Key elements for collaborative breeding models for organic markets in Europe

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Introduction

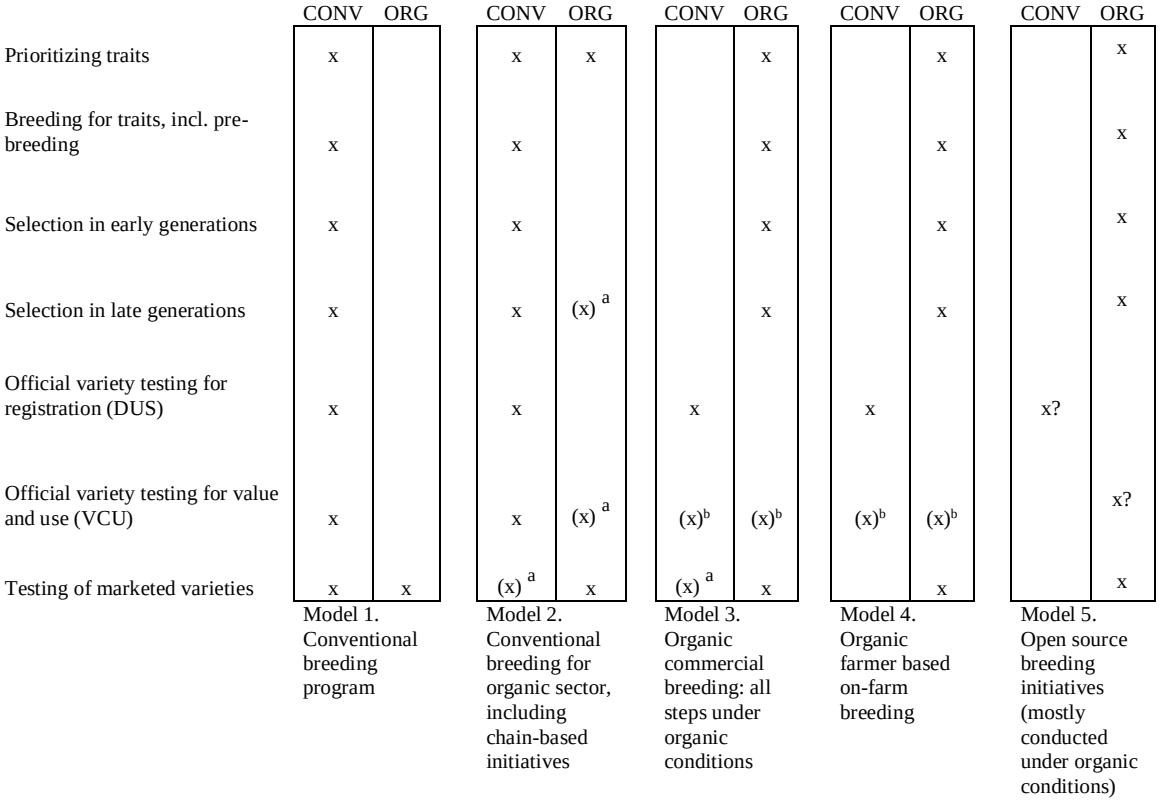
The organization of commercial breeding differs across Europe. In a country such as the Netherlands there are numerous seed and breeding companies oriented at the conventional market, while in other countries such as Italy, not much commercial breeding activity exists. Similarly, in the Netherlands organic farmers use modern varieties, while in countries such as Italy a combination of modern varieties and landraces are available. Differences breeding activity and variety use results in different ideas about breeding for organic agriculture in different countries. The majority of the current available improved varieties for organic farmers come from conventional breeding programs, see Figure 1, Model 1. Although quite a number of commercial breeders produce organic seed for part of their existing variety assortment, not many of these companies are adapting their breeding for new varieties better suited for the organic market (see Figure 1, Model 2). Some other breeding companies have clearly declared not willing to be involved in organic seed production at all as it does not fit in their chemical-based business model. So there are important gaps in the seed portfolio for organic farmers such as late blight resistant potato cultivars, wheat varieties with good weed suppression and good baking quality under low nitrogen input levels, and protoplast fusion (cms)-free brassica varieties etc. A future challenge is the further development of GM-based techniques that are acceptable for conventional farming, but not for organic farming.

