Appendix 1.
Current Participatory Breeding Projects Conducted by the Centers Represented at the Workshop

Farmers and Scientists—Building a Partnership for Improving Rainfed Rice in Eastern India - Phase 1

THELMA PARIS AND GARY ATLIN (IRRI)

The farmer participatory breeding project "Farmers and Scientists—Building a Partnership for Improving Rainfed Rice in Eastern India" was conducted by the International Rice Research Institute (IRRI) and six national agricultural institutions under the Indian Council of Agricultural Research (ICAR) in response to the problem of low adoption rates of improved released cultivars in rainfed rice environments. The main reasons often suggested for this poor rate of adoption are: (1) varieties selected on research stations may not outperform traditional varieties under farmer management; (2) improved varieties may not meet farmers' end use and cooking quality requirements; and (3) farmers may not have access to or information about seeds of new varieties. The project was based in eastern India, which hosts the world's largest concentration of rainfed rice.

The goal of this project was to enhance food security and to promote biodiversity. The main research objectives were to (1) test the hypothesis that farmer participation in rainfed rice breeding can help develop suitable varieties more efficiently, and (2) identify stages in a breeding program where farmer participation has the most impact.

The project also involved a social science component with a gender perspective and a plant breeding component. Household surveys and participatory ranking of useful traits using graphic illustrations of traits were used to understand how farmers' different socioeconomic and biophysical situations influence their preference for certain varietal characteristics. They were also used to understand rice varietal diversity in the region.

The plant breeding component applied participatory varietal selection (PVS) and participatory plant breeding (PPB) methods to promote partnerships between female and male farmers and breeders and social scientists, and to develop and evaluate rice varieties suited to rainfed environments. For PVS, 15-25 elite lines and a local check were included in the trials. Two to three farmers per site grew these varieties under their normal management practices. At two or three phenotypic stages of plant growth, farmers and breeders ranked the same set of varieties grown on-station and on-farm. Ranking was ordered from best to worst. Breeders recorded duration, plant height, and yield for each trial. In addition farmers' comments on the characteristics they liked or disliked and reasons for ranking were recorded in diaries. The objective was to get farmers to share their experiences and perceptions of the breeding lines tested on their fields. Five to ten farmers in the village evaluated (ranked) the same set of rice lines on the station and in farmers' fields at specific phenotypic stages. In some of the sites, female farmers were included as farmer cooperators and rankers.

Kendall coefficient of concordance was used to test the influence of farmer participation in the breeding process. Spearman rank correlation coefficient was used to compare farmers' and breeders' rankings and their rankings to the observed value. Analysis of genotype by environment interaction (GEI) for yield was also conducted. Sensory evaluation was carried out to test the cooking and eating quality of the PVS lines in two sites with both female and male farmers.

Research results indicate that farmer participation in varietal evaluation improves the selection of suitable varieties by ensuring that farmers' selection criteria for rice varieties are better understood by breeders. Furthermore, selecting varieties on farmers' fields minimizes the influence of GEI and ensures that lines are tested and selected in representative environments. Hydrological conditions and land type, as well as the usefulness of the variety to meet specific needs, are the major factors determining farmers' choices. Different varieties fulfill different livelihood functions, and farmers respond to the multiplicity of needs by growing a range of varieties. While men and women were in agreement that grain yield and duration of the variety were most important, women gave more importance to traits related to their specific roles such as competitiveness to weeds, quantity and quality of straw from rice, milling recovery, ease of dehusking and threshing, suitability for different food preparation, and storage quality. Meeting different farmers' needs may be better tackled by creating different varieties rather than trying to produce multipurpose varieties.

