FARMER PARTICIPATION IN BARLEY BREEDING
CENTRE FILE: 96 - 8602

FINAL NARRATIVE REPORT

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THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)

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PROJECT IDENTIFICATION

Project Name: **Farmer Participation in Barley Breeding**

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Full Title: INCREASING THE RELEVANCE OF BREEDING TO SMALL FARMERS: Farmer Participation and Local Knowledge in Breeding Barley for Specific Adaptation to Dry Areas of North Africa

Research Team: INRA in Morocco, IRESA in Tunisia and ICARDA in Syria with the following staff:

Institut National de la Recherche Agronomique (INRA), Morocco:
- Dr. A. Amri, Barley Breeder (left in 1999)
- Dr. Douiyssy, Barley Breeder (left in 1998)
- Dr. F. Nassif, Sociologist

Institut de la Recherche et de l' Enseignement Superieur Agricole (IRESA), Tunisia:
- Dr. A. Yahyaoui, Barley Breeder (ESAK) (left in 1998)
- Dr. M. El Fellah, Barley Breeder (INRAT)
- Dr. S. Rezgui, Barley Breeder (INAT, Tunisia)
- Dr. Boubaker Mohsen (ESAK)

International Center for Agricultural Research in the Dry Areas (ICARDA):
- Dr. S. Ceccarelli (Barley Breeder and Project Coordinator)
- Dr. R. Tutwiler (Socio-Anthropologist)
- Dr. S. Grando (Barley Breeder)
- Dr. M.S. Mekni, ICARDA Regional Coordinator (left in 1997)
- Dr. M.A. Belaid, ICARDA Acting Regional Coordinator (left in 1998)
- Dr. M. El Mourid, ICARDA Regional Coordinator (joined in 1999).

Synthesis

Breeding philosophies and methodologies developed for favorable conditions and high input agriculture have been ineffective in generating improved cultivars for marginal conditions and low input agriculture. The project addressed this problem by implementing a novel breeding approach for barley improvement in low potential, marginal rainfall environments of Morocco and Tunisia, which consists of the selection and testing of early segregating populations by the farmers under their conditions. The project had the following objectives:

1. Development of a participatory barley breeding approach for stress conditions.
2. Improved barley varieties that fulfill the needs of poor farmers in the marginal rainfed environments of Morocco and Tunisia.
3. Enhanced rate of adoption of new varieties through farmers' participation in selection and testing.
4. Identification of differences between selection criteria used by men and women farmers and breeders.

The target environments were the dry and semi-dry areas of Tunisia and the dry areas and the mountains of Morocco. In each of ten locations (six in Morocco and four in Tunisia) participating farmers were identified on the basis of reputation, key farming contacts, past performance, representativeness of gender, producer and consumer categories, and self-selection. The theory, objectives, and implementation of the participatory breeding program were discussed thoroughly with the farmers in order to obtain their input into the design of the breeding scheme, including selection procedures such as the proper time for selection, how often selection is done, etc. Eventually they conducted the selection both in their fields and on-station. Farmers' selections were compared with the selection done by the breeder.

The most important results were: in both countries it is possible to implement participatory plant breeding using breeding material at a very early stage thus giving the farmers a range of choices unprecedented in the classical approach; some of the farmers' selection criteria were different from breeders' selection criteria; the participatory approach is becoming institutionalized in the two national breeding programs; the information generated by the project was disseminated at both national and international level through publications and participation in meetings, workshops and conferences; new varieties were identified in both countries and seed multiplication has been initiated by the farmers. Finally, two national programs, namely Algeria and Libya, were encouraged by the project to start participatory selection programs.

Research problem

Plant breeding has been beneficial to farmers in favorable environments or those who could profitably modify their environment to suit new cultivars. It has not been equally beneficial to those farmers (the poorest) who could not afford to modify their environment through the application of additional inputs. Farmers in favorable environments using high levels of inputs are now more concerned with the adverse environmental effects of these inputs and the loss of genetic diversity. Poor farmers in marginal environments continue to suffer from chronically low yields, crop failures and, in the worse situations, malnutrition and famine. Because of its past successes, conventional plant breeding has tried to solve the problems of poor farmers living in unfavorable environments by simply extending the same methodologies and philosophies applied earlier to favorable, high potential environments.

