Seeds that give

PARTICIPATORY PLANT BREEDING

Breeding Better Barley — Together

A new way to work with farmers in dry areas

In many parts of North Africa and the Middle East, yields of key crops such as barley are chronically low, and crop failures are common. Conventional breeding programs aimed at improving the crop have had little effect, largely because most farmers refuse to adopt the new varieties. The conventional approach has been a centralized, top-down approach that pays little regard to the actual conditions that farmers face. What if you decentralize the breeding program, involve farmers right from the start, have breeders and farmers work side by side to learn from each other, and pay close attention to what the farmers told you? Revolutionary perhaps, but it's a revolution that has produced positive results.

ICARDA: S. Ceccarelli

Working together, researchers, farmers, breeders, and social scientists are increasing barley yields in North Africa and the Middle East.

Farmers in North Africa and the Middle East plant more than five million hectares of barley each year. The secret to barley's popularity among farmers lies in its adaptation to very harsh conditions and in its use as feed for sheep and goats, which are the main source of meat, milk, and milk products for the rural populations. Although yields are often poor, very few small farmers have adopted the new, improved barley varieties from agricultural research centres.

The problem is this: selection in well-managed experimental stations tends to produce cultivars that are superior to local landraces only under favorable conditions with improved management and not under the typical conditions of the resource-poor farmer. The implicit assumption is that what has worked well in favorable conditions must also be appropriate to unfavorable conditions, so very little attention has been given to developing new breeding strategies for less favorable environments.

Don't blame the farmers

Salvatore Ceccarelli is a plant breeder who has worked in the region for many years with the International Center for Agricultural Research in Dry Areas (ICARDA). He sees the problem clearly. "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 unavailability of seed of improved cultivars," he says. "Thus, enormous resources continue to be invested

in a model of breeding which is unlikely to succeed in unfavorable agroclimatic conditions."

Ceccarelli adds that the contrast between the farmers' reality and conventional plant-breeding philosophies is particularly striking in developing countries, but not surprising. "Most of the breeders from developing countries have received their training in those rarely questioned breeding principles enshrined in developed countries," he says. But that is beginning to change.

Emphasis on freedom

In the late 1990s, a team of researchers at ICARDA, led by Ceccarelli, pioneered a new way to work with farmers in the marginal rainfall environments of Morocco, Syria, and Tunisia. It is called participatory plant breeding, or PPB. The work brought together farmers, breeders, and social scientists with the common goal of fulfilling the needs of people living and working in the harsh conditions of the region. The research was funded by Canada's International Development Centre (IDRC), Germany's BMZ/GTZ, and the Italian government.

The preparation for the PPB project started with informal discussions with farmers to make sure that they were willing to participate. Farmers were treated as true partners — their opinions were given the same weight as breeders' opinions. In this framework, issues such as the number of lines, plot size, frequency of selection, whether neighboring farmers can do selection in their field, scoring methods, and access to quantitative data, such as weight of straw and grain, were discussed.

"The emphasis was on the freedom of farmers to do what they believe it is important to do, and to do it in way that makes sense to them and when they think it is appropriate," Ceccarelli recalls. "In this way, a PPB project quickly becomes a farmers' project in which breeders are participating."

In Syria, for example, "host farmers" in nine communities were linked with two research stations. The host farmers and their neighbours took care of the trials, which involved experimental lines from the research station as well as the farmers' own varieties. Farmers and breeders assessed the results independently in successive trials from 1997 to 1999. Several promising new varieties were identified from these trials.

Ceccarelli is quick to point out that the idea of farmers' participation is neither new nor revolutionary. "We must remember that for 10 000 years women and men consciously have been molding the phenotype, and so the genotype, of hundreds of annual and perennial plant species, as one of their many routine activities in the normal course of making a living. All the adaptation — the plant breeding — was done by unschooled peasant farmers with hundreds of distinct varieties.