Scientists involved in the project were: T. Paris, S. Sarkarung, G. Atlin, K. McAllister, G. McLaren, R.K. Singh, B. Courtois, C. Piggin (ex-member), and S. Pandey (ex-member) (IRRI); Abha Singh, V.S. Sisodia, O.N. Singh, S. Singh, and H.N. Singh (NDUAT, a national agricultural research program in eastern India); R.K. Sahu, V.N. Sahu, S.K. Sharma, and M.L. Sharma (Indira Gandhi Agricultural University); R.K.P. Singh, R. Thakur, and N.K. Singh (Rajendra Agricultural University); D. Chaudhary and S. Ram (Central Rice Research Institute); and A.T. Roy and D.C. Pradhan (Orissa University of Agricultural and Technology). This project was funded by the International Development Research Centre, Canada, from 1997-2000, and is part of the SWI-PRGA, International Center for Tropical Agriculture, Colombia.

CG Maize Diversity Conservation: A Farmer-Scientist Collaborative Approach - Phase II

Mauricio R. Bellon (CIMMYT)

The International Maize and Wheat Improvement Center (CIMMYT) and the Institutio Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP-Mexico) have conducted a pilot study on participatory maize improvement in the Central Valleys of Oaxaca, Mexico, since 1997. The goal of this project is to determine whether it is possible to improve maize productivity while maintaining or enhancing genetic diversity. Maize productivity was broadly defined in terms of yield, stability, and other characteristics of interest to farmers. The project conducts and compares different participatory interventions with small-scale farmers in six communities in this region.

Participatory methodologies have been widely used. First, to elicit the traits that farmers value in their maize landraces, during collection of 152 landraces representative of the regional diversity, farmers donating samples were asked to list the advantages and disadvantages of each. This led to the compilation of a list of 25 traits. Second, to measure both the extent to which the farmers demand these traits and the landraces supply the traits, a random sample of farmers, both male and female, was asked to rate each of the 25 traits in terms of importance (very important, somewhat important, not important). All farmers were also asked to rate each landrace in terms of performance with respect to each trait (very good, regular, poor). Since data were collected from male and female farmers in the same household, a Wilcoxon ranked test for two related samples was used to test for differences in ratings of importance by gender. The ratings of performance were compared with a Kruskal Wallis one-way analysis of variance by ranks for grain color, the main taxonomic characteristic used by these farmers. Furthermore, all farmers in the sample were ranked using a wealth ranking method. Then, using a Kruskal Wallis one-way analysis of variance by ranks, the ratings of importance of traits for the three wealth ranks (rich, medium, and poor) were compared (Bellon 2001).

A participatory approach combined with conventional agronomic evaluation was also used to select a subset of landraces for improvement and distribution. It was impossible to work with all 152 landraces collected, so 17 were chosen with good agronomic performance, from different agromorphological groups (a proxy for diversity), and were of interest to farmers. All landraces collected were evaluated in researcher managed trials in farmers' fields in all areas where collection took place. To gauge farmers' perceptions of each landrace, field days at harvest were organized, and farmers were invited to attend. During the field days, participants walked through the trial, observed the landraces, and recorded the numbers of plots that contained populations they liked. All ears from the inner two rows of the experiment were harvested and laid out in front of the stand, so farmers could judge grain yield and examine the ears. The purpose of this exercise was to obtain a rapid "sort" or classification of landraces according to farmers' expressions of interest. The exercise enabled us to systematically deal with many materials (170) and many farmers (approximately 70 per field day) in a relatively brief time period (2-3 hours). We viewed the participants' choices as votes and assumed that the higher the percentage of farmers voting for a landrace, the more potentially valuable it is to participants (Bellon et al. 2002).

Finally, simple experiments were conducted with farmers in their fields. Researchers provided the seed and a simple experimental design, and farmers provided the fields and the management. Each farmer agreed to plant three of the varieties from the field day plus one of his/her own varieties and to manage them in exactly the same way. Each variety was planted in four rows of approximately 10 m. One of the varieties was a common check. Researchers and farmers measured yield at harvest. Farmers kept a management diary during the duration of the experiment and they rated the performance of each landrace according to the 25 traits previously identified.

