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Participatory barley breeding—farmers' input becomes everyone's gain

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Kherbet El Dieb, north of Aleppo, is one of 24 Syrian villages involved in a participatory plant breeding (PPB) initiative started by the International Center for Agricultural Research in Dry Areas (ICARDA). Yields there have increased since the farmers have begun using varieties developed through the PPB program. PPB is one of the most common types of benefit sharing related to farmers' rights as the concept is outlined in the International Treaty on Plant Genetic Resources for Food and Agriculture. Combining farmers' knowledge with that of professional breeders, this approach enables the farmers to benefit from their contribution to the global genetic pool by adding value to their crops, improving their livelihoods and increasing their incomes. However, as the name indicates, the main principle of PPB is participation, and this is a signature characteristic of the barley breeding initiative in Syria.

Fawaz Al-Abboud Al-Hassoun, a farmer in Kherbet El Dieb who took part in the project, is very happy with the participatory approach and the resulting varieties. The productivity of the new varieties is high because of their increased resistance to drought and cold and, thus, they have been adopted by many of the farmers in the village.

This case study describes how PPB evolved in Syria and how benefits have been generated through local action research in which farmers and breeders are engaged in a collaborative learning process. The PPB work in Syria also served as a learning ground for PPB in other countries in the region (e.g. Algeria, Egypt, Eritrea, Ethiopia, Iran, Jordan, Morocco and Yemen). An example of this spreading of PPB in Jordan is described in the next chapter.

Participatory research and plant breeding

In recent years, there has been increasing interest in participatory research in general and in PPB in particular, as scientists have become more aware of how users' participation in technology development may increase the probability of success. The interest in PPB stems partly from the view that the impact of agricultural research, including plant breeding, has been below expectations, particularly in developing countries, in marginal environments and among poor farmers. In fact, according to the World Food Programme (WFP 2011), there are 925 million malnourished people in the world today. The limited impact of most agricultural research in marginal areas is, to some degree, due to the fact that the research agenda is usually determined by the scientists and not discussed with farmers. Agricultural research is also typically organized according to disciplines or commodities and seldom adopts an integrated approach that would more closely resemble the situation at the farm level. There is a large gap between the number of technologies generated by the agricultural sciences and the relatively small number adopted and used by farmers, particularly smallholders.

In relation to plant breeding, most scientists would agree that programs have not been very successful in marginal environments or among poor farmers. It takes a long time (about 15 years) to release a new variety, and few of these are adopted by farmers, many of whom grow varieties other than the officially released ones. Even when new varieties are acceptable to farmers, the seed may not be available or it may be too expensive. Great loss of biodiversity is also associated with conventional plant breeding, and reversing this trend is important both to improve the livelihoods of farmers and to maintain plant genetic diversity.

Defined as a type of research in which users are involved in the design—not merely the final testing—of a new technology, participatory research is now seen by many as a way to address these problems. PPB in particular, a plant breeding system that involves scientists, farmers and other partners (such as extension staff, seed producers, traders, consumers and NGOs), in the development of a new variety, is expected to produce varieties that are: targeted at the right farmers; relevant to their real needs, concerns and preferences; and appropriate in terms of producing varieties that will be adopted.

The science behind participatory and conventional plant breeding is the same. The major difference is that conventional plant breeding is a process where priorities, objectives and methods are all decided by scientists, whereas PPB gives equal weight to the opinions of farmers (and other stakeholders). It is also important to distinguish between PPB and farmers' breeding practices, defined as the various complex activities farmers engage in on their own, with no participation by scientists.

Since the beginning of agriculture and until the rediscovery of Mendel's laws and the start of scientific plant breeding, farmers have planted, harvested, stored and exchanged seeds, modified their crops, moved crops around, and, as a result, have been able to feed themselves and the rest of society. Implicit in the way farmers bred their crops was selection for specific adaptations, both to their environment (climate and soil) and their uses. This led to a large number of landraces of all the main crops. During this process, farmers have accumulated an immense wealth of knowledge.

