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DIAGNOSTIC METHODS FOR BREEDING PEARL MILLET WITH FARMERS IN RAJASTHAN

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ABSTRACT

The role of local farmers in ICRISAT's pearl millet improvement project for Rajasthan has changed: from unidentified suppliers of local germplasm to the base material of a formal breeding program, to active collaborators in selection and variety development. On-farm trials, designed to expose farmers to a wide range of diversity for traits that the local landraces do not possess, provided the starting point for this change in farmers' roles.

Farmers' evaluations of this new diversity have provided insight into their preferences for specific traits and their production objectives, thus allowing the breeding program to focus on improving traits of primary interest for farmers in the target region. Farmers from different regions, and farmers representing different social groups prefer different traits and place different emphasis on yield stability versus maximizing yield in favorable years.

Interested farmers have selected among a wider range of advanced experimental varieties in on-station trials. Their selections reflect the needs of their communities and production conditions.

Farmers' traditional strategies for seed selection and preservation vary among individuals within a village and across regions. Farmers are exploiting the variability generated by the natural outcrossing between the local landraces and the experimental cultivars. An initial on-station evaluation of the effect of this selection indicates that farmers are selecting effectively for improved productivity.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R.Br.) is the primary cereal crop and staple food in the driest, hottest regions of India. In the state of Rajasthan, it is grown on 4-6 million ha annually, which represents approximately 45% of the area planted to this crop in India and approximately 20% of the world acreage. In Rajasthan, productivity of pearl millet has increased only marginally over the past decades, and adoption of modern cultivars is very low. In contrast, modern cultivars of pearl millet are widely grown in better endowed environments in India, and have contributed

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to significant increases in productivity (Jansen, 1989). This situation suggests that specifically targeted crop improvement efforts are required for the harsh environments in Rajasthan. The research presented here is part of a collaborative effort with local and national institutions to identify and develop technologies to improve the productivity of this farming system.

This paper describes the experiences of the ongoing pearl millet improvement program in Rajasthan, with emphasis on diagnostic methods developed for focusing the target of the breeding program on farmers' needs, some lessons learned from applying these methods, and future directions in methods and research.

BACKGROUND

Pearl millet in the farming systems of Rajasthan

The dry environments of Rajasthan are a good example of variable stress environments in the semi-arid tropics. In the pearl millet growing areas, mean annual rainfall ranges from <250 mm in the west to >500 mm in the east. Annual fluctuations in rainfall are large and pearl millet grain yields of 100 kg/ha or less are not uncommon in western Rajasthan (Sharma and Pareek, 1993; Gupta *et al.*, 1994).

Pearl millet is the staple cereal in western and central Rajasthan and, in the west, up to 80% of the gross cropped area is sown to pearl millet. It is usually sown in crop mixtures with short season legumes. Livestock are an important part of the farming system. Pearl millet and legume residues are valuable fodder sources, and farm yard manure is the primary fertility amendment used by farmers.

Breeding for marginal environments

During the Green Revolution era, plant breeders worldwide focussed their efforts on improving varietal performance under favorable growing conditions in which water and nutrients were available to the crop when required. Improved disease resistance was regarded as a key component of yield stability. Three assumptions underlay this approach: (1) that genetic gains could be achieved most efficiently under favorable conditions; (2) that poor soil fertility conditions would be generally overcome through the amendment of mineral fertilizers; and (3) that the genetic gains achieved under favorable conditions would also be beneficial under less favorable, stressed, or marginal growing conditions (Blum, 1985).

Farmers' experiences and research results of the past 10-15 years suggest that the latter two assumptions do not generally hold true, and that specifically targeted efforts are required to address the needs of farmers cultivating crops under marginal conditions characterized by abiotic stresses such as heat and drought (Matlon, 1987; Weltzien and Fischbeck, 1990; Weltzien and Witcombe, 1989; Ceccarelli, 1994; Haugerud and Collinson, 1990).

Selection theory indicates that genetic gains under low productivity conditions are expected to be highest when selection is practiced in the target environments (Jinks and Connolly, 1973; Simmonds, 1991). Results from breeding programs designed to target marginal conditions show that expectations for genetic gains for grain yield under such conditions are high, and individual programs have begun to show good progress (Weltzien, 1986; Ceccarelli, 1994; Richards, 1989; Atlin and Frey, 1990; Bidinger *et al.*, 1994). In these breeding programs, changes in the breeding strategy involved the use of appropriate base material for selection with good adaptation to the

major stress factors, and the use of selection sites in the target region under marginal conditions. Critical to the choice of selection site and its management, as well as for the choice of appropriate base materials, is a good understanding of the environmental conditions under which the crop is expected to perform.

