Towards a more community oriented and chain-based breeding
Understanding underlying principles for successful new models

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Summary: New breeding approaches and organisational models are needed to stimulate breeding for organic agriculture. In order to achieve this, new concepts are needed. We propose a new analytical framework based on two axes: the level of diversity in breeding products and the level of access in the breeding model. This model combines ecological and socio-economic of breeding. With this framework, it is possible to understand the success of particular initiatives, and to understand what technical breeding approaches can be combined with which organisational models Such framework will also help understand how to stimulate the development of more community oriented and chain based breeding models.

Background

Various initiatives exist to develop new breeding approaches and models for organic and low input agriculture, often outside the formal sector, sometimes partly with the formal seed sector, and even from within the formal sector. For example, some initiatives focus to have more diversity within varieties, others to develop populations instead of varieties, to stimulate the use of traditional varieties (landraces), to stimulate collaborative approaches, to involve other chain partners in breeding, to integrate the use of molecular markers in breeding, or in extreme cases to argue that GM methods have benefits for organic agriculture. These initiatives each have different approaches and assumptions. Sometimes, certain approaches seem contradictory or even incompatible with each other. And some are more successful than others. To better understand how to move forward and identify solution pathways, we need to realise that solution pathways often depart from different underlying ecological principles and socio-cultural values. Breeding is not only a technical act, but also a socio-economic activity embedded in culture. Hence, most problems related with breeding have technical, ecological, socio-economic and cultural aspects. And as different groups in society have different opinions on what exactly is the problem and what knowledge is available or not, and what norms and values to meet, many problems are so-called 'messy' problems (see Hisschemöller and Hoppe 2001). In order to better understand possible solution pathways, and to provide potential bridges between initiatives and to see how they complement each other, we need to disentangle messy problems associated with organic breeding developments.

Conceptual frameworks

Often, solution pathways are embedded in particular types of culture. Culture can be understood as a rather fixed or solidified set of norms, values and principles, which is the result of social dynamics within communities. Over time culture may change based on processes within communities and through outside influences. To an extent culture determines the glasses we use to view the world around us and to look for solutions. Our cultural glasses shape our view of nature, the agricultural landscape (the ecological aspects), and also our perception of risk and risk management (socio-economic aspects). Cultural theory identifies four basic forms of social organisation, or solidarity: hierarchism, individualism, egalitarianism and fatalism / isolationism (Maat 2001, Thompson et al. 1999). Fatalism is more commonly used in cultural theory studies, but isolationism may be more informative in our study. These four basic forms are based on a combination of two basic forces: the measure of regulation (grid) and the measure of social involvement (group). With each basic form of social organisation goes a different thought style, a different morality and a different way of perceiving risks and ecology (Maat, 2001). In terms of risk management, solutions typical for hierarchism are insurances and alike, while solutions typical for egalitarianism are often diversification and alike. For example, breeding solutions that aim for diversification (in crops, in varieties, through populations, typically can be considered to have an egalitarian element, breeding approaches that aim to improve particular traits can be considered to have an hierarchical element, while high-tech high-cost approaches could have an individualistic element. Cultural theory is also useful to better understand why certain technology pathways are part of the so-called dominant socio-technical regimes or belong to niche innovations (Geels and Schot 2007). With this information, we can better decide whether it is possible to link certain initiatives, how to stimulate particular initiatives, and why certain initiatives are more worthwhile supporting than others.

Common underlying principles for new chain based breeding models

These different styles of thought shape solution pathways in breeding. Worldwide, within the so-called dominant (socio-technical regime, more and more emphasis is put in (single) trait breeding (with molecular tools etc), while for organic and low input agriculture more holistic breeding approaches are needed. An example of trait breeding is that conventional breeders often work with monogenic disease resistance, Another example is that breeding research

projects, although departing from a holistic context such as need for nutrient use efficient (NUE) varieties, focus on single relationships such as root architecture and its relation to NUE. These are examples of a view in which plants can be subdivided into traits, and that particular traits can be improved and that with an improved plant a farming system can be improved. If a particular crop cannot be improved, it may be replaced with another crop. In an extreme case, a particular farming system may be considered obsolete, as it no longer economically viable. This is not considered a problem as the forces of a free market are at work. A farming system can be considered a set of building blocks in which blocks can be easily replaced with other blocks.

However, a perspective typical for organic agriculture is that a crop can have multiple functions, and that relationships in a farming system are very complex. For example, organic agriculture requires not only varieties that are adapted to low-input farming systems but also requires varieties that allow such systems them to work. This means that varieties should be able to contribute to resilience, e.g. in such a way that grass varieties not only have enough roots to exploit larger soil volumes for higher and more stable yields but that such varieties also contribute with more roots to the long-term building up of soil fertility and water holding capacity by delivering organic matter with their root biomass to increase soil organic matter. Another example is the straw length of cereal crops which modern breeding has eliminated to enhance harvest index. However, organic farming systems need long straw for compost making and needs straw length for soil shading to supress weeds. In other words: crops have multiple functions to support farming systems, and a systems approach is needed to breed different varieties adapted to specific farming systems.

The underlying principles of trait breeding are also visible in the way conventional breeding companies invest in breeding: to breed in particular crops enough return of investment is needed. As the costs of breeding have increased rapidly, and continue to increase, more crops become uneconomical to breed in, and at a certain stage become, or already have become uninteresting, for farmers for cultivation. However, for organic agriculture, crops have multiple functions, and hence crops cannot be so easily discarded, e.g. small crops like endive, spring wheat, oats or leguminous crops. To maintain breeding for such crops alternative organizational and/or financial models are needed. As each crop has different ecological, socio-economic and cultural roles in a farming system, different models are needed. When following a chain based breeding model the following key-elements need to be addressed: ownership of the problem, complexity of the market chain, crop specific traits and the level of policy support needed (Nuijten et al. 2012). For example, club varieties of apple and tomato are examples of chain based breeding, in which various chain partners contribute to the breeding, financially and/or through information. The extent of openness may vary between cases. A different approach is the organizational model of Kultuursaat, where a group of farmers are breeders of new varieties. Such approach can be considered community based breeding. Such approach may also be feasible for community supported agriculture, where also consumers are actively involved. It is important to realize that for each crop, the key-elements are interrelated in different ways. The possibility of using particular technical breeding approaches (OP varieties, populations, F1-hybrids) and organizational models depends on the interests of the various players in a food chain or community.

Future development or research steps

A better balance is needed in technical breeding approaches and organisational breeding models. Pluriformity is important for a viable agriculture, and hence pluriformity is needed in breeding. More attention is needed for community oriented and chain-based breeding models. We propose a conceptual framework as a first step to understand how and which technical breeding approaches can be combined with which organisational models. In this model the breeding approaches can be put along an x-axis describing the level of diversity in the breeding products (from clones and pure lines to composite cross populations) and the organisational models along the y-axis describing the level of ownership (from patents to open source) of the new breeding products. The potential use of various breeding approaches (OP varieties, population breeding) in combination with different models can be better understood by describing various key-elements as outlined by Nuijten et al. (2012). These key-elements may also be useful to understand what new alternatives, e.g. farmer based breeding initiatives are viable for which crops. A further understanding and description of thought styles of different initiatives helps us to identify barriers and bridges to better integrate different breeding approaches.

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