Farmer and participatory maize breeding: increasing the autonomy of paysans

Small-scale farmers (paysans) who are engaged in organic agriculture and regional production in France are increasingly avoiding the use of commercially developed hybrid maize varieties. They are also increasingly rejecting the use of – or are prohibited from using – genetically modified maize varieties. Instead of purchasing seed each year, they are maintaining local maize varieties. Since 2001, the Association for the Development of Organic Agriculture in Périgord (AgroBio Périgord) has been collecting and testing local maize varieties from France and other countries in its diversity platform. AgroBio Périgord has established a seed bank, Maison de la Semence Paysanne, for maintaining and providing farmers with access to local varieties. The Maison de la Semence Paysanne forms the basis for work related to the community management of biodiversity in France; it is described in more detail by Kendall and Gras in Chapter 1.7.

One of the key motivations for farmers to use local maize varieties is their desire to rebuild their autonomy. They manage their maize varieties in a dynamic manner and even conduct some breeding and selection activities, facilitating cross-pollination that is inherent to maize. The diversity platform has been instrumental in motivating farmers to get involved in breeding activities, and to adapt scientific breeding techniques to their own capabilities and resources. In this way, farmers contribute to the management of maize diversity in France, while increasing their autonomy by using their own varieties. In the current chapter, we share some of our experiences working with farmers on participatory maize breeding.

Seed multiplication for the Maison de la Semence Paysanne

Farmer members of the Maison de la Semence Paysanne are vital for maintaining and disseminating seed; their contribution is described by Kendall and Gras in Figure 1.7.4. Farmers produce seed of acquired varieties in on-farm multiplication blocks, using appropriate isolation in space and time, and an agreed selection protocol. These blocks cover an area of about 0.1–0.2 hectares. The seed of varieties of interest are maintained for use, with surplus seed being sent to any new farmers who want to
participate the following year, or being returned for storage. When we receive interesting varieties that are not well adapted to our production environments, we regenerate them through on-farm conservation blocks. However, since the purpose of regeneration is to conserve varieties and prevent their loss, the plots are small in size. Only a few farmers are willing to host such conservation blocks because they require isolation, monitoring and special care. The varieties are regenerated through controlled pollination in conservation blocks in the diversity platform. This is a procedure that we would prefer to avoid, but we are constrained for want of a better alternative.

**Dynamic management, farmer breeding and participatory maize breeding**

AgroBio Périgord and its members are currently engaged in several variations of farmer breeding and the participatory breeding of maize. Farmer breeding involves dynamic management in which farmers maintain and improve their local maize varieties. In this chapter, we look at participatory maize breeding activities that are being implemented in collaboration with Guy Thiebaut, who is a professional breeder. All the activities are conducted by farmers, in farmers’ fields. An important motivation for our breeding activities is that we want to show that farmers can become independent from the commercial breeding companies who offer only limited choices of hybrid and genetically modified maize varieties. Such varieties are not well adapted to our (organic) production system, and genetically modified organisms (GMOs) are simply not allowed and not appreciated in organic agriculture. We focus our dynamic management and breeding activities on practicality and on an increase in diversity and autonomy. Here, we summarize our experience with the four methods used for dynamic management, farmer breeding and participatory maize breeding.

**Method 1: Farmers’ dynamic management of local varieties**

Farmers use several variations of mass selection in the maintenance and selection of their varieties. Most commonly, they use positive mass selection, thus selecting better performing plants for seed production. In some cases, they use negative mass selection, thus detasselling plants before flowering. Each farmer conducts selection using his or her own perception of what the local variety constitutes.

**Method 2: Farmers’ management of composite varieties**

Some farmers take an additional step in selection; they create composite varieties from a mixture of different, open-pollinated populations that often include several local varieties, but which may also include improved varieties. The idea is to increase genetic diversity and to combine different characteristics of the chosen varieties. These composite varieties can be the result of crossing just two different varieties, or they can be the product of crosses between more than 15 varieties. Farmers create their own composite varieties according to their own personal objectives and preferences. One farmer, Bernard Andissac, for example, created the composite variety Andico, by crossing the early-maturing French local white maize variety, Blanc de
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Bresse, with a late-maturing South American blue maize variety. His goal was to make the blue variety mature earlier by crossing it with the white variety. In another example, farmer Bertrand Lassaigne created the variety called Lavergne. He carried out crosses between more than 15 different varieties chosen to create a new composite variety that would be well adapted to the conditions at his farm.

