski (670-1400)	Petiole for special pickle

Source: Baseline survey, PRA , diversity fair, and FGD.

Participatory Improvement of Rice Crops with Tribal Farmers in India

V. Arunachalam

Abstract

Participatory research, including participatory plant breeding (PPB), is now a recognized option for improving the livelihood security of unreached farmers. Tribal farmers in India provide an ideal group for testing the potential of participatory interventions. They live in remote areas, are intensively bound by tradition, and continue to cultivate crops using traditional practices. For instance, the sowing time of crops is often based on a particular month, with an almanac date to harvest the crop in time for its use during festive occasions. Although these traditional cultivation practices are often poorly matched with the weather, they continue because they are consonant with the habitat, soil, agroecology, and available infrastructure. Soils are relatively free from the problems of continuous chemical fertilization. Most cultivated varieties are specific landraces that carry special traits for cooking quality and taste, catering to the tribal farmers' methods of processing food. Tribal farmers live in small villages, inconveniently distant from one another, and do not have readily accessible means of producing and exchanging community seed. Traditional varieties/landraces are also not commercially competitive. Driven by poverty, the tribal farmers yield to commercial exploitation where the cultivation of landraces, local varieties, and other valuable genetic material is replaced by the cultivation of modern varieties despite the fact that they are not preferred by the tribal community. The result is a gradual erosion of precious genetic diversity, most of which is also site-specific. This situation calls urgently for preventive measures.

Jeypore tract in Orissa State is a secondary center of rice origin. Yet farmers do not realize the potential yield of the rice landraces growing there. One reason is that the traditional practices developed essentially for avoiding risks are out of tune with those needed for realizing high yields. Participatory initiatives, setting appropriate methods of cultivation based on a realistic evaluation should provide the right corrective step. This paper describes and discusses such initiatives in the Jeypore tract of Orissa.

Keywords: Tribal farmers, participatory research, rice, landraces, participatory plant breeding, India

Introduction

We describe below a situation typical of tribal farmers in India, where any option, including participatory plant breeding (PPB), has to coexist with the site constraints if it is to be feasible. Orissa state is situated in the southeast region of India between latitude 17°48' and 22°34' N and longitude 81°24' and 87°29' E. The total geographical area is approximately 156,000 km^2 and accounts for 4.74% of India's geographical area. As per the 1991 census, the state has a population of 31.66 million, of which 7.03 million (22.2%) are tribal. The tribal people consist of different ethnic groups (at least 62 were identified in a recent survey) and form three broad categories of farmers—backward, peasant-like, and semi-urbanized—based on their level of development. The backward tribes live partially in isolated pockets and practice shifting cultivation. the peasant-like farmers depend largely on sedentary cultivation, and the semi-urbanized farmers have their mainstay in settled agriculture and wage earning. But all the tribal farmers are characterized by their own traditional life-styles, ancient customs, beliefs, rituals, and sociocultural identities.

Koraput is a district in Orissa State where the economy is based predominantly on agriculture. Jeypore, previously a part of Koraput, was made a separate district in the recent past. Cultivation is carried out in Jeypore at different altitudes, ranging from 600 to 1350 feet above mean sea level.

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Usually lands situated above 900 feet are classified as upland; around 600 feet and below is lowland, and the rest is medium land.

Agricultural practices are more primitive in Jeypore than in the neighboring states. Irrigation is rarely possible, all lands are completely rain fed, and rainfall is erratic. Farmers occasionally apply farmyard manure. Rice is the most common food crop of the region. Landraces and local varieties are mostly preferred because they cater to the cooking quality and taste of the tribal people. High-yielding varieties (HYVs) are not preferred and only commercial incentives compel some farmers to grow them. Government agencies and some private organizations are the ones that encourage this. The planting and maturation of traditional varieties are timed so that their harvest coincides with the time of festivals and family rituals (table 1). The varieties are usually photosensitive and of longer duration than high-yielding varieties. A large number of farmers still practice monocropping.

Table 1. Some Valuable Land Types Cultivated by Tribal Farmers of Orissa State in India for Use in Their Religious Functions

Rice Variety	Predominant Quality	Festivals	Time of Maturity (Month)
Kalakrishna	Scented	All festivals	January
Tulsi	Scented	*Chaitra Parva*	April
Machchakanta	White slender, short grains, good taste	*Manabasa* and *Lakshmi Puja*	November
Mer	Black grains with medicinal properties	Annual ceremony of forefathers	November
Haladichudi	White slender, long grains, good taste	*Shakti Puja*	December
Deulabhoga	Bold, short grains, reddish tinge on cooking with mild scent, preferred during worship at temples	Temple deities	December

Thus we have the following basic realities in which PPB options have to be optimized:

- Tribal farmers live in villages rich in genetic diversity and occupied by one or two tribes. They are situated far away from the reach of government extension agencies.
- Farmers are highly tradition-bound socially and religiously, and would have reservations about switching to new options.
- The enhanced yields of HYVs do not attract them as much as the quality and taste of their lower-yielding landraces and local varieties, which they prefer.
- They have rich indigenous knowledge of their crop diversity but poor knowledge of modern agriculture.
- Their habitats are poorly connected by roads and are typified by poor or absent marketing facilities.
- Against this backdrop, they are vulnerable to commercial exploitation of their natural resources.
- They are ready to learn and practice profitable methods of cultivation, provided such methods can produce perceptible returns.