Successful breeding programs need well defined targets or goals. These goals must be consistent with farmers' needs and production strategies. For farmers in marginal environments, grain yield is usually not the only component of productivity. The stover is frequently used as feed for livestock, and thus stover yield may become an important determinant of crop productivity. In marginal environments, growing conditions, thus total biomass yield, particularly grain yield, vary greatly from year to year. Farmers may pursue different strategies to cope with this situation, e.g., maximizing grain or stover yield over years, or ensuring a minimum level of grain yield even under the most adverse conditions. An understanding of their strategies is required for targeting a breeding program to their needs.

In environments with frequent crop failures, farmers may be as concerned about crop survival and adaptive traits as they are about final productivity. By identifying traits which farmers consider important, the researcher can gain important insight into adaptation and acceptability.

Thus, for the appropriate choice of selection sites, the choice of appropriate base material, and for defining the goals of a breeding program for marginal environments, an understanding of the environmental conditions, farmers' needs and production strategies is required. Diagnostic methods for addressing these questions are described in this paper.

DIAGNOSTIC METHODS

Farming systems research (FSR) and on-farm research (OFR) methods have developed in response to the failure of much single commodity-focused research to meet the needs of complex farming systems, particularly in situations where farmers' needs are not well understood by researchers and where there are strong interactions between different sub-systems or components of the whole farm enterprise. FSR methods allow scientists from a range of disciplines to gain insight into the major processes and constraints contributing to productivity of individual components of a farming system. In FSR and OFR, commodity-focused researchers of different disciplines evaluate technology with the participation of farmers in the context of the whole farming system, i.e., taking into account the interactions between sub-systems. (Shaner et al, 1982; Norman and Collinson, 1986; Byerlee and Tripp, 1988; Norman, 1992).

Methodology for diagnostic research and farmer-researcher interactions has recently seen a large diversification with the adaptation of participatory approaches for rural development as a tool for agricultural research (Chambers *et al.*, 1989; Haverkort *et al.*, 1991). The advantages of participatory approaches to diagnostic research are generally seen in the speed with which reliable results can be obtained and in their open format, which allows for farmers' input of issues, topics and considerations, which are not anticipated by the researchers.

For research on pearl millet improvement, the diagnostic methods were driven by the need to understand the environmental conditions for pearl millet growth, to identify farmers' preferences for individual traits and trait complexes, and to understand interactions between livestock and crops, as these may affect farmers' requirements for pearl millet. These methods include analysis of secondary data on production environments to define target domains; on-farm farmer-managed trials to elicit farmers' trait preferences; surveys of farmers' seed production practices and on-station evaluations of breeding material by farmers; and surveys and informal discussions

to understand the interactions between environment, crops, and livestock. An interdisciplinary team including an ICRISAT breeder, socio-economist, and agronomist, contact persons from government organizations (GO's) and non-governmental organizations (NGO's), and farmers participated in the diagnostic studies.

Identification of target domain, village sites, and farmers for on-farm diagnostic research

The research target is farmers for whom pearl millet production is important, in areas where local varieties still predominate and yields are low. The target region, shown in Fig. 1, is the western and central areas of Rajasthan, where pearl millet is the primary crop and staple cereal.

Choice of districts

Within the target region, four target districts were chosen to span variability in agro-environments, i.e., differences in rainfall patterns, soil types and crop-livestock systems: Ajmer, Jodhpur, Bikaner, Barmer. From Ajmer to Jodhpur to Bikaner and Barmer:

- Rainfall levels and reliability decrease from 432 mm seasonal rainfall in Ajmer to 304 at Jodhpur, 228 mm at Bikaner and 239 mm at Barmer (van Oosterom *et al.* 1995);
- Soils become increasingly higher in sand content and lower in clay content;
- Average pearl millet yields fall from approximately 400 kg/ha at Ajmer to below 100 kg/ha at Barmer;
- There is less experience or familiarity with modern varieties (MV's) of pearl millet (Kelley *et al.* 1996);
- Milch animals become less important, while sheep and goats are important in all the four districts.

