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Farmer participatory breeding and participatory varietal selection in eastern India: Lessons learned

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Abstract

This paper describes the objectives and methods used in a participatory breeding (PPB) project in several rice ecosystems in eastern India. Farmers were interested in a large range and combinations of traits. The selection criteria of farmers were determined by hydrological conditions (water depth) and land types (toposequence) followed by the adaptation of the variety to different user needs (food, livestock fodder, thatching, cash). Other factors determining preference were: the compatibility of the variety in the cropping systems, socioeconomic status, gender and culture. Several lessons learned from the three years' experience led to the refinements in the participatory methods in the next phase of the project.

Introduction

Poverty in Asia is most severe in rainfed areas where people depend on rice for subsistence. To these rural poor, rice is not only the staple food but has many livelihood uses. Sustaining their livelihood and alleviating poverty require a major increase in agricultural productivity. This means, among other factors, developing higher yielding well-adapted rice varieties.

Classical breeding approaches have been successful in developing improved varieties of rice for favourable rice environments. However, these approaches have been less successful in rainfed environments because they fail to account for the high levels of social and agro-ecological diversity in these areas. Witcombe *et al*. (1998), report weaknesses in the formal testing system in India that have reduced the chances that varieties released for marginal areas would meet farmers' needs. The failure of the system is evidenced by, for example, the rejection of many varieties by farmers, and the rapid and high adoption by farmers of non-released varieties that had been rejected in the formal testing, such as Mashuri rice.

The goal of this project was to increase food security by providing suitable varieties for higher and stable yields. The specific objectives were:

1. To test the hypothesis that farmer participation in rainfed rice breeding can help develop suitable varieties more efficiently.

2. Identify the stages along a breeding program where farmer participation is most necessary.

3. Enhance the capacities of the national agricultural research systems (NARS) in farmer participatory research and gender analysis for rice plant breeding and varietal selection (Courtois *et al*., 2001).

Methodologies and major findings

Selection of the research sites

This project was conducted in eastern India, (eastern Uttar Pradesh, eastern Madhya Pradesh Assam, Bihar, West Bengal and Orissa). Eastern India is the largest rice-growing region in the country and accounts for about 63% of India's rice area (26.8 million ha).

However, about 80% of the rice farming in this region is rainfed. The project involves two rice ecosystems and six sites: one in the upland ecosystem and five in the rainfed lowland ecosystem representing different agro-ecologies (drought prone, submergence prone or both). In each site, two to three villages were chosen on the basis of their access to market, agro-ecological diversity and extent of adoption of improved varieties. A team of social scientists (mostly agricultural economists) and plant breeders from each center conducted this research.

Finding out farmers' selection criteria based on their agro-ecological and socioeconomic environment

Farm household surveys and participatory rural appraisal (PRA) methods were conducted to characterize farmers' agro-ecological and socioeconomic environment, farming systems, rice diversity, farmers' crop management practices, gender roles, and seed management practices. Farmers were consulted with regard to their preferred traits as well as the positive and negative traits of local and improved varieties. Through graphic illustration of traits, male and female farmers valued the importance of traits of varieties according to land types (lowland, midland and upland), by socioeconomic groups and by gender. The criteria for varietal choice were:

- *Adaptation of the variety to the hydrological conditions (water depth) and landtype (top sequence location) of their fields.* For the lowlands and submergence-prone ecosystems, long-duration, photoperiod-sensitive, semi-tall and tall varieties were well adapted. For the uplands and shallow-depth medium lands, early to medium varieties were preferred to escape the terminal drought. (Courtois *et al.*, 2001; IRRI 2001).

- *Adaptation to different user needs such as food, livestock fodder, thatching and cash.* Farmers grew more than one variety not only due to heterogeneous rice fields but also for different end-uses.Different varieties fulfilled different livelihood functions (food, livestock fodder, thatching, and cash). For example, farmers preferred varieties with long, fine aromatic grain, because these are used as gifts for special occasions (marriage) and for religious ceremonies.

