5.6 Providing scientific support to farmers using local rice diversity in Jeypore, India

Sushanta Sekhar Chaudhury and Saujanendra Swain

Introduction

The concept of the ‘evergreen revolution’ involves the enhancement of agricultural production and productivity without causing any ecological or social harm (Swaminathan, 2003). For plant breeding, this implies the conservation of genetic diversity and the development of varieties that are adapted to the local agro-climatic and agro-economic conditions, and that respond to the specific demands of the farming communities. The M.S. Swaminathan Research Foundation (MSSRF) has developed a methodology referred to as scientist-supported farmer breeding (SFB), which aims to develop adapted varieties while contributing to the maintenance of local genetic diversity. Linking the conservation and use of local diversity to the improvement of farmers’ livelihoods leads to sustainable pathways of poverty reduction (Arunachalam, 2000), as envisaged in the evergreen revolution. The current chapter shares our experience working with this method in Jeypore, India.

The Jeypore Tract

The Jeypore Tract, located in the Koraput district of Orissa state, in India (see Figure 4.4.1), is recognized as a secondary centre of the origin of rice (Arunachalam et al., 2006). It has a vast tribal and cultural diversity. Twenty-nine tribal groups reside in the Jeypore Tract, nine of which have a population of more than 100 000. The area is characterized by highly uneven and undulating land with varying slope gradients. Farmland is classified as uplands, midlands and lowlands. Midlands and lowlands are mainly used to cultivate rice.

Local rice varieties under threat

Most rice is grown in the rainy season. Tribal households in Jeypore cultivate local varieties based on their traditions. Farm-saved seed is the major source of seed. Specific local varieties are maintained for ceremonies and festivals. Since local varieties are of different maturity groups, they contribute to household food security throughout the year. The strategy of using farm-saved seed guarantees the continued use and conservation of a diversity of local rice varieties.
In the period 1955–1959, the Central Rice Research Institute in Orissa collected 1745 germplasm accessions of cultivated rice and 150 accessions of wild rice from the Jeypore Tract (Govindaswami et al., 1966). From 1995 to 1996, MSSRF re-surveyed the area and collected 256 accessions (Tripathy et al., 2005). In 1998, MSSRF re-visited previously explored areas and were able to collect only 98 accessions. The worrying extent to which the rice diversity had eroded led MSSRF to engage in direct action to revitalize the management of this unique genetic heritage (Arunachalam et al., 2006).

**Rationale behind scientist-supported farmer breeding**

With the aforementioned objective, we at MSSRF aimed to revitalize and enhance farmers’ management of traditional rice varieties. We had to embrace a new paradigm in crop development, promoting the collaboration of scientists with farmers as breeders, and the use of diversity as a principle, without, however, rejecting advances in scientific plant breeding. We developed SFB to utilize genetic resources and support farmers in their crop management, working together with tribal communities and farmers as equal partners. Each initiative and activity was discussed in a free and friendly way, offering constructive criticism. Only those steps that we all agreed upon were implemented.

**Scientist-supported farmer breeding: the steps**

The SFB process was implemented by MSSRF with the tribal communities of the Jeypore Tract, between 1998 and 2007. It included the following steps.

**Step 1: Diversity blocks and travelling seminars**

We collected local varieties from custodian farmers in eight villages in four different agro-climatic locations. In the following year, those varieties were included in a diversity block in the four agro-ecological zones. To evaluate the performance of individual varieties we provided farming families with a small quantity of seed of a single variety of their choice. We cultivated all varieties as a back-up on-station. We organized a travelling seminar to the four sites, where custodian families and MSSRF scientists evaluated the varieties. Together with the farmers, we discussed the agronomic data, using participatory rural appraisal (PRA) tools to facilitate discussion and encourage collective decision-making. At the end of this first step, we decided to continue with 26 varieties from the 98 collected materials for further selection in different rice ecologies. We subsequently evaluated the 26 varieties.

