Decentralized-Participatory Plant Breeding

ICARDA

It is widely recognized that conventional modern agriculture and plant breeding have mostly benefited farmers in high potential environments and those who can profitably modify their environment to suit new cultivars. The poorest farmers who cannot afford to change their fields through the application of additional inputs get left behind. As a consequence, low yields, crop failures, malnutrition, poverty, and eventually famine still affect a large proportion of humanity.

Despite the green revolution hunger and poverty are still widespread

By participating in the very initial stages of breeding, when the large genetic variability created by breeders is virtually untapped, farmers are able to decide which varieties better suit their needs and conditions, without exposing the household to the risk usually associated with unknown technologies. Participatory plant breeding (PPB) exploits the potential gains of breeding for specific adaptation through decentralized selection, defined as selection in the target environment, and is the ultimate conceptual consequence of a positive interpretation of genotype x environment interactions.

Participatory Research

Farmers are involved in the development of technologies instead of only in their testing

Plant breeding is a cyclic process (Fig. 1): each year (or cropping season) a new cycle begins with new crosses, which are made using as parents material largely derived from previous cycles.

In most plant breeding programs, only a small fraction of the entire process takes place in farmers' fields (Fig. 1, left): most of the process takes place in one, or more often in several, research stations. One of the main consequences of this is that a large amount of breeding material is discarded without knowing whether it could have been useful in the real conditions of farmers' fields. The variety that is selected, is likely to perform well in environments similar to those at the research stations, and may not be as successful in the fields of the poorest farmers. We have argued that for crops grown in environments different from the research stations this often results in discarding useful breeding material.

The implementation of a truly decentralized-participatory plant breeding program requires the transfer of part of the breeding materials that are usually grown on the station to farmers' fields (see Fig. 1, right), and also transfer part of the decision-making process, usually done by the breeder, to the farmer. Therefore, decentralized-participatory plant breeding must, by necessity, involve several farmers or farmer communities.

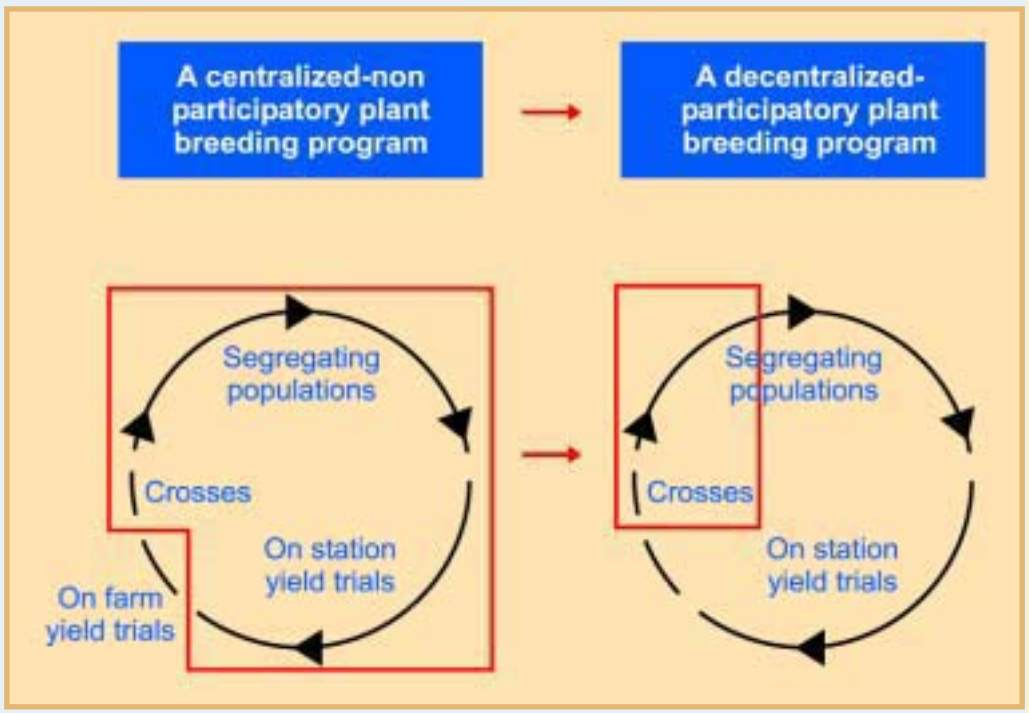


Fig. 1. Schematic representation of centralized-non participatory (left) and of decentralized-participatory (right) plant breeding. The red lines represent a research station.