For commercial conventional breeding companies the (as yet) limited scale of organic agriculture is a significant bottleneck for investing in breeding programs aimed specifically at organic production systems. After all, they have to recover their investment costs through the sale of seeds, and this requires a minimum sales level for each crop. Another issue is the financial threshold for cost-effective breeding which continues to rise. The result is a vicious circle that is not easy to break. This is not only a problem for the organic sector, but increasingly also for minor crops within the conventional sector. Besides, diversity in food crops is decreasing (Khoury et al., 2014), and this has also an effect on the diversity of breeding programs.
Due to such developments worldwide, increasingly more crops are becoming ‘too small’ for commercial breeding. For many grain legumes, breeding programs were cut back decades ago. And among vegetables, breeding programs for many minor crops such as black salsify and parsnip are gradually being abandoned. The same dynamic is visible for arable crops. For example, oats is nowadays considered unprofitable by some commercial breeding companies. The long-term consequence is that the production of these crops will become increasingly difficult, because the available varieties will not be adapted to future changes in the cultivation and value chain system (new methods, new diseases, new consumer demands, etc).

Approach

The Louis Bolk Institute (LBI) has been developing various innovative approaches to funding and organizing crop breeding for organic farming over the past 15 years, initiating collaborative breeding programs that are based on a multi-actor approach. Each of these initiatives is tailored to the specific structure of the value-chain in question, and thus cannot easily be ‘translated’ to other crops. To facilitate this ‘translation’, we have compared and analyzed several case studies and identified various key elements that are crucial for the

success of such initiatives (Nuijten et al., 2014). In the context of urgent needs to fill gaps in the availability of better adapted varieties for the organic agriculture, the question we elaborated is to understand how to stimulate the development of alternative crop breeding models, taking into account not only the technical aspects but also the financial and socio-economic aspects? In particular, we explored options for establishing closer chain-based collaboration with breeding companies and setting up farmer-based breeding initiatives in the Netherlands. Based on these projects, we provide a synthesis of various options in this paper.



Note: a = in some occasions; b = in some occasions the farmer will try to register his variety for marketing purposes and will follow the VCU testing if possible under organic conditions.

Figure 1. Different breeding models to achieve varieties for the organic sector.

Results and Discussion

The various options vary from conventional breeding for organic agriculture to organic breeding from within the sector (Figure 1). Model 1 is the status as described in the introduction: Only after variety registration, breeders consider the suitability of their varieties for organic farming. In this section we describe some aspects of four alternative models (Figure 1).

Closer collaboration with conventional breeders

How can current breeding programs become more beneficial to the organic sector? When it comes to closer collaboration with conventional breeders, several aspects need consideration.

Re-thinking the prioritization of plant traits

The prioritization of crop variety traits is often not the same for organic versus conventional production. As a first step, existing breeding programs could give more priority to traits that are important for organic production, such as growth vigor, nitrogen use efficiency and resistance against multiple diseases. This could lead to different choices regarding parent lines

and selection at an early and later stage of the program. Such a breeding program can be called: breeding for organic agriculture as not all steps will or need to be conducted under organic management, see Model 2. An example is a cereal breeding company in Austria combining conventional and organic selection procedures (see Löschenberger et al., 2008). But it can also lead to forming a consortium of chain actors that take care of organizing and funding the costs of a breeding program and searching for a breeder to step into this concept. LBI is involved in initiating steps towards such a chain-based breeding program for spring wheat involving organic farmers, bakers, seed traders, regional retailers and interested breeders.

Changing the organization of selection programs
Existing (conventional) breeding strategies could be adjusted, for example by involving growers in pre-screening potential varieties before they are send in for registration or have dropped out as not being interesting for the conventional market. In various projects organic growers indicated that they would be very interested to accommodate such trials. Breeding companies are also realizing that they could gain from grower participation, and that it offers opportunities for future sales. But they must make the first move, and adjust their policies.

Improving communication
Communication between larger breeding companies and growers about potential improvements of varieties is often done through sales representatives. As a result, subtle yet essential information on desired and possible (innovative) crop improvements, particularly in relation to organic production, does not reach the breeders themselves. Shorter communication lines are therefore needed. Opportunities to improve communication are farm-based trials where the breeder invites farmers for joined evaluation.

Involving other chain players
It is important that such initiatives are taken within the food chain as what is logical for farmers and breeders is not always logical for traders and retailers. This is especially the case with renewing varieties for those crop species that are sold under their variety names such as apple, grapevine and potato. For instance, in the European project CO-FREE and the organic potato breeding program Bioimpuls we experienced that in a specialized value chain a lot of information gets lost between the parts of the value chain, and that it can be very important to involve retailers to understand the need of farmers to use late blight resistant varieties for yield stability and to avoid the use of copper as ‘organic’ fungicide. But this information is not always useful or attractive to consumers and various ways for successful variety market introduction have been developed, e.g. to avoid variety names and grouping apples in flavor groups allowing frequent variety replacements (Nuijten et al., 2015).