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Participatory Varietal Selection in West and Central Africa

Howard Gridley (WARDA)

Introduction

West and Central Africa (WCA) encompasses a vast, heterogeneous, and poverty-stricken area. Despite its natural endowments and agricultural potential, rice production still lags behind rice consumption in the region. WCA now imports about 3.2 million tons of rice a year, at a staggering cost of one billion US dollars—a cruel strain on the region's economies. The challenge is to develop sustainable rice production in a competitive world economy, and thereby enhance the region's self-sufficiency in rice, or at least significantly reduce its imports.

Rice production in WCA was based originally on the African indigenous rice *Oryza glaberrima*, but is now dominated by the Asian species *O. sativa*, although landraces of *O. glaberrima* are still grown in small traditional production systems in rainfed and deep-water ecosystems. During the last 40 years, rice breeders in WCA have concentrated on developing and releasing improved varieties of *O. sativa*, mainly using conventional breeding methods such as introduction, hybridization, and selection. Crop improvement scientists at the West Africa Rice Development Association (WARDA) systematically evaluate germplasm from both within and outside Africa, generate breeding materials, select superior lines, and test early and advanced breeding materials on-station and on-farm. WARDA's strategy for rice improvement is to combine specific agroecological adaptations of local rice varieties with the yield potential of introductions.

Oryza glaberrima represents a rich reservoir of useful genes for resistance to biotic and abiotic stresses. In 1991 WARDA initiated interspecific breeding to cross-introgess important traits between *O. glaberrima* and *O. sativa* resulting in the development of several highly promising, fertile, and stable interspecific lines that catalyzed the need for rapid dissemination to farmers.

A Partnership through Participatory Varietal Selection

To provide farmers with rapid access to new *O. sativa* and interspecific lines, WARDA eschewed the conventional top-down approach to technology transfer and initiated farmer participatory varietal selection (PVS). Participatory varietal selection aims primarily to accelerate the transfer of new lines to farmers' fields and determine the lines farmers wish to grow, the agronomic and quality traits farmers value, and the magnitude of gender differences. In the first year a rice garden is established in a village with up to 60 lines sown in an unfertilized and fertilized block. Farmers visit the garden at maximum tillering and maturity to select lines and their selection criteria are recorded. Farmers then receive seed of their selections for the next two seasons to sow on-farm and their selection criteria continue to be monitored.

The first PVS project was installed in 1996 at Boundiali in Cote d'Ivoire where farmers appreciated the concept of sharing responsibilities for rice research. Encouraged by the results, WARDA expanded PVS activities in Cote d'Ivoire in 1997, initiated PVS in Guinea, Ghana, and Togo in 1997, and in 1999 in Burkina Faso, Cameroon, Chad, Guinea-Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and The Gambia.

The selection criteria most cited by participating farmers are higher yield, short growth cycle, plant height, high tillering, weed competitiveness, and grain quality. Female farmers who are responsible for harvesting prefer tall rice to facilitate single-panicle harvesting. Participatory varietal selection has instigated the adoption (and release) of many lines, and farmers in many countries are especially enthusiastic about the new interspecifics, now termed NERICAs (New Rice for Africa). An example of a PVS success story is Guinea. Participatory varietal selection was initiated in 1997 and by 2000 NERICAs covered about 8,000 ha. The expected production is in the region of 15,000 t, of which one-third is supposed to be kept as seed; the production in 2000 generated a minimum gain of US$ 2.5 million over pre-NERICA production. The Guinean authorities project that 300,000 t of NERICA will be produced in 2002, with surplus available for export to neighboring countries, where the demand for seed is also increasing rapidly.

Other countries in WCA are also advancing in their PVS trials. In 2001, there will be approximately 24 NERICAs in advanced testing in farmers' fields in 13 countries. By 2001, 7 NERICAs will have been officially released in Cote d'Ivoire and Guinea, and several are in the pipeline for release in Togo, Benin, and Sierra Leone. Research shows that 10% adoption in only 3 countries—Guinea, Côte d'Ivoire, and Sierra Leone—can return an extra US$ 8 million per year. Adoption by 25% of farmers will return US$ 20 million.