However, at the beginning of the last century, plant breeding was gradually removed from farmers' hands, with the result that what had been done by many, many people in many diverse places was being done by fewer and fewer people in relatively few places. Selection for specific adaptations was replaced by selection for wide adaptation to allow seed companies to multiply and sell a few varieties of seed over large geographic areas.

The wealth of knowledge accumulated by farmers over millennia was not taken into consideration. The difference between traditional knowledge and modern science is probably one of the reasons for this. The former is based on repeated observations over time, whereas the latter is based on repeated observations over space (replications). While traditional knowledge is usually shared informally, modern science is almost always communicated in a written and highly formal manner. Because it is difficult for scientists to elicit traditional knowledge using the forms of communication of modern science, farmers' knowledge has often been ignored or misinterpreted in conventional plant breeding, with the result that the technologies produced did not reflect the local needs and priorities of farmers. In contrast, PPB starts with recognition of farmers' knowledge and expertise, and is concerned with building on it and strengthening it.

The first phases of Syria's participatory plant breeding project

ICARDA, which is one of the 15 international agricultural research centers that make up the Consultative Group on International Agricultural Research (CGIAR), has been involved in PPB in Syria since 1995. PPB is well suited to ICARDA's objective of improving the livelihoods of resource-poor people in dry areas by enhancing food security, alleviating poverty through research and partnerships to achieve sustainable increases in agricultural productivity and income, and ensuring efficient and equitable use and conservation of natural resources. The General Commission for Scientific and Agricultural Research (GCSAR), the formal national research institution for breeding in Syria, was also involved in the PPB initiative from the beginning.

The main goal has been to develop a way to move from top-down centralized breeding programs to bottom-up participatory, decentralized programs. An additional goal was to provide a model that could be used in other countries and for other crops. This is a continuing effort, with 24 villages all across Syria now involved. The widespread nature of the program has been possible partly because of collaboration among GCSAR staff at research stations in the provinces and extension staff who have easy access to farmers in the various villages. Most of these villages are located in marginal areas, frequently affected by droughts and resulting crop losses. The breeding of varieties that are adapted to this climate is, therefore, an important aspect of the project.

Farmers have been involved in PPB from the beginning. At first, this meant consultations not only about the overall objectives but also about organization of the trials (number of varieties, plot size, seeding rate, scoring methods, etc.). Together, participants decided that developing new and better barley varieties in farmers' fields with farmers' participation would be the main priority.

In the beginning, the main objectives were to build relationships (the team), understand farmers' preferences, measure the efficiency of farmers' selection methods, develop a scoring system and enhance farmers' skills. Exploratory work included the selection of farmers and test sites, and the establishment of a common experiment in nine villages and two of ICARDA's research stations. The nine villages represented a range of climatic conditions from wet to dry as well as a range of farmer literacy levels, farm sizes (about 5–160 ha), farm types in terms of the extent of crop and livestock production, levels of income (on-farm and off-farm) and differences in the importance of barley in the farming system. None of the villages had adopted modern varieties even though farmers knew about them and, in some cases, had tried planting them.

Kherbet El Dieb is one of the driest villages selected to participate in the PPB project, with an average annual rainfall of 174 mm. As sheep are the main agricultural product, barley as the main livestock feed plays a critical role in the livelihood of the village. Barley is used solely as animal feed (mainly for sheep) throughout Syria. However, although it might be the only crop choice in dry areas, it is also grown as a rainfed crop in more complex farming systems together with wheat, lentils, chickpeas and summer crops. Farmers with their own herds of sheep will use the barley they grow as feed and sell the surplus, while farmers without herds will sell their entire barley harvest (both grain and straw).

The two participating research stations, Tel Hadya and Breda, are located in two distinct production environments. Tel Hadya, with an average annual precipitation of 338 mm, has a typical high-input, favorable environment for barley and a wide choice of crops. At Breda, on the other hand, with average annual precipitation of 268 mm, the environment is low-input, high-risk; barley is the most common rainfed crop and there is a limited choice of other crops and cropping systems.