- Currently there is neither a feeling of strong ownership of natural resources nor any awareness of intellectual property rights.

New PPB paradigms need, therefore, to be simple and productive to promote voluntary participation. They should be cost-effective and, at best, attempt to optimize practices under existing site constraints. They should respect farmers' tastes and be consonant with their strong preferences. They should be risk-insulated and entail a low cost-benefit ratio. Complex PPB options can only be a long-term goal and should be based on short-term benefits.

The method

A number of years of work and association with farm families of several villages in the Jeypore district by the M.S. Swaminathan Research Foundation (MSSRF), based at Chennai, India, has prepared the ground for cooperative and participatory work to improve the productivity of farmer-preferred local varieties/landraces. The work plan envisaged a three-year activity module. The first year was earmarked to survey local varieties sown by farmers and to introduce organized planting of preferred varieties. The seeds of those varieties would then be distributed by MSSRF. A few farmers would be encouraged to raise the crop in their plots by their own methods. The yield data would be analyzed and a few varieties selected for further evaluation.

In the second year, the selected varieties would be grown by PPB farmers in a field design in which farmers and formal practices would be the two treatments. Data on grain yield and its components would be statistically evaluated to select the top two varieties for upland, medium land, and lowland conditions. In the third year, the selected varieties would be grown in large plots under formal technology, provided it proved superior to farmers' practices in the second year of evaluation. Varieties to be evaluated, the sites for testing their performance, and the farmers who would participate in the program would all be selected by the farmers themselves. Periodic checks on the progress of the experiments, the problems that cropped up in the execution of experiments, and related issues would be discussed in periodic PRAs with farmers, and acceptable solutions found.

Results

During the rainy season of 1998, three districts and two blocks per district were selected for upland (U), medium land (M), and lowland (L) cultivation in the Jeypore tract of Orissa State. Fourteen farmers were chosen to raise 10 upland, six medium land, and 10 lowland local races/varieties in their own plots of approximately of 80 m^2. The crop was raised using farmers' practices common in the respective areas. However, a severe cyclone at the time of crop maturity affected crop yields; the data could only be used for a relative evaluation. We devised a form to record various field activities, with which data on cost-benefits were gathered not only on the PPB plots but also on farmers' own holdings. The overall performance and characteristics of varieties were discussed in a PRA with a large number of farmers from the sites.

Only 3 U, 1 M, and 5 L varieties were selected in the PRA from the original 10 U, 6 M, and 10 L varieties tested in 1998. In consultation with the farmers, 3 U, 7 M, and 3 L varieties were added to get a total of 6 U, 8 M, and 8 L varieties for experimentation in the crop season of 1999.

To facilitate periodic visits to plots, it was decided to confine the experiment to two blocks and five villages in the Koraput district, near the MSSRF site office at Jeypore. Nine PPB farmers agreed to

test the selected varieties in two test plots of 90 m^2 each. One of the test plots was divided into three replications of 30 m^2 and the selected varieties were grown in a randomized block design. The other was divided equally between varieties to be tested. They were planted unreplicated by farmers using their own traditional practices. In the replicated plots, formal methods of cultivation were introduced (box 1).

Box 1. Formal Methods Introduced to Cultivate Local Varieties and Landraces in Jeypore, India

- Preparing land and applying farmyard manure in residual moisture when the previous crop has been harvested
- Raising nursery stock in well-prepared land in rows spaced 20 cm apart with optimal moisture
- Pre-soaking seeds in water for 12 hours and selecting only those seeds that sink
- Direct seeding (in U and some M), or transplanting (in some M and L) of about 25-day-old seedlings, in rows spaced 20 cm apart, with plants at 10-cm intervals within a row
- Setting rows north-south to maximize sunlight on growing plants.

Those formal methods were developed as a result of a survey of farmer's plots grown to rice in the first year, where a number of problems were predominant (box 2).

Box 2. Problems with Rice Crops Raised under Farmers' Traditional Practices

1. Erratic rainfall, leading to the tradition of high seeding rate of about 40–60 kg/ha
2. Consequent dense plant populations that lead to yellowing and poor plant growth
3. Ill- or unprepared lands due to lack of moisture prior to the planting season, resulting in poor germination
4. Poor seedling growth, leading to severe disease and high pest incidence
5. Farmyard manure occasionally applied in small quantities during sowing, resulting in no benefit to the crop
6. Nursery plants raised in poor, most often unprepared lands with flooded rain water
7. Transplanting most often with very old seedlings, sometimes even 60 days old

Crop growth on formal and farmers' plots was evaluated in periodic PRAs with farmers. Scientists recorded data on days to flowering, number of tillers, number of panicles, number of grains per panicle, and grain and fodder yield with the help of farmers in each plot. The data were used to compute grain filling and harvest indices. Based on multivariate statistical analysis of yield and its component characteristics, the varieties were ranked on their joint performance across all traits.

The results were striking. They are summarized and shown only for the varieties common in 1998 and 1999 in table 2. The advantages of changing over to scientific methods of cultivation are obvious.

The following inferences stand out:

a. Fluctuations in the yield of varieties occurred even under traditional (farmers') methods of cultivation. For instance, the variety, *machchakanta*, was the top yielder in 1998—a year characterized by cyclonic weather and heavy rainfall. It gave low yields in 1999 under farmers' practices despite consistently good weather. In general, however, varieties responded by giving good yields under the better climatic conditions in 1999.