Cassava Selection by Participatory Plant Breeding Methods in Southern Africa

N.M. Mahungu (IITA)

The Southern Africa Root Crops Research Network (SARRNET) is a regional organization operating within the 14 countries of the Southern Africa Development Community (SADC) implemented by the International Institute of Tropical Agriculture (IITA) in collaboration with the International Potato Center (CIP). The Network is involved in research and development activities on cassava and sweet potato.

Germplasm development, through plant breeding and introductions from IITA, Ibadan, or the region, is one of the major research activities carried out by IITA/ SARRNET. Variety breeding for specific use characteristics (including fresh roots, flour, starch, and feed) is carried out in main research stations/centers. Clones are tested for adaptability in different agroecological zones of the region for root yield, disease/pest resistance, agronomic, and quality characteristics.

Since selected/improved varieties have to be adopted and used by farmers and other producers, these groups need to be satisfied with the technologies developed. Participatory research approaches are therefore advocated to ensure that the technologies generated meet the end users' expectations. This approach accelerates technology dissemination and adoption.

SARRNET advocates participatory plant breeding (PPB) because this approach involves all major stakeholders such as farmers, extension, processors, entrepreneurs, and researchers in several sequential stages of plant breeding, unlike other methods, which involve them in only the final selection processes (Mahungu and Kanju 1997). In cassava breeding, farmers are involved as early as in the selection of segregating materials of F_1 populations. While researchers record quantitative data, most farmers' assessments are visual and verbal comments/observations.

The following examples show how participatory methods have been exploited for cassava breeding in SARRNET and IITA programs:

In Bukoba region of Tanzania, farmers' participation in the selection of cassava varieties from on-farm trials resulted in the selection by farmers of varieties for specific interests, i.e., for high root yield, intercropping, leaves as a vegetable, or processing qualities. However, some of the selections were dropped after farmers were briefed on the disease susceptibility of the varieties (Kapinga et al. 1997).

In a participatory variety selection at Mansa Station in Zambia, farmers selected 15 clones of which 13 were among the 14 clones selected by the breeder. However, after analysis of dry matter, only 12 clones were finally selected that satisfied both farmers and researchers (Mahungu 1999).

Currently SARRNET, Malawi, is involving a timber company in the selection of cassava varieties with good flour characteristics for plywood filler/binder. Of the four varieties tested, the company has selected two with characteristics similar to those of wheat flour for plywood binding.

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Participatory Plant Breeding at the International Center for Research in the Dry Areas

MALIKA A. MARTINI (ICARDA)

Participatory plant breeding (PPB) started in Syria in 1996 and is now being conducted in five other countries in the region covered by the mandate of the International Center for Research in the Dry Areas (ICARDA). In these countries PPB has focused only on barley, except in Yemen where selections have also included lentils. The selection process in these countries has involved male farmers only, except, again, Yemen, where women participated in 2000. Barley entries included in the selection process are both fixed lines and segregating populations.

Entries were chosen to test farmers' and breeders' preferences for different attributes and/or characteristics. The entries were planted in nine farmers' fields and two ICARDA research stations. Unreplicated plots of 8 rows of 7.5 m (12 m^2) in 4 strips of 52 plots were established on-farm and on-station. There was one exception (Sauran), where each entry was arranged in 8 strips of 26 plots. Farmers were given a field book to record daily precipitation and plot evaluations. Different scoring methods were used in collecting the data. A numeric scale from 0 to 5 (0 = worst, 5 = best) was used. Qualitative scoring was also used (bad, medium, good, very good, and excellent).

Many types of selections were performed:

- individual selection by each participating (host) farmer alone in his own field;
- selection by each participating farmer in Breda and TelHadya (research stations);
- selection by the senior barley breeder of DASR, Ministry of Agriculture, in each of the nine locations and in Breda and TelHadya; and
- group selection by neighboring farmers at five of the nine locations.