The model of plant breeding we use in a number of countries is based on a bulk-pedigree method, in which crosses are done on station, where we also grow the F1 and the F2 generations. We then yield test the bulks over a period of three years in the farmers' fields (Fig. 2).

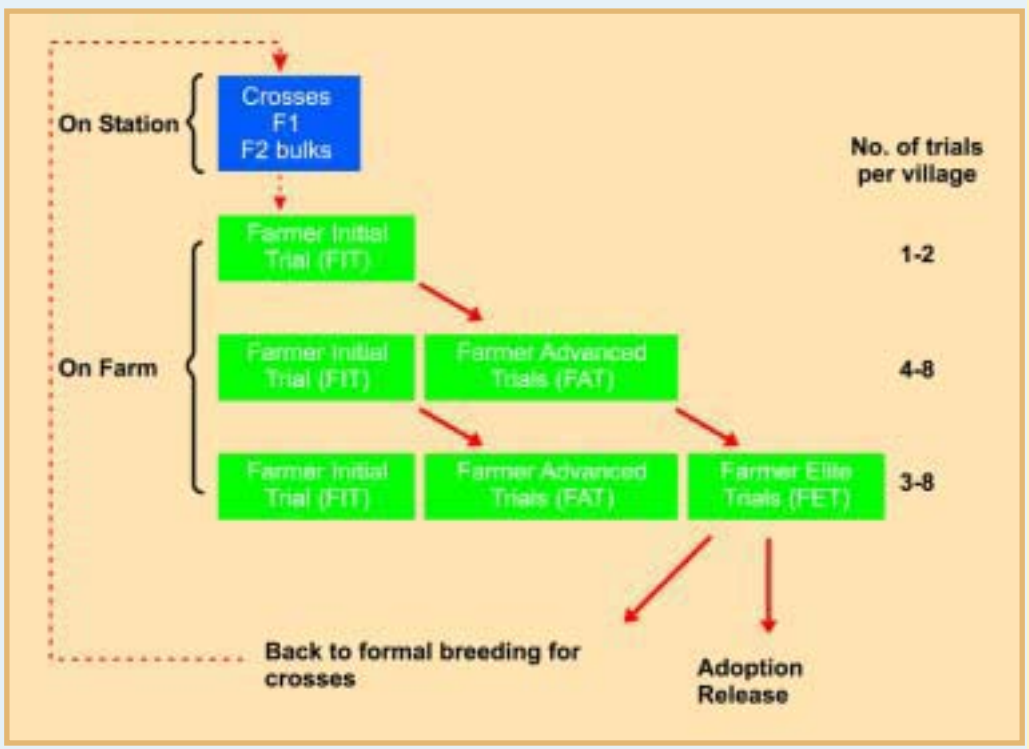


Fig. 2. Model of participatory plant breeding implemented with farmers in Syria, Jordan, Egypt, Eritrea, Yemen, Morocco and Tunisia.

The activities in farmers' fields begin with the yield testing of early segregating populations (three years after making a cross), in trials called Farmers Initial Trials (FIT), which are unreplicated trials with 200 plots of 12 m^2. These contain 170 entries, plus one or two checks repeated 30 times.