The initial barley experiment took place over three cropping seasons (1996–97, 1997–98 and 1998–99) and included 200 new barley types that represented a wide range of characteristics, such as plant height, flowering and maturity date, leaf colour, row type (two vs. six rows), seed colour (white, black, grey), stem diameter and associated lodging resistance and straw palatability. Because barley is used exclusively as animal feed in Syria, straw palatability is a valuable trait for the farmers but is usually neglected by breeders. In addition, eight farmer cultivars from eight of the nine host farmers were also included.

The 208 varieties could be sorted into various categories. They came from either modern germplasm (100) or landraces (108); they were fixed lines (100) or segregating populations (108); they had two rows (158) or six rows (50) and they had white seeds (161), black seeds (28) or mixed seed colours (19).

Both before and after planting, agronomic management of the trials was left to the host farmers. The trials were conducted under rainfed conditions in the farmers' fields as well as at the research stations to ensure that they were grown under typical farm conditions. (At the time, the government did not allow irrigation of barley.)

Each of the participating farmers was given a field book in which to record daily rainfall and observations. Most farmers preferred a numeric scale as a scoring method, while some preferred qualitative scoring, classifying plots as "bad," "medium," "good," "very good" and "excellent." Eventually, they adopted a mix of quantitative scores for some traits and qualitative descriptors for others. The farmers used these scores during final seed selection to assign an overall score. Farmers did not usually need assistance with scoring, but where there was a high degree of illiteracy, they were assisted in recording their scores by other farmers or by the scientists.

Selection processes

Various selection processes were used. Centralized non-participatory selection was carried out by a scientist, in this case GCSAR's barley breeder, at the research station, while centralized participatory selection was conducted by farmers at the research station. The decentralized process was also either non-participatory (carried out by the breeder in the farmers' fields) or participatory, with selection done by farmers in their fields.

The first selection took place in May 1997. The work was done independently by the various participants, who did not know what the others had selected. The varieties were identified based on who selected them and the location from which they were selected:

- selected by farmers in their field
- selected by farmers at Tel Hadya research station
- selected by farmers at Breda research station
- selected by the breeder in each of the farmers' fields
- selected by the breeder at Tel Hadya research station
- selected by the breeder at Breda research station.

The first four groups were specific to the nine farmers' fields, although a number of samples were commonly selected in more than one farmer's field. Using the selected samples and taking care to avoid duplication, a specific trial was prepared for each of the nine farmers' fields. The samples in the two last groups were common to all trials.

In the 1997–98 cropping season, the farmers chose local landraces and improved varieties to use as controls. Abdu Sheiko, a farmer from the area near Al Bab (a large village 60 km northeast of Aleppo) had introduced a forage legume crop into rotation. The trial crop was, therefore, planted twice, once after barley and once after the legume. All ten trial crops were also planted at the two research stations, using the same layout as in the farmer fields. The total number of samples tested in 1998 was 1,348, of which 196 were genetically different as a result of the large diversity reflected in the selection criteria used in 1997. The process of evaluation and selection conducted in 1997 was repeated in 1998 on the lines selected the first year, and again in 1999 on the lines selected in 1998.

Experience during the first three years of the trials indicated that farmers are able to handle large numbers of samples (a frequently debated issue among PPB practitioners), make a number of observations during the cropping season and develop their own scoring methods. It was also observed that farmers select for specific adaptive traits and, in some cases, selection is driven mainly by environmental adaptation. Diversity of farmers' selections was greater in their own fields than at the research stations and greater than those of breeders at both locations. The selection criteria used by the farmers were nearly the same as those used by the breeders. In addition, in their own fields, farmers were slightly more efficient than the breeders in identifying the highest-yielding varieties. The breeders were more efficient than the farmers in selection at the research station located in a high-rainfall area, but less efficient at the research station located in a low-rainfall area. These findings constitute a strong argument for farmer participation.

