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PARTICIPATORY PROCESSES OF AGROECOLOGICAL INNOVATION IN ORGANIC CEREAL BREEDING: A CASE STUDY FROM ITALY

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Abstract

The growing interest towards organic and low input agriculture in Europe has highlighted the lack of cereal breeds suitable for these farming systems and their markets. To overcome this problem, new approaches to cereal breeding have been proposed, known as Participatory Varietal Selection and Participatory Plant Breeding. Based on the adoption of cereal's landraces and old varieties, these methods involve farmers, researchers and food processors with a participatory method. In this article we analyse the reasons and the implications of this approach, interpreting it as a case of open innovation, allowing access to, absorption and exploitation of external knowledge, with liberation of expertise for other members of the cereal supply chain. Emphasis is given to the important social signalling value and the general implications of this practice: the democratisation of the food system. Another consequence of this approach is the establishment of new organizational structures of innovation processes in agriculture, which can also be applied to other breeding methods. The next step could be the inclusion of consumers into the cereal breeding practice, in order to include their preferences and customs right from the beginning of the process. The article is completed by a case study of an organic cereal farm in Italy, part of the European project SOLIBAM, which is aimed at developing new strategies for organic and low-input integrated breeding. The case study is analysed within the framework of AE and open innovation paradigms, in order to understand participatory breeding practices and the consequences of their diffusion.
Keywords: plant breeding, organic cereals, agroecology, participatory approach, open innovation.

Introduction

Italy is an important producer of organic products and the fourth most important market in Europe (SINAB, 2012), but still the availability of organic seeds is not sufficient for many important crops and there are not enough varieties available; although organic agriculture (OA) is well established in most European countries, only little attention has been given to breeding programs specific for organic farming systems. The cropping conditions of OA require varieties especially selected, capable to compete with weeds, to resist to pest and diseases as well as to difficult climate conditions, and to develop an expanded root system. Moreover, varieties for OA should have a broad range of environmental adaptability, to cope with the large variability of environmental conditions (Wolfe M.S. et al., 2008); in fact modern plant breeds have been selected for a broad geographical adaptability, which is exactly the contrary of what peasants did for millennia (Ceccarelli, 2009). The limited availability of organic seeds and the lack of breeding programs specifically aimed at satisfying the needs of OA, has recently stimulated new projects to support public research in this sector. The European project SOLIBAM - acronym for "*Strategies for organic and Low Input Integrated Breeding and Management*" - aims at developing new approaches to plant breeding and to cropping systems, in order to increase quality, sustainability and reliability of organic and low input productions, both in Europe and in Sub-Saharan Africa. In Work Package 6 (*Participatory Plant Breeding* (PPB) *and Management*) specific strategies for participative research in plant breeding are developed. As suggested by Wolfe M.S. et al. (2008),

the need to select for particular adaptability in target environments can receive a positive contribution from decentralized breeding with farmer participation and the use of crops buffered by variety mixtures or populations. In all breeding programs we can find four common phases: 1) generating genetic variability through crosses, mutations or the introduction of exotic germplasm; 2) selecting the best genetic material out of all the genetic variability obtained; 3) evaluating and comparing the selected lines with the existing cultivars, in trials that can take place in experimental fields or on farm. While in conventional breeding all the decisions are taken by the team of scientists, in PPB programs the end-users are involved in the decision making process as soon as possible, generally from the second phase. PPB can be thus defined as a process with the involvement of several partners (framers, traders, consumers, breeders, researchers) from the early stages of breeding programs, taking full advantage of the complementarity of skills and knowledge from each partner (Wolfe et al., 2008). The main features of PPB, compared to conventional breeding, are: a) experimental trials are carried out on farms and are managed by farmers; b) farmers participate equally with breeders to the process of selection; c) the process may be repeated in an independent way in a large number of countries and areas, with different methods depending on the crop and the country (Ceccarelli, 2009). PPB has been applied until now in marginal and disadvantaged environments of Developing Countries. OA in Europe often occurs in marginal environments (Bishaw & Turner, 2007), and the limits of conventional breeding have become increasingly evident; this led to a growing interest for PPB also in Europe, where a pilot project was started in 2001 by INRA in Montpellier, France (Desclaux, 2005). Moreover, due to recognition of the negative externalities of CA (both for the environment and human health), and of the new challenges for the future (food security issues, biodiversity protection, climate change, etc.), there has been also an increasing interest in new agricultural paradigms, like agroecology (AE). Olivier De Schutter, the UN Special Rapporteur for the rights on food, suggested AE as a successful approach to face the actual food, environmental and energetic crisis in agriculture (UN, 2010). AE has been initially defined as the application of ecological principles to agriculture (Altieri, 1983); lately it became an interdisciplinary field of studies, including several scientific disciplines, agronomic practices, social and political movements (Wezel et al., 2011). The participatory approaches to plant breeding, like PPB, are an example of successful agroecological practices.

