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Research paper

Adapting spring wheat breeding to the needs of the organic sector

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ABSTRACT

Organic farmers and food processors need plant varieties that are adapted to their crop husbandry and processing practices. Such varieties are scarce as the mainstream breeding sector focuses on developing varieties for the conventional product chain that has different goals and practices. In this paper we study the case of the Dutch bread production chain to assess options that might enhance the availability of varieties suitable for the organic sector. The research involves an analysis of organic crop management and food processing practices and associated variety requirements. The research shows that several variety traits prioritized by the organic sector are not adequately addressed by conventional plant breeders: high baking quality, weed suppressiveness and tolerance to harrowing. Some of the interviewed conventional breeders are willing to consider technical adjustments to their breeding programmes. However, seed legislation and company economics limit the space to implement such modifications. We conclude that developing spring wheat varieties for the organic bread production chain requires breeders to prioritize selection for high baking quality genotypes that tolerate an organic weed management regime. This would require a concerted initiative of all actors in the organic bread production chain that includes establishing new socio-economic partnerships to overcome current economic and legal barriers.

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1. Introduction

Organic farmers need varieties that grow well without synthetic inputs and possess traits that complement organic crop management practices [1–3]. In addition, such varieties have to provide products that are adapted to handling and processing conditions further down the organic production chain. European organic farmers encounter difficulties to find varieties that suit their needs, because most crop breeding efforts are oriented towards developing varieties for conventional cropping systems that use synthetic inputs to manage the crop growing environment. Varieties selected for the conventional market are not always the best suited for use in organic cropping, due to the differences in management practices between both production chains.

The purpose of this paper is to identify options to transform the breeding of varieties in such a way that breeders are able to address the needs of the organic sector. A plant variety of a certain crop can be considered as part of an agricultural technology. Technology and innovation systems literature teaches us that technology development is embedded in an institutional environment (e.g. legislation, financing system, values) that influences the final outcome of the technology development process [see e.g. 4–6]. Thus varieties are developed within a specific technology system, the breeding system, that can be envisaged as a configuration of actors in its particular economic, institutional and physical crop growing environment (Figure 1). With the design of their breeding programme, breeders take into account the different components of the crop production system, such as the physical growing environment, crop husbandry and processing practices of the actors of the production chain they are selecting for. Furthermore, breeders decision making is influenced by the institutional environment (norms, legislation, financing system, etc.). Hence transforming the breeding system in such a way that it is able to address new needs, is not just a matter of prioritizing other plant traits or adjusting the selection environment, but also involves dealing with (different) institutional constraints [see e.g. 7]. Correspondingly, assessing options to adapt conventional breeding to the needs of the organic sector, requires a study on these changes in the context of the broader system. In this paper we apply such a systems approach to the case of spring wheat in the Netherlands.

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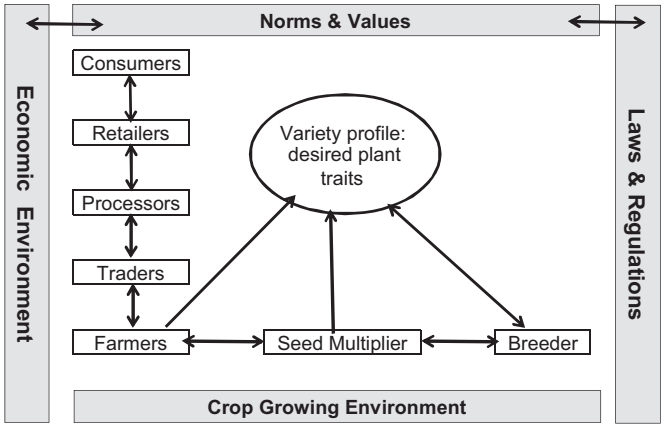

Figure 1. The breeding system and its influence on the shaping of a variety.

The case of spring wheat breeding for the Dutch organic bread production chain was chosen for this study, because actors of this chain are actively searching for new varieties. Currently, Dutch organic farmers rely on a single spring wheat variety, released more than 15 years ago. Although farmers appreciate this variety, they consider reliance on just one, relatively old variety as risky. They fear that sooner or later the genetic disease resistance in this variety will break down. However, screening and testing efforts for more than a decade have shown that modern conventional varieties do not have satisfactory baking quality when grown under low-input, organic conditions. This inability to find suitable varieties through the existing breeding system provoked the authors to study the reasons for this failure and possibilities to revert this situation. More specifically we explored:

- how and why required variety traits and priorities differ between organic and conventional bread production chains;
- breeders' selection practices and choices and how these are influenced by the different components of the breeding system (Figure 1);
- options to improve spring wheat for the organic sector through conventional breeding programmes.