The essential concepts of the conventional breeding approach can be summarized as follows:

(1) selection has to be conducted under the well managed conditions of an experiment station;

(2) cultivars, especially in self-pollinated species, must be pure lines and must be widely adapted over large geographical areas;

(3) locally adapted landraces must be replaced because they are low yielding and disease susceptible;

(4) the dissemination of seed of improved cultivars must take place through formal mechanisms and institutions such as variety release committees, seed certification schemes and governmental seed production organizations;

(5) the end users of new varieties are not involved in selection and testing; they are only involved at the end of the consolidated routine (breeding, researcher managed trials, verification trials) to verify whether the choices made for them by others are appropriate or not.

In situations where the objectives are to improve yield and yield stability for poor farmers in difficult environments, plant breeding programs rarely question the efficacy of this conventional approach. The implicit assumption is that what has worked well in favorable conditions will also be appropriate for unfavorable conditions, and very little attention has been given to developing new breeding strategies for low input agriculture in less favorable environments. There is mounting evidence that this assumption is not valid and, in fact, the special problems of marginal environments and their farming systems must be addressed in new and innovative ways.

In those few cases where applying conventional breeding strategies to marginal environments has been questioned, it has been found that:

(1) selection in well managed experiment stations tends to produce cultivars that are superior to local landraces only under improved management and not under the low input conditions characteristic of the farming systems. The result is that many new varieties are released but few, if any, are actually grown by farmers in difficult environments;

(2) poor farmers in difficult environments tend to maintain genetic diversity in the form of different crops, different cultivars within the same crop, and/or heterogeneous cultivars to maximize adaptation over time (stability), rather than adaptation over space. Adaptation over time can be improved by breeding for specific adaptation, i.e. by adapting cultivars to their environment (in a broad sense) rather than modifying the environment to fit new cultivars. Since diversity and heterogeneity serve to disperse or buffer the risk of total crop failure due to environmental variation, farmers may resist the idea of abandoning traditional cultivars;

(3) when the appropriate cultivar is selected, adoption is much faster through non-market methods of seed distribution; and

(4) when farmers are involved in the selection process, their selection criteria may be very different from those of the breeder. Typical examples are crops used as animal feed, such as barley, where breeders often use grain yield as the sole selection criterion, while farmers are usually equally concerned with forage yield and the palatability of both grain and straw.

Because the concepts of conventional plant breeding are not questioned, the blame for the non-adoption of new cultivars is variously attributed to the ignorance of farmers, the inefficiency of extension services, and the non-availability of seed of improved cultivars. Thus, an impressive amount of human and financial resources continue to be invested in a model of breeding that has not been, and most likely will not be, successful in unfavorable agroclimatic conditions.

The contrast between the reality of the farming systems and the plant breeding philosophies is particularly striking in developing countries. This is not surprising when one considers that most of the breeders from developing countries have received their training in those rarely-questioned breeding principles enshrined in developed countries.

We base our approach on the following four basic assumptions:

(i) farmers know their specific environment better than breeders;

(ii) farmers know their specific needs and objectives better than the researchers;

(iii) farmers will determine the success of a new variety, not breeders.

(iv) it is possible to integrate the breeder's scientific knowledge (in areas such as genetics, breeding, physiology, agronomy), broader experience across environments and ability to create and manipulate genetic variability, with farmers' knowledge and perceptions.

The concepts of the project are not new and there are now several examples of farmers participating to a variable extent in breeding programs. However, the strength of the project lies in the involvement of the major institutions responsible for plant breeding in the two participating countries.

Research findings

The major findings of the project are:

(1) selections on stations, even when made by farmers, are very different from those made on farmers' fields as a consequence of large Genotype x Environment interactions;

(2) that farmers are using selection criteria (grain filling and straw yield and quality) not previously used by the formal breeding programs;

(3) that farmers welcome and are enthusiastic about the possibility of selecting among a large number of lines, and requested the extension of the approach to other crops,

(4) that farmer participation can be introduced successfully into research environments initially reluctant and almost hostile to an approach drastically different from the conventional one, and,

(5) that breeders experimenting in farmer participation emerge deeply changed from the experience, and become enthusiastic supporters of this approach.