Implementing a Participatory Plant Breeding Program

Migrating a conventional program into farmers' fields and building partnership

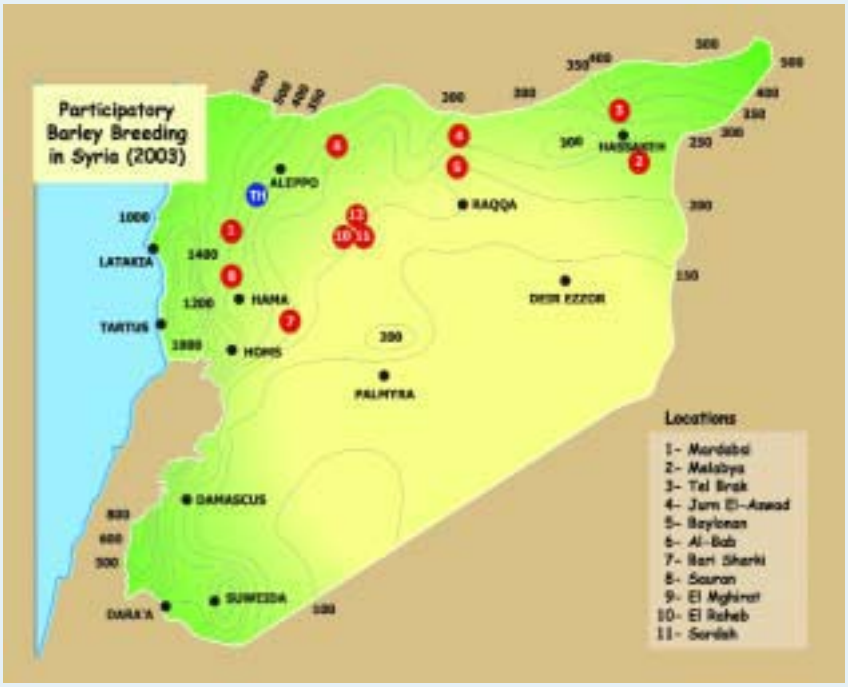
The breeding materials selected from the FIT are yield tested for a second year in the Farmer Advanced Trials (FAT) with a number of entries and checks that vary from village to village and from year to year. The FAT plot size is 45 m^2 in order to produce enough seed to plant the selected entries on larger plots in the third stage. The number of FAT in each village depends on the number of farmers willing to participate in the trial. In each village, the FAT contain the same number and type of entries. Each farmer decides the rotation, the seed rate, the soil type, the amount and the time of application of fertilizer. Therefore, the FAT are planted in a variety of conditions and managements. During selection, farmers exchange information about the agronomic management of the trials, and rely greatly on this information to select entries. Therefore, the breeding materials start to be characterized for their responses to environmental or agronomic factors at an early stage of the selection process.

Farmers' Empowerment

In participatory plant breeding farmers make the most important decision

The entries selected from the FAT are then tested in Farmer Elite Trials (FET), with a plot size twice as large as the FAT. When the three types of trials are fully implemented, a village looks like a research station (Fig. 3).

Fig. 3. A village as a research station.



By the end of 2003, the model shown in Fig. 2 was fully implemented in eight villages and starting to be implemented in another three (Fig. 4), covering most barley growing areas in Syria.
Each year we have about 100 trials and an average of 200 farmers involved in the selection process.

Fig. 4. Villages in Syria where the participatory program was fully implemented in 2002 (1 to 8), and where the program started in 2003 (9, 10, and 11). ICARDA's headquarters is shown as TH.