Different criteria, better results

Ceccarelli and his colleagues believe that farmers' participation in selection under their own environmental and agronomic conditions not only benefits the selection process but also speeds up the transfer and adoption of new varieties without the involvement of complex mechanisms of variety release, seed certification and production, and extension activities. "Such mechanisms, commonly introduced from industrialized countries along with the breeding methodologies and philosophies of formal breeding programs, are not used by most resource-poor farmers as their main supply of seed. Most of the seed and information used by these farmers is either generated on the farm or acquired from neighbours or purchased from local markets," he says.

It quickly became apparent that the farmers' selection criteria, largely based on environmental factors, were quite different from those used by the national breeding programs. To the surprise of many in the formal system, the selections made by the farmers were at least as effective as those made by the breeders. Yields increased in areas where plant breeding had not previously been successful. Seeing these results, breeders quickly adopted new ideas and attitudes, becoming supporters of the participatory approach.

Expect the unexpected

A typical example of different selection criteria between farmers and breeders can be found in the use of barley as animal feed. Breeders often use grain yield as the sole selection criterion, which usually brings with it high harvest index and lodging resistance. However, in unfavorable environments lodging is rarely a problem because of moisture stress, and farmers are interested not just in grain yield, but also in forage yield and in the palatability of both grain and straw for their animals.

"This kind of example," says Ceccarelli, "shows not only that farmers can significantly contribute to the success of a breeding program, but also that with the PPB approach breeders should be open to unexpected and unplanned contributions of ideas."

The researchers learned a number of other critical lessons from the project. Among them, the fact that farmers can handle a large number of lines or populations, or both. Most notably, in Syria in phase 2 of the work, the number of lines assessed increased in some villages from around 200 to 400. In fact, farmers warmly welcomed the ability to select among a large number of lines. Some farmers have started to produce seeds of selected material. These seeds can be shared with other farmers; dependence on seeds delivered by the breeders is thus reduced. This is leading to a more dynamic breeding process, with new materials being introduced from farmer to farmer at any time.

Quantity of breeding material in ICARDA's PPB research

Country	Number of villages	Number of lines	Plot size (in m^2)	Number of farmers/ village
Syria phase 1	9	208	12	5–9
Syria phase 2	8	200–400	12	6–11
Tunisia	6	25–210	4.5	10–20
Morocco	6	30–210	4.5	6–15
Yemen	3–6	100	3	15–20
Eritrea	3	155	3	10–12
Egypt	8	60	6	5
Jordan	6	200	6	5–12

Source: Ceccarelli. S. 2000. Decentralized participatory plant breeding: adapting crops to environments and clients. In Proceedings of the 8th International Barley Genetics Symposium, 22–27 October 2000, Adelaide, Australia. Department of Plant Science, Adelaide University, Glen Osmond, Australia. Vol. I, pp. 159–166.

Building on success

So successful has been this pioneering approach that farmers have requested breeders to work with them using a similar approach to improve other crops. It has also spread to other countries in the region. ICARDA currently supports PPB programs on barley in Egypt, Eritrea, Jordan, and Yemen. In Bangladesh, Syria, Turkey, and Yemen, the same approach is being applied to research on lentils. Complementary to the PPB efforts, ICARDA has begun participatory research in natural resource management, in particular on sustainable land management in dry areas.

In each country, the success has been repeated, and in each project, the researchers have noted that farmers become empowered by their involvement in PPB, gaining the confidence to take decisions on crosses as well as on factors such as plot size and the number of locations. The researchers also noted that women's selection criteria often differed from the men's, highlighting the importance of ascertaining when and why they differ.

Involving women in the projects has met with mixed results. In some countries, the men reacted initially with a mixture of curiosity and skepticism. This turned to acceptance as the value of women's selection choices became apparent. However, there has also been resistance, with men claiming strongly that "Women have other duties in agriculture and the choice of new varieties is a typical men's job," says Ceccarelli.

Perhaps of equal importance to the researchers themselves, the PPB projects have revealed the need for specific training in areas such as experimental design and data analysis suitable for situations where the environment (a farmer's field under farmer's management) cannot be under the scientists' control as it is in the research stations.