Benefits

The first phase of the barley PPB project in Syria led to increased awareness among the farmers of the nature of plant breeding and what it can offer. This was evident from the number and quality of questions raised by the farmers during the entire process. Requests to extend PPB to other crops also showed how interested the farmers were in this approach. The fact that farmers were at least as efficient as breeders when it came to selection was an important finding that allowed the approach to be extended to other countries (Algeria, Egypt, Eritrea, Ethiopia, Iran, Jordan, Morocco, Tunisia and Yemen) often after visits by scientists from these countries to Syria during the first project phase.

The demonstrated ability of farmers to handle a large number of populations discredited the belief that they are simple-minded people, incapable of dealing with more than 20–30 varieties at a time. This was essential if the project was to move from the linear process used in the first phase to a cyclic process and a truly participatory program. The results from the three-year experiment indicated that there was much to gain, and nothing to lose, from implementing a decentralized PPB program; thus, a second phase was initiated. This meant ensuring that the farmers knew that the project would not be short term, but ongoing and evolving. The farmers were agreeable, and the project could continue.

The second phase of the project

An important feature of the second phase was that the role of the research stations changed; they were now used only for seed multiplication, making crosses and preparing the initial material. The number of villages taking part in the project increased from 9 to 11 in 2003 and to 24 in 2005. The number of farmers directly involved also increased as a result of strong support from the Syrian Ministry of Agriculture and Agrarian Reform following a workshop organized in Hama at the request of the minister of agriculture. In addition, seed production was initiated in some villages. Details of the experiments, such as the number of lines to be tested, plot size, type of germplasm, selection criteria and issues related to seed production, were discussed in meetings with farmers in each of the participating villages. This led to the development of a more refined PPB model, which ICARDA would subsequently use in other countries.

It is worth mentioning that there are no fixed models for PPB. For a particular crop, even within the same country, different models may be required depending on the genetic structure of the varieties and how farmers are used to handling on-farm genetic diversity, among other factors. In the model used by ICARDA for a number of self-pollinated crops (barley, bread wheat, durum wheat, lentils and chickpeas) and in a number of countries (Algeria, Egypt, Eritrea, Ethiopia, Iran, Jordan, Syria and Yemen), the role of the scientists is to make the crosses (mostly between landraces and between improved cultivars and landraces and wild relatives), grow the first two generations of crops on research stations, assess traits the farmers have defined as important, analyze the data and keep a safely stored electronic copy of the information. The farmers routinely evaluate and score the breeding material, decide what to maintain and what to discard, adopt and name varieties, and produce and distribute seed of the adopted varieties.

The testing process occurs in four stages: initial yield trials, advanced trials, elite trials and large-scale trials. The initial yield trials in Syria included 165 varieties. When crop diversity is great and farmers in different villages have different preferences, the initial trials in the villages use different varieties and only a few (usually five) common checks (traditional varieties used by local farmers). In these cases, the total number of varieties tested can be fairly large: in Syria, more than 400 genetically different varieties were tested. As there is only one initial trial per village, choosing which farmer will be involved and which field will be used is a serious decision requiring careful discussion with the farmers. If an unfortunate choice is made, for example, conducting the trial in the field of a farmer who is using agronomic practices different from those of most other farmers in the village, the resulting selections may not be well suited to the rest of the village.

The advanced and elite trials, which test the varieties selected during initial and advanced trials of the previous year, include two replications. Statistical analysis of the data is used to produce the best linear unbiased predictors of genotypic values and a number of variables including heritability. The large-scale trials use a replicated block design with very large plots and farmers' fields as the replications. Thus, the PPB trials generate the same quantity and quality of data as those obtained from multi-environment trials used in conventional breeding programs. In addition, they provide information about farmers' preferences, which is not usually available from conventional trials. Because the data are so sound, the resulting varieties usually qualify for official release. In several countries, including many in the developing world, this is a prerequisite for commercial seed production dictated by law or ministerial regulations.

Increasing crop diversity

One key aspect of this PPB model is that, once it is fully implemented, the lines selected as best are used as parents in a new cycle of recombination and selection, just as in a conventional breeding program. The difference is that these lines have been selected by farmers and can vary from location to location. This cyclic aspect, where farmers' best selection is used to produce the following generation, has an enormously empowering effect on the farmers, who feel their choices are valued by the breeder, and creates a strong sense of ownership among them.

