Organic Seed Production and Plant Breeding – strategies, problems and perspectives –

Proceedings of ECO-PB 1rst International symposium on organic seed production and plant breeding, Berlin, Germany 21-22 November 2002

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Preface

These proceedings summarise the results of the oral and poster presentations of ECO-PB's first international symposium on the state of the art and future developments in Organic Seed Production and Plant Breeding – Strategies, Problems and Perspectives, which was held in Berlin at the Humboldt University, 21-22 November 2002. This symposium was organised by ECO-PB in co-operation with the Bundesamt für Naturschutz, Stiftung Ökologie & Landbau, Zukunftstiftung Landwirtschaft and the Humboldt University Berlin, and co-founded by Stichting Triodos Fonds and Iona Stichting.

The fact that the derogation for seed and planting material of non-organic origin for organic food production in the EU-regulation 2092/91 for organic agriculture is about to expire by the end of 2003, has stimulated several seed companies, research institutes and farmers to get engaged in organic seed production and even organic plant breeding. With organic seed production many aspects have to be taken into account, like variety trials, research on adjusting threshold values for seed-borne diseases, permitted seed treatments, improved seed production system and so forth. Some initiatives on organic seed and plant breeding already exist for more than 20 years, others have just started. To meet the requirements of the organic farmers and consumers we have to scale up and further build up the expertise network and get an overview on what is going on, how, where and with whom.

The aim of the symposium was to show and discuss different scientific and practical approaches to meet the requirements, problems and challenges in organic seed production and plant breeding in Europe anno 2002.
The symposium started in the evening of the 21st of November with keynote speakers and a buffet as part of the opening event. On 22nd of November the program included oral and poster presentations. The participants consisted of breeders, researchers, experts and farmers involved or interested in organic seed production and plant breeding.

This publication has benefitted from the concerted action of all contributers and the editorial help of Esther Bremer and the layout by Gerda Peters.
We hope that these proceedings which includes information on ECO-PB and the mailing list of the participants can function as a network book for further activities on organic seed production and plant breeding.

Edith Lammerts van Bueren (chair of ECO-PB) and Klaus-Peter Wilbois (Secretary of ECO-PB)
Driebergen, Februari 2003

About ECO-PB

The Goal

The European Consortium for Organic Plant Breeding (ECO-PB), founded 20th April 2001 in Driebergen (NL), pursues…

- providing a platform for discussion and exchange of knowledge and experiences
- the initiation, support of organic plant breeding programmes
- the development of scientific concepts of an organic Plant Breeding
- the provision of independent, competent expertise to develop standard setting with respect to organic plant breeding

The Principles

- commits to the principles of organic agriculture as laid down in the IFOAM Basic Standards and EU regulations 2092-91
- is member of IFOAM
- offers full membership to all organisations that are actively and predominantly engaged in the development and promotion of organic plant breeding and organic agriculture
- offers supporting membership to all persons and organisations predominantly engaged in organic agriculture and complying with objectives of association

The tasks

- carry out meetings on organic plant breeding issues
- work out a sound concept based on principles of organic agriculture as a basis for organic plant breeding
- set up organic variety trials on cereal and vegetable crops in different countries in Europe to study how they perform under different conditions
- set up research projects on organic plant breeding
- raise funds for projects and ECO-PB's work
- providing discussion paper on plant breeding issues to support the decision making process

The foundation members

- Danish Research centre for Organic Farming (DK)
- Elm Farm Research Centre (UK)
- Forschungsinstitut für Biologischen Landbau (CH,D)
- Institut Technique de l'Agriculture Biologique (F)
- Louis Bolk Instituut (NL)
- ArbeitsGemeinschaft Ökologischer Landbau (D)
- Vitalis Biologische Zaden B.V. (NL)

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Part A
Oral Presentations

Opening by the State Secretary of the German Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft

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Introduction

On behalf of the Federal Government, I would like to extend a cordial welcome to you all in Berlin! Federal Minister Renate Künast, as patroness of your organization would have liked to be here personally, but she regrets being unable to come due to another long-scheduled event. She therefore asked me to pass on her warmest greetings and good wishes.
We are, of course, delighted that the first International Symposium of the European Consortium for Organic Plant Breeding is being held in Germany. We hope that we can make your stay a pleasant one.