The only possible approach

Ceccarelli believes that PPB is the only possible approach to breed crops grown in unfavorable conditions or remote regions, in areas not sufficiently large to justify the interest of large breeding programs, and to breed for minor crops neglected by both private and public plant-breeding programs. "PPB should be linked not only with formal breeding programs — providing a continuous flow of novel genetic variability — but also with the informal seed supply system which can spread new varieties in the farmers' communities without the unnecessary requirements of the formal seed system," he says.

Because lines with good performance in unfavorable sites and poor response to favorable conditions have a low average grain yield, they are systematically discarded. Yet they would be the ideal lines for farmers in unfavorable locations. This implies that improving specific adaptation to difficult conditions requires direct selection in the target environments — in other words, decentralized selection.

"Decentralization from international to national breeders is also much 'greener' because it adapts crops to an environment, rather than vice versa," explains Ceccarelli. "Fewer chemical inputs are needed and biodiversity benefits because it favours the deployment of more varieties." He recognizes, however, that decentralization will not respond to the needs of resource-poor farmers if it is only a decentralization from the experimental station of the international centre to the experimental station of the national agricultural research system.

True partners

It is not enough, according to Ceccarelli, to conduct a series of ad hoc studies for a limited period of time to document indigenous knowledge and farmers' preferences. "To be effective, participation should become a permanent feature of plant breeding programs addressing crops grown in agriculturally difficult and climatically challenging environments," he insists.

"To achieve this it is essential that farmers are considered as true partners and that they have access to the same type of information usually available to breeders. For crops grown in remote regions, or for those considered as minor crops, and therefore neglected by formal breeding, this could be the only possible type of breeding."

This case study is one of a series of six on participatory plant breeding written by Ronnie Vernooy, senior program specialist at IDRC, and science writer Bob Stanley.

www.idrc.ca/seeds

Why diversity matters

Modern agriculture rests on a precariously narrow base. Genetic erosion could threaten the future food supply if anything should happen to reduce the effectiveness of the high-yielding varieties that much of the world has come to rely on. Crop breeders tend to rely increasingly on a narrow set of improved varieties, making it more and more difficult to broaden the diversity base. In the past, researchers have been able to depend on farmers to retain sufficient crop diversity to provide the "new" genetic material they need, but homogeneous modern agriculture threatens that source of genetic diversity, and thus threatens both local and global food security.

The high-yielding varieties developed by the formal research system are often high-maintenance varieties. They may require regular applications of fertilizer and other inputs. These constraints effectively put them beyond the reach of millions of small-scale farmers who cannot afford the high-priced seed and fertilizer. Many of these farmers reject the plant breeders' offerings because they simply are not designed for marginal farmland — they meet neither the farmer's needs nor local preferences.

Rethinking conventional breeding strategies means above all recognizing the key roles of farmers and their knowledge and social organization in the management and maintenance of agrobiodiversity. Recognizing these roles is the basis of the approach known as PPB. Simply stated, the aim of PPB is to ensure that the research undertaken is relevant to the farmers' needs.

Sustainable Use of Biodiversity

IDRC's Sustainable Use of Biodiversity program initiative looks at ways to conserve biodiversity by promoting its sustainable use by indigenous and local communities. It emphasizes research approaches that are sensitive to gender issues and inclusive of indigenous knowledge and culture, and seeks ways to inform policies with these approaches.

June 2003 CASE-SEEDS-1-E

For more information

The ICARDA projects' Web address is
www.icarda.cgiar.org/Participatory/FarmerP.htm

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References

For an overview of the issues raised in this article, read *Seeds that Give: Participatory Plant Breeding*, by Ronnie Vernooy (IDRC 2003) and browse www.idrc.ca/seeds.

For more information on agricultural biodiversity in general visit the Web site of the International Plant Genetic Resources Institute, www.ipgri.cgiar.org, or see *The State of the World's Plant Genetic Resources for Food and Agriculture* (FAO 1998).

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