Biotechnology and Participatory Plant Breeding

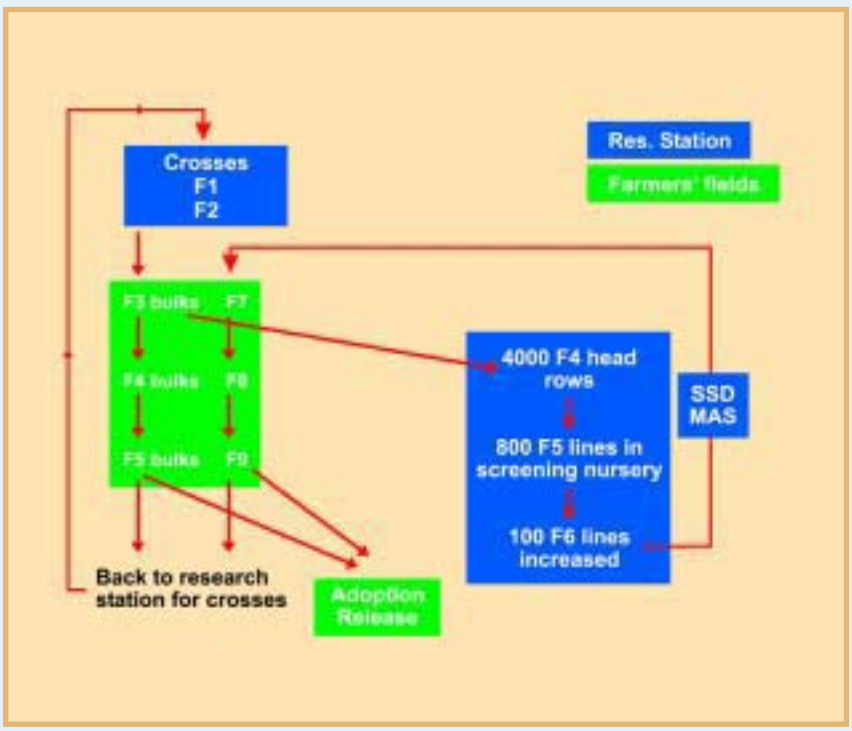


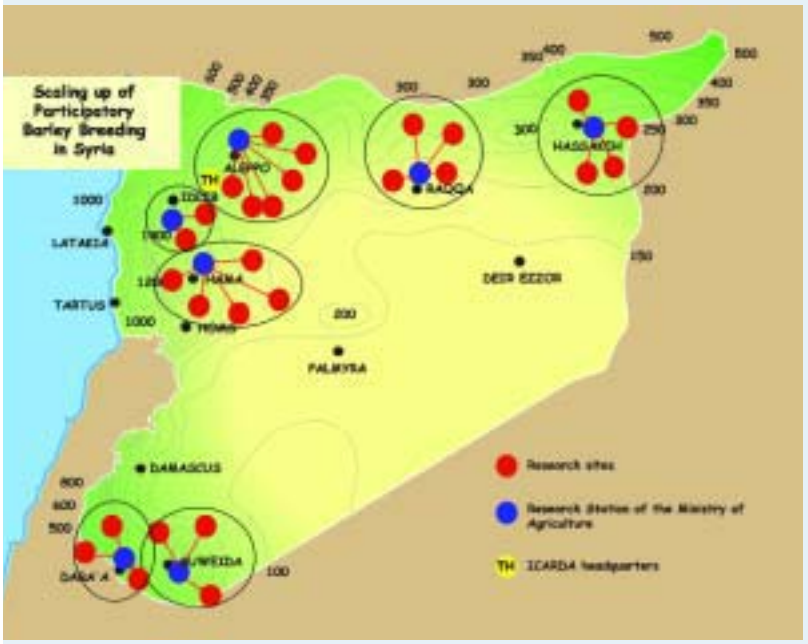
Fig. 5. Pure line selection, Single-Seed Descent (SSD) and Marker-Assisted Selection (MAS) combined with participatory plant breeding (blue, research station, green farmers' fields).

In parallel to the model shown in Fig. 2, we conduct pure line selection within the selected segregating populations (Fig. 5) by collecting heads on selected F3 bulks on station. The F4 head rows will be promoted to the F5 screening nursery only if farmers select the corresponding F4 bulks.

The process is repeated in the F5 and the resulting families, after one generation of increase, return as F7 in the yield-testing phase. Therefore, when the model is fully implemented, the breeding material which is yield tested includes new bulks as well as pure lines extracted from the best bulks of the previous cycle.