The paper first describes the general characteristics of the organic bread production chain and its actors. Thereafter we analyse the management of spring wheat under organic growing conditions and the organic bread making process in more detail to analyse the interaction between these two parts of the chain and to assess how variety requirements for the organic chain differ from those for the conventional chain. In addition, we explore to what extent current spring wheat breeding aims at meeting the variety demands of the organic sector. Next to possibilities to directly or indirectly select for the desired characteristics, we discuss the factors that are essential to produce an environment conducive for creating more effective spring wheat breeding programmes that can supply such varieties for organic agriculture.

2. Research approach and methods

Information on the characteristics of the organic bread production chain were collected in the course of several projects on spring wheat variety testing and breeding with involvement of breeders, farmers, traders, millers and bakers conducted by the first author from 2000 to 2010. Data from an earlier study by Osman & Lammerts van Bueren [8] were used to compile criteria set by farmers, traders and millers from the organic sector and to develop a user-defined profile of organic spring wheat variety (Table 1).

We approached the five most important North-Western European spring wheat breeders for interviews on breeding approach, selection criteria and priorities. Four breeders agreed to participate in the study: three German and one Dutch breeder. Interviews were held both in the breeding nursery as well as in the office, and telephone communication was used for follow-up questions. Prior to the interviews, the content of the companies' seed catalogues and websites were studied. This allowed to cross-check the consistency of the breeders' information on variety traits and selection criteria. From these discussions we composed a list of variety traits considered important by organic farmers or listed as essential by one or more of the breeders (Table 2). The four breeders then received the compiled list to score the criteria for importance (0 = not considered, 1 = lowest priority, 5 = highest priority). Breeders were also asked how they would change their selection if they would be developing varieties for the organic spring wheat production.

3. Particularities of Dutch organic wheat production and processing

3.1. Preference for spring wheat over winter wheat

Cereals play important roles in an organic crop rotation, namely restoring soil quality and balancing labour demand. For these reasons farmers maintain cereals in their rotation, despite a relatively low economic return. Bread wheat is the most profitable cereal because Dutch organic traders pay a premium for baking quality. As spring wheat usually produces a better baking quality grain than winter wheat, organic farmers producing for the milling industry prefer to sow spring wheat (Table 3).

In conventional farming, spring wheat is only a small crop. In the Netherlands about 15% of the conventional wheat acreage consists of spring wheat [9]. Conventional farmers mainly grow high-yielding winter wheat for the feed industry. They aim at maximizing grain yield, because the conventional baking industry pays a lower premium than its organic counterpart.

Spring wheat offers two more advantages over winter wheat in organic farming systems in regions with a temperate humid climate like The Netherlands. Firstly, weed control – a major problem in organic cropping systems – is more effective in a spring wheat crop. In late winter and early spring the fields are often too wet to enter with heavy equipment. The weeds developing in that period can, however, still easily be eradicated mechanically shortly before sowing the spring wheat crop in March. Secondly, spring wheat based cropping systems allow for a catch crop in winter that more effectively reduces nitrogen leaching during wet winters than winter wheat does [10].

3.2. Bread production chain actors

The Dutch conventional bread market is dominated by supermarkets and their suppliers: large scale bakeries who obtain their flour from industrial mills (Table 3). Organic subsidiaries of actors in the conventional bread production chain also produce the organic bread for the supermarkets. However, only 30% of organic bread is sold through the supermarket channel [11]. Most organic consumers buy their bread in specialised organic shops. This bread is prepared by specialised organic bakers. Part of the specialised organic bakeries prefer wholemeal from traditional mills with millstones over roller milled wholemeal produced by a flour plant. They argue that stone milled flour has a better flavour and higher nutritional value because it contains all the original parts of the grain kernel. In contrast, wholemeal from a roller mill is product of a reconstitution process, in which the nutritious germ and outer layer fractions are usually left out, because these shorten flour shelf life and may reduce baking quality.

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