Key elements for successful chain based collaboration with breeding companies
The following key elements to a successful collaboration of chain partners in breeding programs have been identified, see Box 1. Together these key elements determine the possibilities for new models of plant breeding. These possibilities vary between crops and sectors. The historical context and institutional organization of plant breeding differs significantly among crops and sectors. In the Netherlands, potato growers have always been directly involved in selection and breeding (Almekinders et al, 2014). This has been the base for setting up the Bioimpuls organic potato breeding program in the Netherlands as a collaboration between organic farmer-breeders and conventional breeding and seed potato trade companies, see www.louisbolk.nl/bioimpuls. The organic farmers are involved to select in early generations for late blight resistant clones. In spring wheat, however, crop production

and crop improvement are entirely separate activities and it requires more effort to involve farmers in selection of lines which can be done in later stages of the breeding program. Compared to wheat and potato breeding, vegetable (hybrid) breeding is more competitive, and therefore more often takes place 'behind closed doors' (Nuijten et al., 2014).

Box 1. Key elements for successful chain based collaboration with breeding companies

- All food chain partners must feel ownership of the problem.
  - In general, the greater the economic importance of the crop, the sooner the problem is collectively recognized and prioritized.
  - The larger the market, the sooner a breeding initiative becomes financially feasible.
- Complexity of the food chain.
  - The more players with different business cultures, the more difficult it is to get everyone committed to a common goal.
  - Collaboration has to be initiated within the food chain.
  - At the start, a (neutral) facilitator is needed who recognizes and balances the different interests of all parties involved.
- Crop specific traits play an important role.
  - In some crops it is easier to select for certain traits than in other crops.
  - Growers can have a larger role in crop improvement of vegetative propagated crops and open-pollinated varieties, than in the improvement of F1-hybrids.
  - Quite a few vegetable crops are biennial, leading to longer breeding time lines.
- New forms of collaboration deserve policy support.
  - Crop-specific study groups can be crucial to bring together different players (breeders, growers, traders) and to identify the key elements for successful collaboration.

Setting up organic breeding companies

In a time when many commercial breeding companies are merging or being bought up, the start-up of new, specialized organic companies is certainly noteworthy. A few young specialized organic seed companies in Europe are particularly worth mentioning: Bingerheimer Saatgut AG in collaboration with the Kultursaat (biodynamic breeders) Foundation in Germany, Sativa in Switzerland and De Bolster in the Netherlands. Each of these companies has a specific history and view how to develop further in the future. What they share is that it is crucial to be attuned to the needs of the sector and be a trusted partner in the market chain. Therefore they work closely together with growers, for example in on-farm trials to test and demonstrate promising new varieties. In Figure 1 that is indicated as a commercial organic breeding company conducting all steps under organic conditions (Model 3).

Farmer-based breeding

There are also crops for which none of the abovementioned options offers a solution; for example when marketing perspectives are not sufficiently positive in the short term. To cover the various needs of the organic farming sector and provide a portfolio of regional adapted varieties and crops, a larger number of breeders have to be involved. Some farmers initiate their own breeding to cover the need of their farm or beyond (Model 4). They do this for a range of reasons. Some farmers think it is very important to have adapted varieties, developed on the principles of organic farming. Enthusiasm and passion for their crop is seen with many farmer-breeders involved in potato selection, Financial motives often do not play a role. Often, such farmers are working on their own. Some have a good understanding of genetics and the principles of plant breeding, while many do not. At this stage farmer breeding lacks continuity. Farmer-based breeding can be strengthened in several ways. One aspect is access

to knowledge about breeding. This can be achieved through crop breeding courses for growers as is realized for potato breeding in the Netherlands. Another aspect is connecting individual farmer-breeders, through cooperatives. A fruitful example is Kultursaat e.V. in Germany, which is a collaborative association of farmer-breeders. To form and maintain such associations requires a common objective and vision. These forms of collaboration are most suited for breeding of vegetative propagated crops and open-pollinated varieties. The collaboration of Kultursaat with Bingenheimer Saatgut is an example of how new varieties developed by farmer breeders can be put on the market. An alternative is to foster collaboration with existing breeding companies, as is the case in potato in the Netherlands.

Other alternatives: open source breeding

However, Also alternative strategies are being developed based on the idea of considering seed as common good, such as open-source breeding (see Figure 1, Model 5). The underlying idea is that seed needs to be considered a common heritage. It is a reaction to current developments in commercial plant breeding leading to a further monopolization of genetic resources (e.g. patents). Seeds as a common heritage may provide interesting points of view. Even commercial plant breeders agree that they cannot work without access to a broad gene pool. The concept of open source breeding, however, requires further elaboration.

Conclusions

To serve the organic market with an appropriate assortment of varieties is quite a challenge, not only in the technical sense but also making it feasible at the financial and organizational level. It is important not only to involve farmers and breeder-researchers but also other actors in the value chain to arrive at varieties suited for organic farming, processing and accepted by consumers. Approaches can differ per crop species. Ensuring continuity of breeding trajectories needs more attention to ensure progress in breeding for organic agriculture..

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