In this PPB model, particular care was taken to design a scientifically robust model for two reasons. First, the farmers could be provided with scientifically correct information (the same type of information a breeder usually has) on which to base their decisions. Second, PPB programs are often criticized, sometimes rightly so, for not using a rigorous experimental design or statistical analysis; this model can withstand such criticism.

Because of the decentralized selection process and farmer participation, the PPB process leads to increased crop biodiversity. The number of different varieties at the end of a breeding cycle in farmers' fields is greater than the number of lines the Syrian National Program uses in its on-farm testing, which occasionally results in only one or two recommended varieties across the country. Many more varieties are adopted in the PPB program. This increase in biodiversity takes place not only in space (because different villages select different lines) but also in time, because of the cyclic nature of the process, which ensures rapid turnover of variety at the same location.

On average more than 1,000 farmers benefit from the program each cycle. During the second phase, the number of farmers directly involved in the program varies from 5 to 10 per village at the time of selection and from 10 to 15 per village at the time of data discussion. As a result, 200–400 farmers are directly involved in two of the most important decisions during each cropping season. In addition, in some villages, as many as 60 farmers buy seeds of the varieties selected through the PPB program.

A number of farmers have started to produce seed from the resulting PPB varieties. Because they are buying seed of a variety they have seen grown in the field by a farmer whose agronomic practices are similar to their own, farmers are sometimes willing to pay more than they would for little-known "improved" varieties available on the market. They also usually buy small amounts (100–200 kg) of seed because they subsequently multiply it. Therefore, the buyers in turn become seed producers and the benefits derived from the new varieties spread.

Everyone gains

As PPB progressed, farmers also contributed by suggesting changes in methods. In the beginning, visual selection occurred in the field, as requested by the farmers, on a day close to harvest time. That day, the farmers would gather, a short explanation would be provided for newcomers and each farmer would be given a score sheet for each trial. The farmers would then score each plot. At some locations, this could take up to half a day, at the end of which the scientists would collect the score sheets to enter the data into their computer programs. Visitors interested in the project would often be invited to these gatherings.

In 2005, Majid Awad, a farmer from Bylounan in Raqqa province, one of the driest villages taking part in the project, declared that he was not happy with this procedure. He complained that he could not concentrate properly on the scoring, a process he regarded as very central to future selection, because of frequent interruptions by visitors asking questions and walking in front of him as he was rating crops. He also pointed out that even though the selection day was chosen in consultation with the farmers, a last-minute commitment could prevent a farmer from attending and thus cause him or her to lose the opportunity to participate in the selection.

He suggested that the score sheet be distributed to all interested farmers well ahead of time, giving them the opportunity to choose when to do the scoring. They would be able to take as much time as they needed and even repeat the scoring if a climatic event changed growing conditions. (This had occurred one year when the various lines reacted differently to a heat wave after the selection day, and the farmers decided to repeat the scoring process.) The system Awad suggested was eventually adopted by the other villages, even though most of the farmers still preferred to set aside one day to discuss various aspects of the trials with the scientists.

Another modification of the method was related to the use of mixtures. Given that farmers in Syria do not generally plant heterogeneous plots, the ICARDA scientists were surprised to learn that Abdu Sheiko had decided to mix two very different barley varieties: a two-row variety, susceptible to lodging but drought resistant, and a six-row, lodging-resistant variety that produced a high yield in years of heavy rainfall. He explained that he had learned about the characteristics of the two varieties by conducting PPB trials and taking notes, and thought that mixing them could be a good strategy to stabilize yields. When other farmers were told about Abdu Sheiko's mixtures, some of them began mixing their leftover seed after samples had been taken to measure the yield. In the last three years, these mixtures have been producing better yields than any single variety; thus, the scientists and farmers decided to include experimental mixtures as part of the testing. This, in turn, contributed to the development of a program on evolutionary PPB because the farmers accepted the idea that mixtures can change with time in the direction of better-adapted genotypes.