Selection of villages

Local organizations (GO's or NGO's) in the target districts were identified to act as local links between ICRISAT researchers and farmers in the on-farm trials. The criteria for choosing local organizations were: interest of the organization in the research; experience/interest of the organization in the agricultural development of their target groups; and quality of their existing relationships with potential villages. NGO's were identified in Ajmer[2] and Bikaner[3] districts; two GO were identified in Jodhpur[4] district. Initially no suitable organization was identified in Barmer district; a year later an NGO[5] in Barmer was identified. Each local organization nominated individuals to serve as 'contact persons' for the collaboration.

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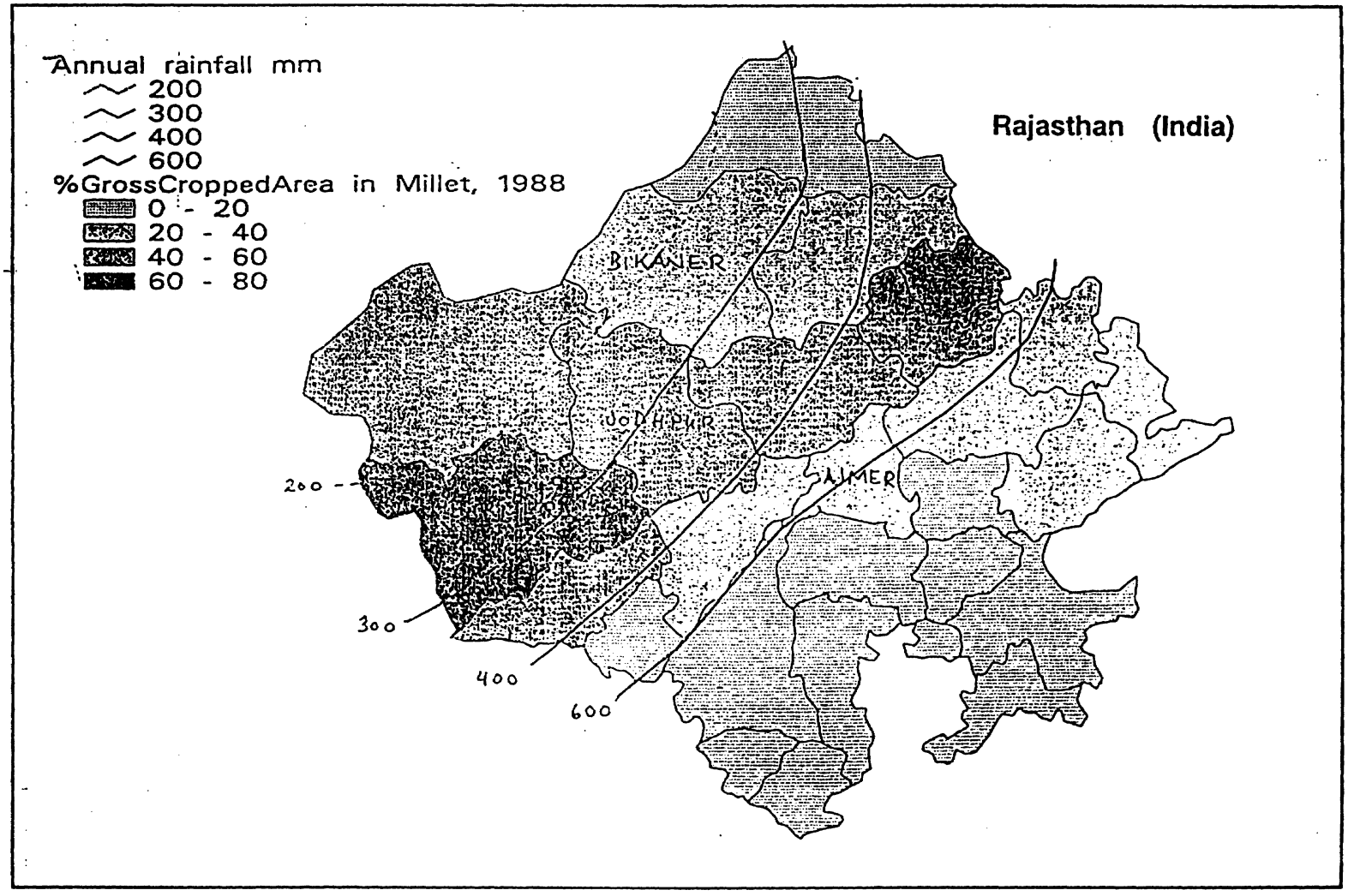
[3] URMUL Trust, Lunkaransar and Nokha, Bikaner District