Selection was conducted exclusively between entries.

The data available from the research to date are restricted to the year of selection, farmers' scores of the different entries, and farmers' reasons (up to five) given to support their choices. The top 15 varieties have been coded and entered onto a computer database. A profile questionnaire was designed, and approximately 140 farmers were interviewed over 3 years (1996-97, 1997-98, and 1998-99). Information on seed scoring was also collected (positive, negative, and neutral).

We are interested to know if other people have used the same PPB methodology, and, if so, how they analyzed the data on farmers' preferences and farmers' scoring of varieties. At present we lack the expertise to analyze this information. As the first step, we are in the process of collecting information on the socioeconomics of PPB in Syria and Yemen.

Participatory Variety and Clone Evaluation within Farmers' Field Schools in San Miguel, Peru

Oscar Ortiz (CIP)

Background

The International Potato Center (CIP) and CARE-Peru initiated a collaborative project on the integrated management of late blight (IDM-LB) through farmers' field schools (FFS) in 1997. This project aimed at developing IDM technologies and adjusting the FFS methodology to work with potato farmers in the Andes. As part of the technology development with farmer participation, the work focused on facilitating farmer access to resistant genotypes and evaluating control practices (optimizing fungicide use).

Participatory Variety and Clone Evaluation

During 1997 and 1998, farmers evaluated 12 varieties with different degrees of resistance to LB. In 1999, CIP's breeding program provided 54 promising clones with resistance to LB, which were divided into groups and evaluated by 13 farmer groups. In 2000, farmers continued evaluating 25 selected clones from the previous season. Farmers also evaluated clones originating from true potato seed. Experiments had 2 or 3 repetitions and each involved between 10 and 15 genotypes.

Farmers evaluated genotypes at harvest, focusing on yield and tuber characteristics (tuber shape, color, and proportion of different sizes). After harvest, farmers also evaluated culinary quality.

Taking into consideration that most people in the San Miguel area have difficulties in reading and writing, a visual evaluation methodology was used. Each farmer expressed his or her opinion using small cards with drawings of human faces on them. If the farmer liked the genotypes, he/she used the card with a happy face drawn on it; if he/she considered the clone as regular (not good, but not bad either), he/she used a card with a serious face on it. If the farmer disliked the clone, he/she used the card with a sad face on it. The evaluation was made on an individual basis and each evaluator put the card in a paper bag located near the genotype that was being evaluated. At the end of the evaluation, all participants should have evaluated each genotype.

After the evaluation, the facilitator counted the cards (according to type of face) in each genotype. Results were written on paper or a blackboard and presented to the group. Each genotype had a total number of happy, regular, and sad faces, which allowed the facilitator to see which genotypes were preferred by farmers. The facilitator asked farmers why they liked or disliked each of the genotypes, taking notes of the farmer criteria.

With the purpose of quantitative analysis, a value was given to each type of card. In this way, each genotype was represented by an index, which was ordered to see which were the preferred genotypes. The ranked genotypes, according to the index, were useful to compare opinions among farmer groups that evaluated the same genotypes. Non-parametric tests were used for comparison purposes. The method was also useful to see if female preferences were similar to male preferences.

Participatory Breeding with Sorghum in Mali: Statistical and Analytical Aspects

E. Weltzien Rattunde (ICRISAT)

The research on participatory sorghum (*Sorghum bicolor*) improvement in Mali focuses on two key objectives: (1) the modification of the priorities and objectives of sorghum improvement research for Mali to better meet farmers' needs and preferences, and (2) farmers' assessment of specific new varieties of sorghum in a wide range of production zones. The work thus involves variety evaluations conducted by farmers and in depth discussions on criteria for choosing or rejecting new varieties as a basis for understanding which characters are priority traits. Included in these discussions are the advantages and disadvantages of the local varieties being grown and changes in the production system that have occurred.