Evolutionary PPB uses broadly diversified germplasm and long-term natural selection processes in the relevant areas to produce highly adapted crops. It also allows some degree of adaptation of the genetic material and increases the capacity of local communities to manage their seed populations. The handling of complex populations is very simple as all that is needed is to cultivate them in locations affected by either abiotic or biotic stresses or both, and let natural selection slowly increase the frequency of the best adapted genotypes. With the experience and skills they have developed through PPB, farmers and breeders can superimpose artificial selection for traits that are important at each specific location. Different farmers may select different plants and grow the progenies in their own field over many years; the expectation is that the varieties derived from this evolving population will be better adapted than those of preceding years.

These two examples show that farmers take the projects seriously and have ideas about how they can be improved. Farmers' experience should be taken into account and their suggestions incorporated into PPB projects. The degree to which information spreads from farmer to farmer and village to village also demonstrates how farmers learn from each other and experiment with new methods they think might be beneficial.

In 2010, to facilitate the sharing of lessons learned among the farmers, five computers were distributed to PPB participants in five villages. Farmers had expressed an interest in enhanced communication with ICARDA scientists and with other farmers participating in the program and in accessing information about agronomic management available online. The computers will also be used for the discussion of results of the PPB trials in farmers' fields.

The gender dimension

In 2006, a study revealed that women farmers in Syria were interested in PPB but were not being informed about the possibility of collaborating or were assuming they could not participate. Since then, a female researcher has been supporting the integration of Syrian women farmers into the PPB efforts by combining gender analysis with action research.

Participatory fieldwork has revealed gender-based differences in agronomic management, crop preferences and needs. Multi-criteria mapping was used to determine women's expectations of the program, their views on the validity of the current PPB process and their suggestions for improvement. PPB activities are now organized in ways that facilitate the involvement of women farmers by organizing events directly with women as well as collaborating with local institutions and creating women-only venues. The team tries to respect local sensitivities, particularly with regard to the participation of young female farmers in public events, and to create arenas for discussion that make it easier for women to interact with male strangers.

ICARDA also feels that it is important to create opportunities for women, men and ICARDA staff to collaborate, and it organizes mixed meetings and opportunities for sharing common concerns and implementing solutions. PPB activities are evaluated along with the farmers to gain a gender perspective on any problems that have been encountered. Gender issues are also taken into account when it comes to knowledge sharing. Because women, on average, are more illiterate than men and have less access to technology, reports are produced in both digital and hard copy, and include visual and oral material. In addition to these changes in approach and methods, the PPB project is expanding to include crops other than barley—e.g. chickpea and cumin—to reflect women's priorities and including priority traits for selection that were suggested by women—e.g. spike hardness, which is necessary for hand harvesting and palatability, and stem flexibility, which is important for handicrafts.

PPB, therefore, can accommodate varieties relevant to both women and men farmers who are often involved in complementary agronomic activities that entail different priorities and knowledge. Moreover, PPB facilitates access by women farmers to good seed supplies and information. This is a key element in the empowerment of women farmers in Syria who are generally disadvantaged in terms of access to resources, revenue and information. A study on the gender aspects of seed governance and PPB in Syria is currently underway.

A key challenge to achieving gender-balanced PPB in a patriarchal country, such as Syria, is ensuring that the participation of women farmers is an empowering and enriching opportunity for them, their households and communities. When this is achieved, the participation of women in public events is likely to be supported rather than resisted by their communities, and the benefits of the program can be shared more equally between men and women.