Materials and methods

The methodological framework used for this paper was qualitative research approach; data have been collected through literature review research, interviews (see table 1) and participation in the annual meeting of the Italian Rural Seeds Network (RSN) and the SOLIBAM project. The participant observation method was also adopted in 2011 and 2012 during the “PPB Week” at *Pratini* farm (Italy). Therefore it may reflect our bias and subjectivity (Kumar, 2011).
The choice of this case study is justified due to the fact that the farm is carrying out innovative strategies in organic cereal breeding, together with the first PPB trials in Italy. AE was chosen as a framework for our paper because it underlines the importance of the link between science and society, and of the contribution of professional, traditional and local knowledge by actors, which usually do not participate in decision making and innovation processes.

Table 1		
Actors interviewed	**Role and activity**	**Form of the interview**
Rosario Floriddia	Farmer and owner of *Pratini* farm	semi-structured
Riccardo Bocci	Coordinator of RSN	structured
Riccardo Franciolini	Staff member of RSN	semi-structured
Claudio Pozzi	Collaborator of RSN	informal
Ambrogio Costanzo	PHD candidate with thesis about PPB	semi-structured
Stefano Benedettelli	Professor, Florence University	structured

Case study description

The organic farm *Pratini* is situated in Tuscany region (Italy), and more precisely in Pisa province. Rosario Floriddia and his brother Giovanni own 300 Ha of hilly land with clay soils; major crops are cereals (wheat, barley, oat, and millet), legumes (chickpeas, lentils) and fodder (alfalfa, clover, faba bean *var. minor*). The farm turned to OA in 1987, mainly to face the *price squeeze*[7] by cutting off the external chemical inputs. In 2006, following the suggestion of the President of "Tuscan Coordination of Organic Producers" (CTPB), they started to cultivate older varieties of bread wheat, acknowledging that the modern ones were not suitable for OA cropping conditions. Due to the support of the Universities of Pisa and Florence, and to the good agronomical and economical results obtained, since 2009 Pratini farm grows only older wheat varieties and landraces, and started carrying out different breeding trials with participatory approaches within the SOLIBAM project.

Participatory Varietal Selection (PVS). PVS is a selection process in which farmers and other partners are involved in the last phase of the breeding program, to evaluate and select the best varieties previously obtained by researchers (Ceccarelli, 2012). In collaboration with the University of Florence, several trial plots of old bread wheat varieties were planted at Pratini farm, and a decentralized PVS process was applied to determine the best varieties suitable for artisanal bread production. A blend of these varieties is now used at the farm to produce bread, and it is re-sown year after year. All the old varieties are also cultivated separately in single plots (1,5 x 10 m), in order to provide the farm with its own seed bank. Other experimental plots were sown with populations of durum wheat, obtained by the University of Florence from crosses between modern varieties (Urria, Svevo, etc.) and the old Italian variety Senatore Cappelli; this variety is appropriate both for OA and pasta production, but at Pratini farm it didn't give good agronomic results. PVS was used in order to select new lines more suitable for this specific environment.