Fulfillment of objectives

The project had four main objectives, namely:

1. Development of a participatory barley breeding approach for stress conditions.
2. Improved barley varieties that fulfill the needs of poor farmers in the marginal rainfed environments of Morocco and Tunisia.
3. Enhanced rate of adoption of new varieties through farmers' participation in selection and testing.
4. Identification of differences between selection criteria used by men and women farmers and breeders.

The first objective was successfully fulfilled: the two national programs are mastering the approach and can continue to implement it without the need of external expertise.

The second objective was also successfully fulfilled as four new varieties have been identified in Tunisia (one to be released during the year 2000).

The third objective was only partially fulfilled, mainly because it was too ambitious to expect measurable adoption in the short timeframe of the project. However, farmers in both countries have requested seed of selected lines and have started their own seed multiplication for large scale testing and distribution to neighboring farmers.

The fourth objective was also only partially fulfilled. While the identification of the differences between selection criteria used by farmers and breeders was very successful and very reliable, since it was repeated over seasons, the selection criteria used by woman was very poorly addressed, particularly in Tunisia. This was mostly due to cultural and social reasons. Towards the end of the project, with increased familiarity between the participating farmers and the breeders, there was some evidence that a higher degree of woman participation could have taken place, if the project could have been extended.

Project design and implementation

A Rapid Appraisal exercise was undertaken within the agricultural community associated with each of the selected agroecological locations, to identify local "expert farmers". The indigenous knowledge component was based on formal ethnographic techniques used in socio cultural anthropology, including participant observation, structured interviews, and taxonomic and componential analyses of labeled traits.

The analysis of the biological data, which was initially based on standard analysis of variance, evolved towards the use of the residual maximum likelihood method (REML). The analysis was done by fitting different models ranging from the lattice model to the randomized complete block and to the spatial analysis using ASREML. Towards the end of the project we also introduced the use of clustering and ordination procedures to assist in the pattern analysis of genotype x environment (GxE) interactions. Cluster analysis or numerical classification is one technique used to simplify the data set by grouping individuals with similar responses for all attributes. In the case of GxE tables of yields, clustering is used to simplify the data set by grouping the genotypes, over all environments, with similar response patterns for all yields. Then grouping the environments, over all genotypes, with similar response patterns for all yields. Biplots are used to represent the information contained in GxE tables in a two or three dimensional graph.

Finally, similarity analysis was used to compare the selection done in different environments by the breeder and by the individual farmers. The analysis is based on the Dice coefficient and consists in reducing the selection data into a matrix of 1 (selected) and 0 (discarded), and then in the calculation of the Dice coefficient as 2a(2a+b+c) where a (1/1) is a case when a line is selected twice (for example by both the breeder and a farmer, or in two environments), b (1/0) and c (0/1) are the two possible cases when a line is selected only once out of two possibilities, and d (0/0) is a case when a line is discarded twice. The Dice coefficient (as indicated by the formula) does not consider the number of d's, and therefore is an index of similarity in positive selection only. The dendograms of the various combinations of environments of selection and selectors were obtained by the unweighted pair group method with arithmetic average (UPGMA) cluster analysis. These analyses were done using the program NTSYS-PC version 2.02 (Numerical Taxonomy System, Applied Biostatistics, N.Y.).

Project outputs and dissemination

The following outputs have been achieved during the three years of the project:

(1) The lines that have been selected from the various nurseries in Morocco are now in the advanced yield trials, a compulsory step for the official registration of the varieties. In Tunisia a new six-rowed barley variety (called Momtaz) was proposed late in 1999 to be officially registered. Momtaz is the product of the decentralized-participatory barley improvement program and derives from a cross between a local barley with an improved cultivar. In addition to Momtaz three new promising barley varieties are identified: Elite 1 (TL1), Elite 9 (TL 2), Elite 10 (Mut. Martin);

(2) Farmers were encouraged by the results of their selection and they have begun their own seed increase (for example in Fahs in Tunisia).