Benefit sharing

Data from the last few years, including the very dry 2008, show that the PPB lines outperformed both the commonly used landraces and conventionally bred modern varieties. In Kherbet El Dieb, which received rainfall of 189.5 mm in 2006, 206 mm in 2007 and only 139 mm in 2008, four PPB lines outyielded the local black-seeded landrace grown by most farmers by 12.3–23.2%. During visual selection, Al-Hassoun and the other farmers also scored the four lines higher than the landrace. The farmers from Kherbet El Dieb estimate that, in 2009, about 5,000 ha of the cultivated land in the area were planted with varieties introduced through the PPB program four years ago, then multiplied by the farmers. In 2010, they estimate, 90% of the farmers in the area planted one of three PPB varieties selected in the last five years. This estimate, which is based on the amount of seed sold and distributed, illustrates how successful the project has been in terms of variety adoption.

In Om El Amad, a village in the province of Hama with an average annual rainfall of 249 mm in the last four years (range: 183 mm in 2008 to 328 mm in 2007), the two best lines outyielded the local white-seeded landrace by 11–19% and a conventionally bred modern variety by 5–13%. In Bari Sharky, a drier village in the same province with an average annual rainfall over the last four years of 204 mm (range: 130 mm in 2008 to 238 mm in 2005), the largest yield increases were obtained with two lines resulting from crosses with the wild progenitor of barley. These lines outyielded the local landrace by about 33%.

But the selected lines are superior not only in marginal and drought-affected areas. In Suran, another village in Hama province, average annual rainfall over the last four years has been 277 mm. In three of these years, it received more than 300 mm; in 2008, it received only 198 mm. In this area, two sister lines obtained from crosses with landraces outyielded the local landrace by 15–25% and a conventionally bred modern variety by 18–27%.

All these lines are currently grown by farmers in the four villages and the seed will be distributed to other farmers. According to Ali Turkia from Tel-Hassan Bash, everyone who saw how the “Yana mixture” (a mixture of seed from the advanced, elite and extended trials in his field) grew requested seed for the next season as they were impressed with the plant height and spike length of the new variety, in particular. Compared with the local barley variety in this area as well as the conventionally bred Furat 2, the mixture performed very well.

Thus yields can increase and livelihoods can be improved by farmer participation in the breeding process. PPB studies in Syria have shown that no matter how many varieties are released and how much higher their yields are than local varieties, farmers in marginal environments will not adopt them unless they have participated in their selection. This makes PPB a particularly important tool in benefit sharing. Cost–benefit analysis of barley production at the farm level shows that participation of farmers in the breeding program does not mean higher costs of production. Farmers adopting varieties bred through PPB projects would likely pay higher input costs, but gain higher net returns. In addition to the economic returns, participating farmers appreciate other benefits, such as increased knowledge of barley production and variety selection and collaboration with scientists and other farmers. This demonstrates the importance of PPB and farmer participation. The benefits for women farmers, in particular, highlight the importance of adopting a gender-sensitive approach.

Cost–benefit analysis

The economic benefits of PPB are clear. Cost–benefit analysis showed that there is more to gain by implementing PPB than by continuing conventional plant breeding. Market-level benefits, calculated from the estimated adoption rate and yield gain, were compared with investment costs for PPB and conventional plant breeding. Even assuming only a 10% adoption rate and a 33% gain in yield for the varieties produced in the PPB programs, the benefit–cost ratio, as well as the internal rate of return, was higher for PPB crops. Because the impact of PPB depends on the availability of seeds from the resulting varieties, it is important to ensure that farmers, especially those on marginal lands, have access to these seeds.

The farmers benefited in other ways as well. The knowledge they gained through their participation in the program has improved their ability to make decisions regarding variety testing, evaluation and selection. Almost all the participating farmers say that, even if the PPB process ends, they will continue to practice what they have learned about variety selection. They also intend to maintain seeds of the new varieties and keep looking for good varieties along with other farmers. Many feel that their participation has improved their knowledge of barley production, as well as agriculture in general.

Working with researchers is assumed to improve the "human capital" of participating farmers, and some, women in particular, did feel that their knowledge has increased as a result of their interaction with breeders and technicians. The women farmers also believed that their role in agronomic management, usually overlooked at household and village levels, and by researchers and development practitioners, had become more visible through PPB.