[4] Department of Watershed Development and Soil Conservation, Regional Office Jodhpur and Central Arid Zone Research Institute (CAZRI), Division of Economics, Jodhpur

[5] Society for Uplift of Rural Economy (SURE), Barmer and Bhadka, Barmer District

Figure 1: Distribution of pearl millet (% gross cropped area, on a district basis) and rainfall isohytes in Rajasthan and on-farm trial locations



Selection of village sites was done jointly by ICRISAT researchers and the contact persons. The criteria for choosing village sites were: (1) village ties to the local organization which would enable our work to build on existing trust of local farmers; (2) villages where pearl millet was important in the local farming systems and farm household incomes; (3) villages which are representative of the district in terms of agro-environmental conditions and socio-economic conditions, e.g., don't have extremely unusual soils or occupations; (4) villages where there are no social/political hindrances to effective researcher-farmer interaction. These are not easy criteria to evaluate through secondary data. Visits to potential villages with members of the collaborating organization and informal discussions with village farmers were used to evaluate appropriateness.

Village investigators and participating farmers

Once a village was chosen, ICRISAT researchers and the contact persons jointly identified one or two villagers as potential local investigators. The role of the village investigators was to monitor the on-farm trials and collect information from participating farmers during the crop season. The criteria for choosing investigators were: (1) one male and one female investigator in each village; (2) must be able to read and write sufficiently for project needs; (3) must have good relationships with village farmers and be able to interact positively with farmers of any caste; (4) must be interested and serious about the work. ICRISAT economists, with the assistance of the contact persons, conducted a three-day training workshop for village investigators to explain project goals and methods, and to train them in basic survey techniques. Based on their performance in the training program, investigators were employed.

To choose participating farmers for the on-farm trials, ICRISAT economists and the local contact persons visited each village with the investigators before the beginning of the rainy season. First, a meeting of farmers was held to explain the objectives of the trials and the way trials would be conducted.

Initial choice of farmers was done through a village census, in which farm households and their resources were identified (land, livestock, farm resources). The criteria for choosing participating farmers were: (1) to span the range of household resources, i.e., landholdings; (2) to include both men and women farmers; (3) to choose farmers with a serious interest in the research, i.e., a preference for experimenters and farmers interested in seed production.

In selecting villages and farmers, we have relied heavily on the knowledge of the local collaborating organizations. We are now developing some simple techniques for initial village characterization which provide rapid information to support village selection and to stratify village households in economic or social terms.

On-farm trials

Choice of pearl millet varieties for on-farm testing

Three contrasting varieties were chosen by ICRISAT researchers for the on-farm trials in 1992 and 1993. For the 1994 trials, four varieties were chosen. They were chosen to represent the widest possible range of variability of traits of potential interest to farmers, including different maturities, tillering potential, panicle and grain size. We preferred to distribute seed of open-pollinated hybrids rather than single-cross hybrids because farmers expressed interest in using the harvested grain as seed for the next season.

Methodology for on-farm trials

Thirty farmers participated at each location during 1992 and 1993. During 1994, 20 farmers in each village participated, to allow us to cover a greater number of villages. Each participant was given one of the experimental cultivars. For actual distribution of seeds, a lottery method was used. Each participating farmer was asked to take a piece of paper on which the name of a cultivar was written. This method helped to avoid consequences of imposing choice of seed on farmers.

Farmers were asked to sow the experimental cultivar near their own cultivar and to manage the two cultivars as similarly as possible, so that they could observe the relative performance on their fields. The plot size thus was also the farmers' choice, and varied with planting density and the crop mixture used. This is similar to the strip tests conducted by breeding firms, during the final stages of variety testing. The field location was chosen by the participating farmer.

Throughout the growing season, the village investigators monitored trials and collected information from participating farm households, including structured questionnaires on farm household resources, cropping history, crop and livestock management, crop management in relation to environmental stresses, changes in crop management over time, and management of the season's experiment.