(3) The methodological approach that has been developed is now a permanent feature of the research agenda of the two NARS.

(4) The knowledge and understanding of farmers' criteria, the desired characteristics and the role played by barley landraces in farmers’ perception.

(5) Host farmers and neighboring farmers worked closely with breeders and generated information, local dynamism, and participation for self reliance to alleviate poverty and establish sustainable farming systems for difficult environments.

(6) Scientists from research, training, and extension workers in several provinces of Tunisia and Morocco were brought together in implementing the project objectives.

(7) In Morocco the women's assessment of barley grain and spike as selection criteria.

The project outputs have been disseminated through the project's annual reports, which have been widely circulated within the two countries. In addition, various elements of the project have been illustrated in the following events:

- Seminar on "Assessing the Impact of Participatory Research and Gender Analysis" (Quito, Ecuador) organized by the SWP PRGA
- A seminar on "Decentralized and Participatory Plant Breeding" given at FAO headquarters by S. Ceccarelli).
- Workshop on "Breeding for low-input conditions, and consequences for participatory plant breeding" organized by the DLO-Center for Plant Breeding and Reproductive Research and the Department of Plant Breeding and Crop Protection of the Wageningen Agricultural University.

- A Workshop on Farmer Participatory Research, which was held at ICARDA Headquarters from May 6 to May 11, 1999. The Workshop was sponsored by the Islamic Development Bank, FAO and the System Wide Program on Participatory Research and Gender Analysis (SWP PRGA). The Workshop was attended by 34 scientists of National Programs of Algeria, China, Ecuador, Egypt, Eritrea, Jordan, India, Iran, Iraq, Libya, Mauritania, Morocco, Pakistan, Tunisia, Turkey, and Yemen.
- The presentation days at ICARDA headquarters in 1999 and 2000 when the barley project organized a specialized tour "Participatory Plant Breeding".
- The seminar of the SWP-PRGA on Participatory Plant Breeding in Washington in 1999.
- The International Workshop on "Broadening the Genetic Base of Crops" held at the Scottish Agricultural College (SAC), Edinburgh, and organized by SAC in collaboration with FAO and IPGRI.
- The Barley Symposium organized at Obregon (Mexico) to celebrate the retirement of Dr. H. Vicar.
- Two papers currently in press: Decentralized and participatory plant breeding for marginal environments to be published in "Broadening the genetic basis of crop production" (IPGRI/FAO) and "Farmer Participation in Barley Breeding in Syria, Morocco and Tunisia", to be published in a special issue of Euphytica. Both papers are co-authored by all the participants in the project.
- An invited paper at the International Barley Genetic Symposium in Adelaide (Australia) in October 2000 "Decentralized-Participatory Plant Breeding: Adapting Crops to Environments and Clients"

Two NARS scientists (one from Morocco and one from Tunisia) were planning to participate at the International Barley Genetic Symposium in Adelaide (Australia) in October 2000 and to present posters on the project's activities: however, this will not be possible as the extension of the project was not approved.

The national programs in Algeria and Libya have expressed a strong interest in the project's activities that they visited on several occasions. The Libyan National Program has included farmers' participation in their barley breeding program in the cropping season 1999/2000.

Capacity building

In Tunisia, the scientists' confidence in these new approaches was not very solid. The barley breeder who had been working for about 20 years with conventional breeding and centralized research, couldn't explain why the varieties produced by the centralized research outputs were not well received by farmers in the dry areas. The project was of great importance in clarifying what was wrong with the conventional breeding methodologies approach once applied in arid areas where barley production is often the only farming activity. As capacity building, training in participatory research was beneficial to the breeders, to his collaborators, to the research technicians and to the male and female farmers (host/neighbors/farmer's spouse). In addition, the local Ministry of Agriculture extension service agents in several provinces were trained and were helpful in supporting the project team.