Participatory Plant Breeding. While in PVS the choice of farmers is restricted to the selection of varieties already existing, in PPB programs the farmers are taking part themselves to the creation of new varieties better responding to their specific environment and/or processing purposes. PPB trials are conducted within the SOLIBAM project and the farmers are assisted by the staff of the Rural Seeds Network. The experimental plots are sown with heterogeneous populations of wheat bread, obtained by the Italian scientist Salvatore Ceccarelli from all the possible crosses among 7 parental lines of a Hungarian wheat population, and the crosses among 21 parental lines of an English population. The result is called "Composite Cross Population" and presents the higher level of genetic diversity, which can be achieved from the initial parental lines. Wheat is autogamous, but in such heterogeneous populations the percentage of heterogamous pollination is expected to be higher

[7] The "price squeeze" indicates a situation in which the costs of production raise, while the prices of agricultural products do not increase in parallel, provoking a reduction of incomes.

than the average, with positive effects on biodiversity. When these population are re-sown year after year, in locations characterised by abiotic and/or biotic stresses, the increase of the frequency of the most adapted genotypes leads to a gradual adaptation to the local conditions of the environment - especially to those stresses they are facing more frequently, e.g. tardy frost, excess of rain, etc. (Ceccarelli, 2009). The high level of heterogeneity of these populations is beneficial especially in OA; in fact AE studies have demonstrated that agro-ecosystems can achieve a high degree of stability and resilience through biodiversity (Altieri and Nicholls, 2000). Within the SOLIBAM project, the same populations have been sown in 10 different farms across Europe to analyse their adaptive response to different environments and agronomic practices.

Theoretical background: The open innovation paradigm

PPB can be considered as an innovative approach in organic seed selection processes. Hereby innovation is defined as new ideas, successfully implemented in organizational processes and outcomes (Dodgson and Gann, 2010). This may seem a strange claim, as seed selection appears to be part of natural evolutionary growth and development path within biology and agriculture, but when we compare this approach with the standard plant breeding methodology of private enterprises, we can see that these companies apply *closed innovation models* in their seed breeding processes. These models are based on a fading innovation paradigm of *science push*, where new ideas are created and applied in a closed environment of inbound research & development laboratories. The created intellectual property and associated revenues are protected through patenting of new varieties. This approach does not only make farmers more dependent on their suppliers in the food supply chain, but also suppresses innovation[8]. Kanter (2006) explains that the belief that innovative ideas can only be created in closed laboratories is a structural mistake in innovation management. New ideas, such as PPB, cut across different knowledge ‘silos’, sectors, and actors of the organic cereal value chain. Therefore PPB can be identified as an *open innovation model* in seed selection processes. Open innovation has been coined and defined by Chesbrough (2003), as meaningful search and dissemination of knowledge in order to speed up internal innovation processes, and enlarge opportunities for external use of innovation. Open innovation paradigm allows access to information by all the members of PPB projects and other actors interested in this breeding process. The process stresses absorptive capacity of data and knowledge by farmers, food processers, seed producers and suppliers, and promotes exploitation of external information. PPB endorses liberation of expertise and experience for other members of both the organic and conventional cereal supply chains. This is the same approach of AE, aimed at valorising different sources of knowledge, its sharing and appropriation. AE recognizes the importance of participatory approach, because even in the more advanced forms of agriculture, farmer’s knowledge has been recognized as a fundamental resource to enhance innovation (Ashby and Lilja, 2004).

Social signaling value. The open innovation paradigm and its implementation in PPB example should be seen as what Von Hippel (2006) calls ongoing democratization of innovation. “*Democratization of the opportunity to create is important beyond giving more users the ability to make exactly right products for themselves. (…) the joy and the learning associated with creativity and membership in creative communities are also important, and these experiences too are made more widely available as innovation is democratized*” (von Hippel, 2006, p.124). Therefore PPB has an important social signaling value in transforming the current food system through opening up the seed selection processes. The open model is responsible for new relationship between knowledge and economic value creation (Van Berlo and Jansen, 2013). This goes beyond the scope of sole seed production, as we are dealing with such topics as biodiversity and vivid ecosystems,

[8] “Closed innovation embraces a strategy of vertical integration and exclusive control” (Chesbrough, 2003, p.12).

livelihoods of farmers, urban-rural networks, and creation of learning and innovation networks for sustainable agriculture[9].