**Step 2: First participatory varietal selection**

We planned an experimentation scheme that included trial and demonstration plots for the 26 accessions. Varieties were tested in their appropriate lowland, midland or upland rice ecosystem, across four locations. We helped the farmers to prepare land, layout fields and plant using an experimental layout. One trial included three replications with individual plots of 30 m². We guided the farmers to use refined management practices. In an adjacent trial, farmers laid out single replication plots of 90 m².
each using traditional management practices. We evaluated the varieties based on seven agronomic traits and calculated performance scores for each variety, based on those traits. We discussed the results with farmers and it was interesting to see that for each ecosystem, the farmers chose the same two varieties as those that outperformed the others using scientific varietal evaluation. Farmers selected nine varieties out of 26 varieties grown. Those varieties that were not selected, owing to poor performance, were replaced by an additional 22 varieties.

**Step 3: Second participatory varietal selection**

In the subsequent year, we continued with PVS in the same locations, evaluating the nine selected and 22 additional local varieties for a series of quantitative traits. Farmers learned to distinguish quantitative traits related to yield performance. We collected data on those traits, which were analysed statistically. For each rice ecosystem we identified the two best-performing varieties, based on two years of PVS. It was heartening to observe during the discussion of the outcome of these PVS trials that once again our selection, which was based on performance, matched the selection made by farmers. The decision was made to select one upland variety, two midland varieties and one lowland variety, and to produce and disseminate their seed for promotion on a wider scale. In the same seasons as those during which the PVS trials were conducted, farmers learned to identify and remove off-types as part of a special training on seed production. Over three seasons, farmers acquired the knowledge needed for quality seed production.

**Step 4: The involvement of farmers in making crosses**

During a capacity development activity, we explained to farmers the difference between pure line and multi-line varieties. We demonstrated how crosses are made, showing emasculation and pollination techniques using rice plants cultivated in pots. This activity raised curiosity and interest. Many farmers volunteered to emasculate and pollinate plants in a hybridization plot, which was laid out in a village (i.e. farmers were eager and curious to make crosses among rice varieties). We further explained the need for, and the process of, the staggered planting of varieties so that the emasculation–pollination process can be completed over a period of time.

Based on their initial performance in the PVS trials, seven varieties were selected as parents. Eight women and seven men from three villages volunteered to assist in carrying out the crosses. Some of the volunteers were old farmers with an increased interest in agriculture, while others were boys and girls. From among the 15, four were selected to be responsible for taking care of the crossed plants. Over a period of four weeks, the group made more than 10,000 crosses. However, due to lack of expertise in making crosses, many of the mother plants did not set seed, leaving only 593 seeds for crosses that involved five parent varieties; the success of pollination was only 6%.

**Step 5: Early generation multiplication**

F$_1$ seeds were sown in single plots for each cross. However, due to heavy intermittent rain during crop growth, some of the plots were completely washed out. The rains
also caused the plants to mix with plants from adjacent plots, leaving only mixed F$_1$ plants from five crosses. From each plot allotted to F$_1$ from one cross, 200 g of F$_2$ seed were collected. The 200-g samples were planted in five lines. In the following season, populations from each of the five F$_2$ lines were cultivated in 8-m rows.

**Step 6: Early selection and formation of F$_3$ populations**

Two composite samples compiled from the seed of three plants were planted within each row. We measured plant height, number of tillers, number of panicles, panicle length, number of filled grains per panicle, and grain weight. Grain filling percentage was computed from the data. Statistical analysis of variance was conducted for each character. We grouped potential lines using the performance scores we had computed. Multivariate means testing for all traits assisted with the selection of F$_3$ lines that showed significant superiority over the parents. One F$_3$ line selected had outperformed four parents (S1); two lines that had outperformed three parents were joined in an S2 population; and two lines that had outperformed one parent constituted S3. Twenty-two other F$_3$ lines that had performed similarly to the parents formed S4. The remaining lines were discarded.

**Step 7: Evaluation and advancement up to F$_5$ populations**

We evaluated the four composed populations and advanced them to F$_5$ populations over the two subsequent seasons. Field observations showed synchrony of maturity in the populations S2, S3 and S4. S1 was still segregating at F$_5$, although it flowered early in comparison to the other populations. When compared with the parents, the four populations showed superiority for most traits. During F$_6$, we started to homogenize the populations. We involved farmers in all the steps, sharing the process of plant breeding with them. Farmers’ groups began to produce seed of those populations and lay out demonstration plots to promote their use.