Evaluation of on-farm trials

Three methods were used for eliciting farmers' trait preferences:

- Individual comparisons of experimental cultivars with farmers' own cultivar;
- Group interviews to compare a range of experimental cultivars;
- Farmers' descriptions of an ideal variety.

Individual interviews, group discussions, and formal questionnaires were used to improve our understanding of the environmental conditions for pearl millet production.

Individual comparisons

Before flowering, researchers and farmers visited each field and discussed field management and early growth of the experimental cultivar relative to the farmers' own cultivar. Prior to harvest, plots were visited again to discuss in detail farmers' perceptions of differences between the experimental and their own cultivar. Individual assessments while viewing the standing crop indicated what characteristics farmers use to distinguish between the cultivars. For each distinguishing trait, farmers were asked to rank the two cultivars, as well as on their overall preference. Researchers probed into reasons for preferences.

We thus obtained lists of traits that farmers used to distinguish between the two cultivars. This gives an indication for which traits the varieties differ, which traits farmers consider important, and which traits they look for when examining new genetic variability. This was particularly important during the first years, when we tried to understand what the main issues for varietal selection are. During the past year, we started to improve our understanding of farmers' opinions on tradeoffs between traits, like high tillering and panicle size, or early maturity and high biomass yield in good years. This involves more structured discussions on these specific topics.

The results of these discussions are certainly influenced by the particular genotype under evaluation and by the growing conditions in the experimental field. To try to overcome the first limitation, we discussed with each farmer the most important characteristics of an ideal variety. Furthermore, interested farmers were invited to the research station to examine a broader range of experimental cultivars (see below).

After harvest, farmers measured grain and fodder yields and evaluated grain and fodder quality of the experimental varieties in comparison to their own. Initially we used semi-structured interviews with individuals to understand the components of quality assessment for fodder and grain. Because responses were very uniform, we started in 1994 to evaluate the traits in group discussions in which all the farmers who grew one experimental variety formed a group (see below).

In the on-farm trials, each farmer was given only one experimental variety to grow. This minimizes risk to the farmer. With only one variety, the farmer observes keenly its behavior and characters relative to his/her own variety. We encouraged farmers to also visit each others' fields so that they would see the range of diversity in plant traits represented by the three/four experimental cultivars. But this seldom happened even when the fields were close. On the other hand, this approach has provided rich information on the growth and behavior of the cultivars in farmers' fields, as well as on farmers' trait preferences.

In the on-farm trials, researchers have made the initial choices of traits for farmers to evaluate. In the future, farmers could be involved at an earlier stage in defining the traits and trait complexes of potential interest to them for on-farm evaluation.

Group assessments

With different groups of three to six farmers each, representing farmers' participating in the experiments, non-participating farmers, and women farmers, we conducted group interviews to compare all experimental cultivars with each other and with the local cultivar at the end of the season. Groups usually toured a cluster of fields to see all experimental cultivars under similar growing conditions. Farmers collected three to four representative plants from each cultivar to have specimens available during the discussions.

Discussions were structured so that farmers were first encouraged to talk about differences between the local cultivars and the experimental cultivars. For each trait they mentioned, a picture was drawn on a card. The cards were then used to construct a matrix ranking table. Farmers ranked the three experimental cultivars for each of the characteristics they had mentioned. Usually these discussions led to other topics, such as crop management, crop utilization and seed selection.

In conducting these group discussions, care had to be taken to keep the groups small enough to be able to listen to the opinion's of individuals. In larger groups, there was a tendency for strong personalities to dominate the discussions. For the same reason, women group discussions had to conducted separately.

We also started using group discussions for the postharvest evaluation of yields and quality parameters for grain and straw in 1994. In this case, groups of farmers who had grown the same variety were formed, men and women separately.

The advantage of group discussion was that it frequently lead to discussions between farmers on debatable issues, and the researcher assumed more of an observing role. This allowed the researcher to gain a better understanding of the background for certain differences in preferences for traits, less driven by his/her own preconceptions on the issue under discussion.