In Morocco, the national research capacity has been enhanced tremendously through the project because of:

(1) the nature of the research activities and the approach used constitute new elements to all concerned parties;

(2) the nature of the data collected and types of data analysis;

(3) the participation of the Moroccan team in several training opportunities, workshops, and other capacity enhancing opportunities. Among these the participation of one Moroccan farmer in the Workshop on Farmer Participatory Research held in Aleppo (Syria) in May 1999 is one good example;

(4) the organization of the farmers' traveling workshop in 1999 cropping season allowed participating farmers to visit and conduct selection in their own trials as well as those conducted in INRA research stations. During the workshop, farmers were accompanied by their respective local extension workers and the research team;

(5) the challenges and difficulties encountered in conducting the research.

All these aspects contributed to strengthening the national capacity in participatory plant breeding research. In fact, Morocco is increasingly gaining experience and skills in this type of research. The departure of the national barley breeder from Morocco constitutes one of the most important constraints faced by this evolving experience.

Project management

The administration of the project by ICARDA was reasonably smooth due to the assistance of the Regional Office in Tunis. Some initial problems in keeping the actual spending within the approved budget were eventually solved and did not occur again.

The scientific management of the project was also satisfactory, due to the fact that the two NARS have been working closely with ICARDA long before this project. Delays in reporting due partly to lack of training by NARS in this particular activity, was one of the major problems.

Finally, the support and administration of IDRC was fully satisfactory: delays in reporting were sometimes due to lack of precise guidelines on the required format and content of reports. We regret that it was not possible to extend the project and that we lost part of the funds which were supposed to support the participation of scientists to an international conference.

Impact

The project has developed a new philosophy and new ways to improve the use of the research products (barley varieties developed by both breeders and farmers) to promote sustainable agricultural systems. The real impact is the successful introduction of new research approaches, attitudes and ideas for both farmers and breeders as well as research outputs and dissemination. Breeders gained more confidence in the local indigenous knowledge and its importance to developing successful germplasm for unfavorable zones. Farmers are now much more receptive and confident in new technologies generated with their participation in the project. Valuable local biodiversity preservation was another important impact.

The efficiency of the selection operated by breeders, male and female farmers has had a strong impact in defining the most important parameters on which farmers focus their choice, and in changing the breeding strategies in selection in segregating and advanced material.

Farmers' confidence in researchers' work and their acceptance of the joint findings have corrected several decades of mistakes and built mutual confidence.

The project activities have helped farmers redefine their self-image and their perception of their environment. The participatory approach adopted and the type of relationships developed with farmers have been conducive to farmers' internalization of the project objectives and their total commitment to project work. This positive impact has been directly and clearly expressed by farmers themselves. Moreover, over the years, partner farmers started reserving their best parcels and started asking for the participatory trials. They even became defenders of INRA and its collaborating institutions.

Finally, an important impact of the project was the restructuring of the various cereal improvement projects of the research institutes in the light of the findings as well as the new work environment and renewed confidence of farmers.

Overall assessment

The project was instrumental in providing a precious opportunity for farmers to work side by side with scientists. This aspect cannot be emphasized enough because it was an opportunity for farmers to be solicited to do visual selection over a wide array of materials. Most importantly, they were aware that their selection was taken seriously and that their criteria and their knowledge are not only being considered but they are valued and respected. We also believe that one of the strengths of the project lies in the multidisciplinary character of the work. The breeder and the sociologist have learned to work together. The local extension services have also been involved from the very beginning.

Participatory research is primarily concerned with processes, which are continuously evolving and changing. Participatory plant breeding requires time and continuity. Unfortunately, the duration of the project has been too short to permit the shift from line selection to seed multiplication and seed distribution systems, which represent the ultimate and concrete contributions of the project.

Recommendations

1. The project be renewed to a second phase to cover more zones and to follow up the adoption of the first phase findings.
2. To initiate the farmers group training in growing, using, etc., the obtained lines.
3. To develop research on barley as a food crop as barley is widely consumed in the dry areas of Tunisia.
4. To strengthen and build up the local seed increase by farmers.
5. To strengthen the capacity building in barley participatory research in NARS and further strengthen bonds between research, training and extension
6. Gender issues will be more important, as farmers' wives and women farmers were very supportive and interested throughout the first phase.