New organizational structure. The open innovation model implies new ways of organizing the work processes in networks, clusters and even initiating co-creation among the cereal supply chain. Farmers can be seen as the 'prime species' within the agro-ecosystem; through the price squeeze this system gets perturbed and innovation initiatives stifled. The existing closed model leaves little space for innovation outside the R&D laboratories, within the current seed selection methodology. As a result, farmers together with other stakeholders react trying to create alternative food networks and innovation ecosystems based on agroecological values, where the partners of PPB projects act as custodians of biodiversity and local knowledge. These alternative food networks (AFNs) depend on their embeddedness into broader local social networks; they can renew the lost connection with producers, nature, land and the consumers because they not only add innovations into the food supply chain, but they also reintroduce the lost social component to the current food system, such as the need for cooperation, resilience, reduction of alienation, valuable relations and solidarity that represent social capital, trust, and increased adoptive capacity. The AFNs based on these values also tend to approach the environmental and economic aspects of the food system in a different way, which is expressed through their organizational structure into open innovation networks.

Open for consumers. Evolution of the open innovation concept will eventually lead to a bigger influence and involvement of concerned consumers. Examples of this future trend are the already existing Solidarity-based Purchase Groups (GAS[10]) in Italy and in particular in Tuscany region. According to von Hippel`s classification, these consumers groups can be considered as lead users of sustainable agricultural output and producer – consumer relations (Brunori, Rossi and Malandrin, 2011). "*That is, they are ahead of the majority in their populations with respect to an important market trend, and they expect to gain relatively high benefits from a solution to the needs they have encountered there*" (von Hippel, 2013, p.5). As Brunori, Rossi and Guidi (2012) have shown, GAS have the capacity to co-create together with other actors/members of food supply chains and food networks; the new way of co-production can lead to a more general change in the way innovation is applied in the seed selection processes, both within closed as well as open models. AE and PPB can add diversity to the existing production methods, and therefore challenge and increase its innovative capacity.

Discussion and conclusions

The recent emergence and diffusion of PPB movement is considered as a response to the weaknesses of the conventional approach to plant breeding. Decentralized plant breeding approaches based on participatory methods offer the following advantages: i) improved local adaptation; ii) promotion of genetic diversity; iii) increased breeding efficiency and, iv) empowerment of local communities. PPB programs allow farmers to take part in the development of new varieties or populations, more suitable to marginal environments and to organic farming agronomic practices. The cereals obtained from such breeding methods can be successfully valorized through artisanal processing (bread, bakery, or pasta making), which is more flexible than industrial one and thus can be adjusted according to the characteristics of the flours (Morris and

[9] LINSA are defined as networks of producers, users, experts, civil society organizations, local administrations, formal Agricultural Knowledge System components, SMEs that create mutual engagement around sustainability goals in agriculture and rural development, and to this purpose they co-produce new knowledge by creating conditions for communication, share resources and co-operate on common initiatives (Moschitz, 2012).

[10] GAS - *Gruppi di Acquisto Solidale* - are Italian food networks run by concerned consumers and based on solidarity purchasing activities (Brunori et al., 2011).

Bellon, 2004). Participation is an important issue that still need to be implemented, especially the consumers' one, in order to be able to take into account also the needs of the end-users in the breeding process. At Pratini farm, the ongoing innovative participatory methods for organic cereal breeding, started and developed thanks to the fundamental interaction among the farmers and other partners: the Rural Seeds Network, the Tuscan Coordination of Organic Producers, the Universities of Florence and Pisa and the SOLIBAM European project. This participatory process led the farmers involved to a change in their approach to agriculture, which shifted from the closed innovation models typical of the 'Productionist paradigm' (based on intensification of agriculture through technological advancement) to open innovation models, typical of AE and the 'Ecologically integrated paradigm' (based on a more holistic management approach towards agro-ecosystems).

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