Every year the farmers continue to use mass selection in their composite varieties for seed production. Several varieties used today by farmers associated with AgroBio Périgord have been grown in this manner for up to ten years. Experiments carried out at the diversity platform and in farmers’ field conditions have shown that these composite varieties have valuable characteristics.

In dynamic management, as applicable to methods 1 and 2, composite varieties originating from the same source and accessed through the Maison de la Semence Paysanne become distinct composites that are adapted to different locations and farmers’ preferences. As illustrated in Figure 1.7.4, these varieties may be returned to the Maison de la Semence Paysanne and then included in the diversity platform for comparison. If they prove interesting, they can be included on a more permanent basis in the Maison de la Semence Paysanne for wider distribution. The network of farmers, in combination with the diversity platform and the Maison de la Semence Paysanne, contributes to the dynamic management of local maize varieties at a national level beyond that of individual farmers.

Method 3: ‘Brazilian selection method’

Since 2008, we have been introducing members of our network to a particular method for developing composite maize varieties. A Brazilian agricultural technician, Adriano Canci, inspired us with the method during an exchange visit, which is why we refer to it as the ‘Brazilian selection method’. Canci et al. (Chapter 1.5) and Ogliari et al. (Chapter 5.7) provide further details on some of the work in Brazil that inspired us to apply their methodology to the participatory enhancement of a local maize variety.

The purpose of the method is to develop a composite variety in a relatively short time. We learned that the Brazilian method takes 3–4 years to create a homogeneous population. An important advantage is that it is relatively straightforward and can be easily implemented by individual farmers to develop their own well-adapted composites. The method is particularly interesting for AgroBio Périgord because it can be used to develop composites adapted to organic production.

The method can be summarized as follows. In the first year, we select, for example, ten populations. From each, we take 300 seeds, using 150 as ‘mother’ plants and 150 as ‘father plants’, providing pollen. During harvesting, we collect cobs from the 24 best female plants of each of the populations. In the second year, 13 seeds from each of the 24 cobs are planted to maintain the composite. One hundred and fifty seeds from each of the selected 24 cobs are planted to be mother plants, while another 150 seeds are planted to contribute pollen for the pollination mixture. During the following harvest, 24 plants are selected and subsequently multiplied for another two years using the same procedure. In the fifth year, we start to apply cycles for stratified mass selection to reduce the variation for some traits in the newly created composite.
Bertrand Lassaigne began to apply the Brazilian selection method in 2010, using some of his own composites that he had been developing since 2001, and including some productive but late-maturing Brazilian varieties. For each late-maturing Brazilian variety, he included two early-maturing local ones. He further added varieties with an intermediary cycle that served as a ‘genetic bridge’, bringing the total number to 25 varieties. Another farmer from Périgord, Didier Margouti, also began to create his own variety in 2010, developing 12 different varieties with this method. Guy Thiebaut began a similar breeding programme in 2009 at his farm, including 12 varieties, of which ten were local varieties from Périgord. Today, several farmers are interested in this method. In 2012, three new farmers in other regions of France began to use the Brazilian selection method. Testing of the first new composite varieties created with this method will start in 2013 in farmers’ fields and at the diversity platform.

Method 4: Development of hybrids based on local varieties

AgroBio Périgord has been implementing a breeding programme, in collaboration with Guy Thiebaut, since 2001, aimed at developing maize hybrids based on local French varieties. The idea was to combine their distinct qualities, and explore how to increase their yield potential, while aiming to adapt them to organic production systems and the agro-climatic conditions of south-western France. In Figure 5.4.1, we visualize this complex procedure for the development of the hybrid maize variety as implemented by AgroBio Périgord and its member farmers.