Working in groups and being encouraged to share information and knowledge may lead to increased "social capital," in terms of ability to cooperate and share information. Many of the participating farmers said that they gained valuable experience through interactions with other farmers. One of the most important successes of the PPB program was that it had a positive impact on the livelihoods of most of the participating farmers. Most farmers who have not yet felt the impact on their livelihoods live in areas where the PPB program started later, and it is likely that their situations will improve as PPB continues. Women farmers particularly valued their increased access to good seed and information.

Only a very small number of farmers believed that those who were involved in selecting new varieties should keep the benefits for themselves; most felt that the benefits should be shared at the community level. This might indicate that the farmers view local plant genetic resources as their common heritage, not something only a few should benefit from. Other projects will probably also be more in tune with the values of the farming communities if they take cooperation, sharing and equal distribution of benefits as their point of departure.

It is commonly thought that Syria's legislation regulating variety release and seed multiplication and distribution has been an obstacle to the participatory barley breeding project by limiting the amount of seed that can be produced and distributed, thus preventing thousands of farmers from benefiting from the project. However, the only legislation in this area is a Ministerial Decree from 1975 (available only in Arabic), and it does not contain any specific restrictions on the movement of seed. The legislative situation with regard to this issue may be somewhat unclear, and the uncertainty surrounding the legality of seed distribution might be a barrier to upscaling. The Ministry of Agriculture and Agrarian Reform is currently in the process of drafting a seed law, including a new system for releasing new varieties. This law will probably bring legal certainty to the field, but if it places restrictions on the exchange of seed, it might also be detrimental to farmers' rights.

Conclusions

The participatory program in Syria has already inspired other countries in the region (Algeria, Egypt, Eritrea, Ethiopia, Iran, Jordan, Morocco, Tunisia and Yemen) to start PPB of several crops. One of the most important lessons for those seeking to copy this project's success is that similar projects should also start by involving their national institutions with responsibility for plant breeding. It can be argued that only by institutionalizing PPB can the method achieve full impact. To ensure the success of such projects, especially in reaching out to a substantial number of farmers, it is also crucial that seed laws allow the necessary seed multiplication and distribution.

PPB gives farmers the opportunity to influence the development of technologies that are better adapted to their specific needs, agro-ecological environments and cultural preferences. It also provides them with the opportunity to influence decisions about how financial resources for research and agricultural extension services are used. In addition, the project makes use of the traditional knowledge of farmers and, thereby, elevates the profile of that knowledge and its holders, creating incentives to continue using and developing it. Although PPB is still not a very widespread practice, it can be structured to provide opportunities for women to contribute to the development of varieties relevant to the food chain and to enjoy the benefits of PPB. That is what the project in Syria has tried to do with its gender-sensitive approach.

Participatory processes also bring farmers into contact with professional breeders, making the farmers more aware of what science can offer them. This awareness can have an empowering effect, something that can be seen in the enhanced quality of the Syrian farmers' participation over time as they become true research partners. The farmers are involved not only in breeding activities, but also in the registration of the resulting varieties, their maintenance, seed multiplication and distribution and, as appropriate, commercialization. PPB has also strengthened the seed systems by improving production, selection and access to seeds. Along with increased yields, this is an important contribution to food security in Kherbet El Dieb and the other villages involved.

Finally, it is worth mentioning that by increasing access to better-adapted and higher-yielding varieties, PPB can contribute to ensuring the right to food. In fact, PPB is one of the recommendations of the interim report of the Special Rapporteur on the right to food, who also places special emphasis on the importance of collaborating with small-scale, women and marginal farmers (United Nations Special Rapporteur on the right to food 2010).

References

United Nations Special Rapporteur on the right to food (2010) Mission to Syria from 29 August to 7 September 2010. Office of the United Nations High Commissioner for Human Rights, Geneva, Switzerland. Available at: www.srfood.org/images/stories/pdf/officialreports/20100907_syria-mission-preliminary-conclusions_en.pdf (accessed 10 February 2011).

WFP (World Food Programme) (2011) World hunger. WFP, Rome, Italy. Available at: www.wfp.org/hunger (accessed 10 February 2011).