During the final stage of the breeding programme we lost the seed of the four S1 to S4 populations. This was due to bad weather conditions in the grain-setting stage; heavy rainfall and a cyclone destroyed our work. Unfortunately, we did not have a back-up at that point in time. As a result, the SFB experiment with farmers making crosses with scientists in a collaborative manner, finalizing and releasing varieties was abruptly ended. This disaster concluded the experiment of MSSRF to design a methodology for SFB with tribal communities. Fortunately, we had begun another PCI programme in parallel, which focused on the participatory genetic enhancement of a local variety.

**Participatory genetic enhancement of Kalajeera**

The 12 years we spent collaborating with the farmers on the scientist-supported farmer breeding programme inspired us to begin working on the development of the improved traditional variety, Kalajeera. However, improved Kalajeera was not the result of farmers making crosses; it was only purified through a process of participatory genetic enhancement (PGE), a participatory crop improvement (PCI) method
that is also described by Silwal et al. (Chapter 5.5). During the selection process, Kalajeera emerged as a better variety than other traditional varieties that are grown in lowland areas. Following the genetic enhancement of this variety, we began to work on preparing good-quality, improved Kalajeera seed, and to promote its commercialization, as we further describe in Chapter 4.4. We observed that improved Kalajeera has a very good market demand and farmers are interested in growing it on a large scale. The yield per hectare of this improved Kalajeera is substantially higher than that of the traditional Kalajeera varieties.

**Registration of Kalajeera**

Together with four other varieties, we have applied to register Kalajeera as a farmers’ variety with the Protection of Plant Varieties and Farmers’ Rights Authority. The SFB methodology has been instrumental in putting this globally innovative legislative and regulatory framework into practice. The formal recognition of Kalajeera as a farmers’ variety will provide the farmers with the benefits of improved traditional varieties. Since improved traditional varieties are widely appreciated for their characteristics, a significant demand for Kalajeera seed has emerged. Those farming communities in the Jeypore Tract that are involved in breeding are now being rewarded by becoming commercial seed producers.

**Impact on farmers’ income**

There has been a clear-cut 20% increase in economic benefits in cultivating Kalajeera, compared to the cultivation of other rice varieties. Kalajeera seed is sold at a 40% higher price. Its grain fetches a 50% higher premium because of its aroma, supported by the fact that it is produced in an organic (traditional) production system. The average net profit obtained by tribal households through Kalajeera cultivation, in 2010, was US$500 per hectare. Profits are higher if the farmer sells processed rice, which increases the economic benefits a further 40%. The average household income of farmers involved in the cultivation of Kalajeera rice is 20% higher than those who cultivate other traditional rice varieties.

**Lessons learned**

The communities participating in SFB expressed excitement at the novelty of the entire process. They also shared with us the fact that their participation in carrying out plant crosses and selection had demystified the notion that rice breeding is for scientists only. Almekinders et al. (2006) compared various cases of participatory plant breeding in south-east Asia, and included examples of farmers making crosses. In the design that was developed by MSSRF, SFB, coupled with CBM practices, has strengthened communities, who, as a result, assume responsibilities that lead to the continued use of traditional rice varieties (Arunachalam, 2007). By incorporating SFB into our approach for implementing CBM, we have been able to revitalize the management and promote the use of local rice varieties in the Jeypore Tract, thus strengthening genetic and ecological, as well as social, cultural and economic dyna-
mism, which is crucial to achieving on-farm management, thereby supporting the perspective described by De Boef and Thijssen in Chapter 1.8. We realize that our work has contributed to the social empowerment of farming communities in terms of organization, for example, of experimentation and seed production. Our work has also contributed to the legal empowerment of the farming communities in the Jeypore Tract, in terms of their recognition of their custodianship over unique genetic resources and their formal release of Kalajeera as a farmers’ variety. Furthermore, it has contributed to the economic empowerment of these communities, by generating income through the commercial seed production of Kalajeera. An outcome of the process is that with SFB we have been able to create community awareness of the value of, and ownership over, the local genetic resources, guiding a transition from the replacement of local diversity to the conscious use of diversity.