In 2001, we selected 12 individual plants from five local French varieties, planting the seed of each selected cob in individual rows in two sites. The five best half-sib families of each variety were selected based on yield potential, plant vigour, disease resistance and drought tolerance. Instead of self-pollination, we conducted pollination between half-sib plants, developing what we refer to as inbred families. We selected the 11 most vigorous plants within each inbred family, planting the seed of five plants for self-pollination and six for pollination between full-sib plants. In the subsequent year, we only used self-pollination to create the full-sib families that were included in the following year in tests for ‘combining ability’, for which we used isolated areas to avoid contamination. Four farmers agreed to set up such genetic islands. Each block contained six inbred families that were used as male parental plants, and 12 inbred families used as female parental plants. The female inbred family plants were pollinated with mixed pollen from several plants of one male inbred family; this made one cross. We were able to make 200 crosses between the inbred families, which gave 200 F₁ progenies. We planted these progenies in an 8 m row without repetitions, and used commercial hybrids as control. An initial group of progenies were eliminated based on their visual appearance (e.g. limited vigour, agronomic performance). We selected 50% of the remaining F₁ progenies based on visual observations of their production potential. The selected progenies were included in another trial with two repetitions for extensive agronomic evaluation. A progeny with the code B53, originating from a cross between inbred families, based on Grand Cachalut × Ruffec, proved to be outstanding. In 2007, seed for the hybrid B53 was produced, while the remaining seed was used in more trials to evaluate their production potential. In 2008, we evaluated a number of variants of B53 and they confirmed the potential of this hybrid.
Figure 5.4.1 Procedure as used by AgroBio Périgord and its member farmers for developing a hybrid maize variety based on local varieties.

Since 2009, the hybrid programme has taken another direction, following the demands of farmers. We began to test the descendants of B53 in order to evaluate how they evolve through dynamic farmer management.

**Reflections on different farmer and participatory breeding methods**

In 2009, the farmers who were engaged in hybrid breeding mobilized themselves to finalize the development of the hybrid B53. We were ready to establish a group of farmers who would collectively maintain inbred families, produce B53 seed on a large scale and continue with testing other hybrids. However, parallel to our work in producing the hybrid, the Brazilian farmer selection method had begun to bear fruit. More and more farmers have been adopting this method to improve their local maize varieties as it is less complex, allows individual farmers more freedom, and promotes autonomy in varietal development and seed production. It became clear that our hybrids would require a more sophisticated organization of farmers, and technically complex procedures for maintenance and multiplication. Although we were prepared to engage in the development of hybrids, we realized that this would lead to an increase in dependency among farmers, instead of the envisaged autonomy. In addition, results concerning the production capacity of the B53 hybrid were not convincing enough when we evaluated them. We also considered that the seed production of this hybrid variety would mean engaging in a technically complex process. Moreover, farmers and the network would have to invest much time and resources in producing seed of this hybrid variety.

The Brazilian method allows for a wider use of diversity, which is one of our key goals. Farmers lost their enthusiasm for continuing with the hybrids and we decided to continue trying to develop a composite local population using the proven interesting combination of Grand Cachalut and Ruffec. By focusing on the development of a composite local population, we could tackle the issue of dependency associated with the hybrid approach.

**Farmer breeding, maize diversity and autonomy**

We have learned many lessons from our work in farmer and participatory maize breeding. We realized that there is room for farmers to use their own creativity in managing local maize varieties, and in maintaining and developing their own varieties. As in many other parts of the world, where small-scale farmers are interested in keeping their autonomy and in operating independently from large-scale seed companies, many small-scale farmers in France maintain and develop their own varieties. Small-scale farmer colleagues in Brazil, Guatemala and in many other countries inspired us to follow similar pathways. We have seen that an increasing number of farmers who produce maize in organic farming and for regional production, but also those who opt to use their local varieties within conventional farming, engage in the dynamic management of local maize varieties.

The diversity platform and Maison de la Semence Paysanne have been instrumental in sharing knowledge and materials, and in motivating farmers to experiment with
several breeding methods, varying from simple mass selection to more sophisticated methods of developing hybrid varieties. What we have learned is that in farmer and participatory maize breeding we promote the use of diversity, strengthen farmers’ capabilities in dynamic management, and guarantee their autonomy in management and selection. We may seek sophistication in, for example, developing hybrids, but the process of producing seed of hybrid varieties bypasses one of the key pillars of the farmers’ management of maize diversity (i.e. the farmers’ autonomy in managing their diversity within the specific conditions of their farms and according to their specific preferences). A key lesson to be shared with others in similar situations is that we need to cherish autonomy and, more importantly, the skills and enthusiasm of farmers for maintaining and using diversity.

Note

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