We thus have a large body of three types of data:

1. Quantitative data from measurements taken in farmers' plots. We use alpha designs to increase the number of participating and contributing farmers in each village. We use REML-based procedures for the analysis of these quantitative data, to deal with the relatively larger number of missing plots, and to be able to include each farmer's choice of control variety in the analysis.

2. We have increasingly multi-facetted data from farmers' rankings of the tested varieties for a large and variable number of criteria, over many locations, by different members of the participating farm household, and for up to three years of consecutive testing. We use the ranks primarily to establish whether or not a new variety is superior to the local control. To date the numbers of responses per agricultural zone seem too low to attempt statistical analysis.

3. The third type of data is listings of variety traits and characteristics that farmers use when they describe the advantages and disadvantages of a variety in a trial. For each trait we determine the frequency with which it has been used by the farmers evaluating the varieties. Together with this frequency, we also record whether the test variety was judged superior, similar, or inferior to the control variety for the particular trait. With this type of data we can make frequency comparisons for specific traits, for groups of traits, by specific types of farmers, in specific production regions, to allow for a quantitative analysis of key issues. However, we have focused more effort on a qualitative analysis of these results so far. The aim here is to gain a better understanding of what

farmers' concepts are of specific traits or groups of traits, e.g., grain quality or requirements for adaptations. This also requires a detailed understanding of the production systems from the farmers' perspective. Thus, this type of qualitative data is used to gain detailed understandings of key issues, to formulate hypotheses for testing, and for detailed analysis.

Participatory Improvement and Dissemination of Maize Varieties with Resistance to Stem Borer in Southeastern Nigeria

Sam O. Ajala (IITA)

Maize cultivation in southeastern Nigeria is plagued by two major constraints: stem borers and acid soils. Acid soils, which occur in pockets throughout the region, can be easily managed through soil improvements including chicken manure. Stem borers, however, are usually controlled using insecticides or by planting local varieties—both approaches are often considered inadequate by the local farmers. Although southeastern Nigeria has a bimodal rainfall pattern, stem borer infestation is so intense in the second season that maize is generally not planted.

Cassava is the major food crop grown in southeastern Nigeria because it survives in the poor (acidic) soils; however, a large proportion of the people interviewed for this study emphasized the importance of maize. Maize is primarily a cash crop; green ears are sold for consumption fresh, roasted, boiled, or made into breakfast cereal. The farmers interviewed wished to increase their maize cultivation but were limited by the lack of improved varieties with resistance to stem borer, especially in the second planting season.

Trials were conducted in association with petroleum industry-based nongovernmental organizations (NGOs) in the region. A number of maize varieties with resistance to stem borer and local checks were planted in different locations and seasons. Farmers were invited to assess the varieties at maturity. Preference ranking and pair-wise comparison were used to assess and select varieties. At the end of the exercise, three varieties were selected (through participatory methods) and established on-farm in the next season. Two of the three varieties have been adopted and are now commonly grown in the region.

Farmers want to retain these varieties because they are higher yielding and perform well in the second season. However, the concerns expressed by different farmer groups on the fresh maize and milling qualities of the varieties highlighted the need to breed varieties for different niches. Initial discussion on how to select the new maize varieties revealed farmers' desire to become partners in the improvement process. Recurrent selection in maize involves the generation and selection of desirable progenies for recombination to form a new but improved cycle of the same population. Because maize is an open-pollinated crop, however, the appearance of the final product after recombination will be different to that of the selected progenies. It is therefore imperative to come up with innovative ideas for involving farmers in the actual participatory improvement process. Issues at stake include the type of progenies to generate, the number of progenies to evaluate with individual farmers or groups of farmers, the choice of checks, and the design/analysis of data generated to aid effective selection of progenies for recombination. All of these issues are being addressed by a group of maize scientists working under the auspices of the regional network, the West and Central Africa Maize Network (WECAMAN).