One difficulty with organizing group discussion in the western part of Rajasthan is that farmers do not normally live in closed villages, but rather in hamlets near their fields. It can thus be very time consuming to arrange group meetings, and to conduct the field tour to look at each experimental cultivar under similar growing conditions. To overcome this limitation and to encourage visits to each other's fields, we had formed clusters of farmers, whose fields were close to each other. Within each cluster, all the three/four varieties were distributed randomly. However, with the high chance for crop failure, the frequent need for replanting and the wide range of soil fertility conditions in any small area, only a few clusters were successful.

Ideal cultivar

During the individual and the group assessments, farmers were asked to describe the characteristics of an ideal cultivar, thus ranking the individual traits that they had mentioned before. This was usually followed by discussions of the reasons for this ranking. The discussion of an ideal variety gave farmers the opportunity to mention traits that were not exhibited by the experimental or farmers' own cultivar, and to mention preferred trait combinations and rankings of traits. However, it was not always easy to keep farmers' imagination within the biological limits of the harsh environmental conditions of western Rajasthan.

Characterization of the production environment for pearl millet

The expression of individual traits of a crop cultivar depends not only on the cultivar's genetic composition but also the environmental conditions where the cultivar is grown. The growing conditions have important direct effects on a cultivar's growth and performance, but more importantly the expression of many productivity related traits depends on the interactions between genetic and environmental factors. These interactions are usually unpredictable, and thus an important part of formulating goals for a breeding program is the identification of key environmental factors and production constraints. Three areas were targeted through individual structured interviews and informal group discussions: farmers' fertility management, i.e., crop mixtures and rotations, fallowing practices, and fertility inputs; management of seasonal drought stresses, i.e., crop mixtures and response farming; and management of crop-livestock interactions.

Farmers' selection practices

We have experimented with farmers' participation in the selection among experimental cultivars and in varietal mixtures with the aim to complement formal variety evaluation with their opinions, and to confirm previous results on preferences by exposing farmers to a wider range of genotypes than what is possible in off-station conditions. We have begun to study farmers' practices for seed production, the type of selection they use, and the selection criteria they employ using in-depth informal surveys. Formal surveys conducted previous to this research also gave indications for criteria used for adoption of new cultivars (Kelley *et al.* 1996).

Farmers' selection in on-station trial

Farmers visited one replication of a trial evaluating the most advanced breeding materials resulting from the collaborative breeding programs with the Central Arid Zone Research Institute (CAZRI) at Jodhpur, and Rajasthan Agricultural University at Fatehpur-Shekhawati and at Jaipur

(Durgapura). Included in this experiment were appropriate controls and unimproved local varieties. Farmers were given ten numbered labels each. They were asked to attach the labels to the ten best rows they could find in the trial, considering the needs of their local area. Farmers were told to tie only one label per row. Each plot had four rows, and was accessible from both ends. Farmers thus had the opportunity to select the same genotype more than once.

Crucial for the success of these efforts is the identification of farmers who have a keen interest in seed issues and selection for their own local area and social group. We invited farmers from the villages where we were conducting on-farm trials, while conducting the final evaluations. The local investigators were encouraged to invite also farmers who are not growing trials of their own, but have an interest in seed issues. Care was taken to invite women groups separately.

Before showing farmers the trial, we held a discussion with the whole group on management practices on the station and the rainfall pattern during the season. Then groups of four to six farmers looked at the whole experiment before making their selections. We then discussed the range of variability that they saw, which traits might be useful, which ones problematic, and their considerations in making the selections. Care was taken to let participants express their personal opinion.

At the end of the farmers' visit to the station, we invited every participant to select one variety from the demonstration of approximately 20 advanced and released varieties. They received seed of the selected variety at the beginning of the following season.

We evaluated farmers selections in the trial by grouping the entries according to their predominant traits. i.e., earliness, tillering, panicle size, and then comparing the frequencies with which each group was selected. Differences between preference patterns for farmers from different agro-ecological zones, and between men and women were consistent with previous results, but often more pronounced.

Potential weaknesses of evaluating farmers' selections in on-station trials are: the trials are grown under different conditions than farmers' own; and farmers only see the varieties at one time in the season. Specific differences may not be clearly visible at the time of the farmers' visit, e.g., early maturity or synchrony of tillering, if the visit occurs late in the season, or grain and stover yield of all entries if the flowering range in the trial is large and the visit occurs earlier in the season.