  Poor farmers were more interested in the quality of leftover rice, which should remain tender and soft - characteristics found in traditional varieties. Similarly, traditional varieties were perceived to be better for preparing puffed rice and other rice products (Paris *et al.*, 2001). In the uplands, farmers preferred tall varieties such as Brown Gora, Vandana, RR 151-3 and Kalinga III because they need the straw for animal fodder (IRRI, 2001). Other farmers grew traditional varieties with a purple-pigmented base in drought-prone areas in Bihar, Madhya Pradesh, and Cuttack. This trait helped farmers distinguish rice from weeds, especially in direct-seeded rice where weeds are a major problem (Sahu *et al.*, 2001)

- *Compatibility with existing cropping systems.* Farmers preferred medium-height varieties in the medium lands of early duration (90-110 days) that allowed the timely sowing of a following crop of pulses, wheat, or vegetables. In Bhubaneswar, Orissa, farmers rejected certain rice varieties that had dense root growth because these inhibited the establishment of a relay crop of pulses (black gram) broadcast into the standing rice crop in rice (IRRI 2001).

- *Socioeconomic status of farmers.* Farmers preferred different grain types according to socioeconomic status or degree of market integration. For example, in Faizabad, eastern Uttar Pradesh, farmers and field workers of lower castes with small landholdings preferred varieties with coarse grains, which give them a feeling of fullness due to their slow digestibility. the higher caste farmers with large landholdings who sell rice to the market preferred fine slender grains, which command a higher price.

  In general, smallholder farmers from the lower castes used rice mainly for consumption, while farmers from the upper caste with more land sold their surplus (Paris *et al.*, 2001). Farmers in the uplands of Hazaribagh preferred varieties that do not require high inputs. Farmers who depend on family labour preferred varieties with a range of maturity dates so that harvests can be staggered (IRRI 2001).

- *Gender-specific roles in rice production, post harvest, consumption, and livestock care.* At all the sites, there were gender-specific tasks in rice production. Women from poor farming households provided most of the labor in rice production (pulling of seedlings, transplanting, weeding), post harvest (winnowing, hand threshing, seed drying), and seed management (selection, storage). Men were mainly responsible for land preparation, application of chemicals, and transporting inputs and products. Male and female farmers in Faizabad agreed that grain yield and duration were the most important traits when choosing varieties for upland and lowland areas. However, women gave more importance to traits such as competitiveness to weeds and post-harvest qualities such as ease of dehusking, ease of threshing, and high milling recovery or suitability for different food preparations (puffed rice). In Raipur, Madhya Pradesh, women consistently identified straw quantity and quality as important, whereas the men never mentioned these as important. Women's criteria for varietal selection were likely related to their roles and responsibilities (Paris *et al.*, 2001; Sahu *et al.*, 2001).

Selecting new varieties suitable to farmers' preferences and agro-ecological conditions

Participatory plant breeding (PPB). Farmers and breeders selected individual plants from segregating populations (F5) from different crosses, using the pedigree selection method. Trials were held on-farm and on-station. Plants selected by breeders and farmers were advanced separately through several generations until fixed. Farmers and breeders evaluated these genotypes at maturity on the basis of panicle and grain characters, and susceptibility to stem borer. Breeder-selected and farmer-selected materials were then compared. Promising lines were selected and these genotypes were multiplied and supplied to farmers for evaluation.

Participatory varietal selection (PVS). In PVS, similar sets of fixed varieties (13-25 advanced lines and a local check) suited for the specific hydrological conditions in the area, were tested on-station and on farmers' fields. The advanced lines were from the IRRI Shuttle Breeding Program and from breeding programs of project partners in eastern India. Two to three farmers per villages conducted the on-farm trials under their level of management. At vegetative (pre-flowering) and reproductive stage (maturity) of rice, farmers and breeders visually ranked the rice lines grown on-station and on-farm trials. The Kendall coefficient of concordance and the Spearman rank correlation coefficient were used to analyze the agreement of ranking of the genotypes among farmers, among breeders and between farmers and breeders (Courtois *et al.*, 2001). The results were as follows:

- There was strong agreement among farmers' visual rankings, but not always among those of plant breeders.
- Agreement of breeders with farmers was fairly good on plant traits but many quality traits were overlooked.
- Agreement between visual ranking of traits by men and women during pre-harvest stage was good. However, they differed during post-harvest assessment.
- Yield and duration were important traits considered by farmers. However, ranking preferences were not always correlated, indicating that these traits are not the only factors taken into farmers when selecting rice varieties.
- Sensory evaluation showed that the mode of rice preparation (parboiled or not parboiled) influences farmer selection. Sensory ranking did not correlate with results of classical physico-chemical analysis (Singh *et al.*, 2001).