The process of pure line selection shown in Fig. 5 can be accelerated by using the same techniques used in Single-Seed Descent and Marker-Assisted Selection: this considerably increases the speed and the precision with which the desirable genotypes are produced.

The Future: Institutionalization and Scaling-Up (the Example of Syria)



Most of the work described previously is a participatory breeding program where the main players are the farmers and ICARDA scientists, with the occasional participation of the breeder of the General Commission for Scientific and Agricultural Research (GCSAR) of the Ministry of Agriculture and Agrarian Reform of the Syrian Arab Republic, and of six-seven staff members from the Extension Service.

The first step towards the institutionalization of participatory plant breeding (PPB) was the organization of a workshop, supported by the Embassy of Switzerland in Damascus. The workshop was held in Hama on February 17-18 2003 with the participation of about 20 farmers from the villages where the PPB program has been implemented, a large number of researchers, including heads of research stations and of Agricultural Offices from most provinces, the Director General and the Deputy Director General of the GCSAR, the Director General and the Deputy Director General of the General Organization for Seed Multiplication (GOSM), and the Director General and several staff members of the Extension Service.

Fig. 6. Scaling-up participatory barley breeding in Syria from 8 villages and 200 farmers to 27 villages in 7 provinces and 1000 farmers.

The workshop discussed the relationships between PPB, seed production, and variety release, and drew a plan for scaling-up participatory barley improvement with the objective of determining an impact on the barley production at the national level. The mechanism for scaling-up PPB is a gradual transfer of responsibilities from ICARDA scientists to GCSAR scientists and the staff of the Extension Service so that at the end of the process each province will implement all the various PPB activities within its boundaries, with the overall coordination shared by ICARDA and GCSAR. Therefore, one important initial component of scaling-up is an extensive training program of the GCSAR scientists and of the extension staff on all the aspects of PPB.

When the transfer of responsibilities is completed, the PPB program will be implemented in the provinces of Hassakeh, Raqqa, Aleppo, Idlib, Hama, Homs, Sweida and Deraa that together represent 95% of both the barley area and the barley production. The research and extension staff in each province will be able to work with between 15 and 30 farmers per village and handle five to seven villages (Fig. 6). Such a large network of farmers will enormously facilitate the access and large scale adoption of non-participating farmers to the products of PPB. For this to be possible, village-based seed production will play a key role.

Farmer Centered Research

We need to readdress plant breeding in such a way that farmers become the focus of developing new cultivars, including the aspects of seed production

The potential advantages of PPB, such as the speed with which new varieties reach the farmers, the increased adoption rate and the increased biodiversity within the crop due to the selection of different varieties in different areas, will not be achieved if the seed of the new varieties does not become available in sufficient amounts to all the farmer community. In many countries this is associated with, and depends on, the official recognition of the new varieties. This process called variety release, is usually the responsibility of a committee (the variety release committee) nominated by the Minister of Agriculture, which makes decisions based on a scientific report on the performance, agronomic characteristics, reaction to pests and disease, and quality characteristics of the new variety. The farmers' opinion is not requested, and therefore, there are several cases of varieties grown by farmers that were not released and of varieties that were released but never grown by any farmer. In these cases the considerable investment made in developing the new variety and in producing its seed has no benefits. It has been shown that the economic cost to farmers of releasing an inferior genotype is much less than the economic cost of not releasing a superior genotype.

Participatory plant breeding can considerably improve the efficiency of the delivery phase by considering farmers' acceptance as one of the main criteria in releasing a new variety. In this system, varieties are released only after monitoring their acceptance by farmers through an initial adoption (Fig. 7), and therefore, seed multiplication can be concentrated on varieties that farmers already know and trust.

Fig. 7. In Conventional Plant Breeding new varieties are released before knowing whether the farmers like them or not. In Participatory Plant Breeding varieties are released after the initial adoption by farmers.

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