Advantages of farmers' selection in on-station conditions are that farmers can be exposed to a much larger range of variability under uniform growing conditions than in the on-farm trials, with no risk of crop failure for the participating farmer. Farmers who decide to participate in the visit to the research station are usually keen experimenters and are prepared to spend time interacting with the researchers. Thus discussions are fruitful and informative. The fact that farmers choose their own variety for on-farm evaluation is advantageous, because it allows an earlier involvement of farmers in the process of varietal evaluation.

Selection in variety mixtures

Groups of two to four farmers were asked to tag the ten best individual plants. Each farmer did his/her selection individually in a plot grown to a mixture of experimental varieties. Each farmer was asked to cut the panicles from the three best plants and bring them for a follow-up discussion. Farmers were first asked to describe the most important features of their selections individually. This was followed by a discussion on the reasons for these choices.

The advantages of this method of using farmers' selections to understand preferences for specific traits is that it can be conducted at small stations or experimental farms that do not have the equipment and infrastructure necessary to grow large varietal trials under uniform conditions. They can thus be conducted in the area where the farmers live, and under management conditions that are more similar to their own practices. Farmers need to spend less time to participate in the exercise. This is particularly important for involving women and poor farmers. A further advantage of this method is that it is possible to let farmers cut selected panicles and bring them for the group discussion, because this leads to intensive interaction among the participants on the advantages and disadvantages of certain types of plants and traits.

The disadvantage of this method is that the genotype of each individual is not always identifiable, and it is thus not directly possible to give participants seeds of their selections for further testing in on-farm trials. Furthermore farmers do not get information on specific cultivars during the course of the interview.

Understanding farmers' methods of seed selection

Through semi-structured interviews in villages where farmers have participated in trials, we sought information about indigenous methods of seed production and selection. The interviews are mainly held with farmers who are locally considered as experts for seed selection and production. Topics addressed during the interviews include the traits used for selection under different conditions, factors affecting the decision to select in the standing crop or on the threshing floor, the storage of seed and food grain, and the movement of seed in and out of individual farms. During the interview process, much effort is spent to interact with individuals with specific knowledge and experiences of these issues. These studies are ongoing.

The advantages of these unstructured interviews is that they do provide in-depth information on what farmers regard as the main issues in relation to the topic of seed selection and production. The results are thus more likely to present a complete overview of important issues and trends as farmers view them. The results should be less limited by the researchers' own concepts and priorities.

Surveys on causes for non-adoption of modern cultivars

In an initial study, we used formal, structured, pretested questionnaires to understand farmers' perceptions of the merits of available released varieties, with specific emphasis on understanding issues related to stover yield and quality (Kelley *et al.*; 1996). The survey did give indications that the available modern cultivars did not have the necessary adaptation to the harsh growing conditions of western Rajasthan, and that stover yield and quality are important criteria for adoption or non-adoption of new cultivars.

However, the results of this survey were mainly limited by the fact that farmers in the marginal areas of pearl millet cultivation had not been exposed to the wide range of variability available among newly released pearl millet cultivars and pre-released experimental cultivars. Farmers could thus not consider the whole range of available variability while expressing their preferences and concerns. Furthermore the commitment of the individual farmer during the interview was less serious because the interviews were not conducted in the context of a commitment for further collaboration.

FUTURE DIRECTIONS

Evaluating varietal preferences

In a special project we are looking at how to target different groups within villages (based i.e., on gender, wealth or caste); and at alternative techniques for farmer evaluation of genetic material to provide information on varietal preferences. This will include:

- Different ways to characterize villages
- Different ways to select farmers
- Different ways to select cultivars for farmer evaluation, i.e., demonstrations of a wide range of plant types, preferably grown under conditions close to that of farmers' fields (perhaps on NGO land or perhaps in villages on common land or on land of large farmers).
- Different ways for farmers to evaluate material

Evaluating farmers' selection

We are initiating a project on the opportunities and prospects for diversifying the genetic base of the local varieties of pearl millet that farmers in Rajasthan are maintaining and using for their own breeding efforts. The work will utilize participatory diagnostic methods developed by the ongoing study. How successful are farmers in improving their seed stocks? Is introduced variability improving farmers chances for improving productivity of their own seed stocks? When crop failures occur, how are seed stocks replenished? What are the implications for research aimed at introducing improved genotypes and increasing genotypic diversity as well as productivity? What opportunities for farmer participation in the formal process of variety development could be most useful?

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