Lessons learned

Several lessons were learned from the three years of experience in developing and testing the methodologies for farmer participation. These lessons are related to the concerns:

- *Choice of representative sites*. During the first year, a few of the sites selected for on-farm trials were not representative of the environments targeted in the breeding work. They were chosen for convenience reasons (e.g. close to the station). Thus new trial sites, which better represented farmers' environments, replaced some of the sites.

- *Number of villages to represent a specific agro-ecology*. Due to limited resources and staff, only two to three trials and farmers were included in each village. Thus the risks of losing information due severe drought, poor management of trials, etc. were high. The 'mother-baby' trial model may provide an alternative in reliably testing a large number of cultivars under farmer management (Atlin *et al*., 2001; Witcombe this volume).

- *Choice of the varieties to be included in the experiments.* The material chosen for the PVS trials was not always ideal. The lack of clear-cut differences between some of the varieties included in the PVS made it more difficult for the farmers to rank them. The number of varieties tested should be balanced between what is useful for the breeders (many lines), acceptable by the farmers (fewer lines) and what is possible on a reasonable plot size.

- *Number of varieties to rank*. Farmers had difficulty in visually ranking too many (13-25) rice lines from 1 (best liked) up to n (least liked). Farmers were willing to test a maximum of five varieties on their own field. A rating system for example, 1-3 (bad, average, good) or 1-5 numerical scale, for traits is a simpler method (Atlin *et al*., 2001).

- *Constraints in post-harvest operations of too many lines*. The need to harvest, thresh, and weigh the different varieties in small quantities was too cumbersome. Moreover, this work increased the burden of the women cooperators who did the post-harvest work. The number of lines for testing and selection should be reduced. A local field technician is required to assist in post-harvest work and to ensure that the varieties are not mixed.

- *Number of varieties to include in sensory evaluation*. Men and women found it difficult to evaluate the cooking and eating quality of too many lines. Orgonoleptic tests should be modified so that fewer varieties are tested at any one time.

- *Access to new seeds*. During the first two years of the project, the availability of seeds was quite limited and not all farmers who wanted to participate in the selection of new rice lines on their own farms could be included.

- *Institutional constraints*. There was a lack of plant breeders at centers and NARS with experience on participatory approaches. In some centers, it was difficult for the breeders to change their practices and incorporate the participatory approach into their formal breeding program. There were fears that farmer participatory breeding will replace, rather than complement, conventional breeding. Moreover, the skills in doing this kind of work, which involves multi-institutional participation, diverse socio-cultural settings and many stakeholders, were not well developed. In many of the centers, there were no female social scientists or female plant breeders included in the team. Thus, it was difficult at the beginning for the male plant breeders to increase the number of women cooperators in the PVS on-farm trials. Thus there is a need to develop partnerships with NGOs and extension research institutions.

Conclusions

PVS is essential in unfavourable rainfed environments and diverse socioeconomic groups that use rice for their livelihood. Farmer participation improved the selection of suitable varieties for complex rainfed environments in eastern India because: a) farmers screened new varieties on their own farms under their own levels of management, and b) breeders better understood farmers' quality requirements.

The close collaboration between scientists and farmers helped ensure that farmers had access to useful germplasm that was adapted to their circumstances and met the requirements of the community for quality and livelihood use. Providing farmers with diverse materials also help enhance genetic diversity. Continuous feedback mechanisms between breeders and farmers should be established to ensure appropriate materials are disseminated to farmers.

There was little evidence of major differences in the way farmers and breeders visually rated varieties in the field. Hence, simply having farmers take over the early generation visual selection is unlikely to result in significant improvements in the acceptability of cultivars. On the other hand, extensive farmer-managed trials appear to be a promising approach to reducing the effects of random variability and increasing gains from selection.

Although it is too early to show the impact of PVS through the spread of the materials generated from that PVS, there are promising signs that farmer-selected varieties are easily spreading through farmer-to-farmer exchange. Plant breeders are beginning to change their mindsets and have realized the necessity of interacting with farmers, as well as with socio-economists. However, the challenge lies in institutionalizing farmer participation as integral in the formal breeding programs and in scaling up PVS as well in dissemination of quality new seeds.

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