General agricultural policy

First allow me to make a few remarks concerning the agricultural policy framework conditions. Brussels has made its decision on how the Common Agricultural Policy will be financed. This now gives us a framework for planning the EU-25: We now know how much money is available for the agricultural sector until the year 2013 and what upper limits we can anticipate. The ceiling for the year 2006 is 45.3 billion euro and 48.5 billion euro for the year 2013. We must not lose any time in further developing and thus strengthening the CAP! We expressly agree with Commissioner Fischler on this point. We have the leeway to shape the necessary reforms:
In market policy, old provisions for payments to farmers will simply expire. This has to be regulated!
The following applies to the promotion of rural development:
We must make sure that the rural region is capable of further development, and that jobs are created there as well as a viable infrastructure. All of us need dynamic rural regions.

We have the promotional instruments in Germany in the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK). Its agri-environmental measures in particular ensure that even difficult locations can be farmed.
Within the GAK, funds are to be used in future in an even more targeted way to promote environmentally and socially sound methods. The funds are to be increased by the *Modulation Act* introduced by us.

The concrete funding principles of the Joint Task for the year 2003 will be decided by mid-December by the ministers of agriculture of the Federal and Länder governments.
For example, the promotion of the following measures is presently being harmonized:
- Expansion of crop rotation

- Cultivation of blossoming areas or belts
- Winter greening
- Precise application of liquid farmyard manure
- Organic plant protection methods
- Environmentally sound husbandry methods

This catalogue of promotional measures is primarily intended to align plant production more to ecological demands.

At the WTO negotiations the EU must put a negotiation offer on the table by September 2003 at the latest for the next conference in Mexico. However, this is only possible if the Community decides, at least on principle, to gradually eliminate the trade-distorting effects of its direct payments.
This explains the proposal of the Commission to decouple the direct payments.
Failure at the Conference would neither be good for us nor for the so-called developing and newly industrialized countries. It would also not be in line with our ideals of global justice!
All of us must make a contribution to ensure that the growing world population has enough food.
For us, the most important principle here is that of sustainability, meaning that we must use the available natural resources intelligently and carefully so that there is enough for everyone – not only for today, but for tomorrow as well.

Promotion of organic farming

In Germany, Minister Renate Künast has paved the way for increased promotion of organic farming. For example, the premia for converting to organic farming were increased in the programme for the promotion of market- and site-adapted farming. This aid is also provided to those who pledge to continue employing this environmentally-friendly method of production.
In addition the Federal Government has set up the *Federal Organic Farming Scheme* to help improve the competitiveness of the German organic sector und to contribute to balanced growth of supply and demand. The measures of the Federal scheme therefore aim at all of the levels of the value added chain – from production to the consumer.
The scheme, with a volume of 35 million euro in Federal funds for both 2002 and 2003 is based on an analysis of critical points by a group of experts and on the results of a hearing with actors from science, business and administration. Roughly one third of the funds will be used for consumer information.
The Federal scheme comprehensively supplements the introduction of the eco-label and the improved promotional conditions for organic farming. It focuses on training, educational and general informational measures as well as on the promotion of research and the development of new technologies. For example, we offer detailed information on the new central Internet portal, www.oekolandbau.de, at trade fairs, among disseminators, at informative stands, exhibitions or seminars:
Concrete aids, for instance in the form of differentiated information, education and counselling programmes, are being created for farmers willing to convert. Processors such as bakers, butchers, dairies, etc. are informed about the valid regulations for organic production. This provides incentives for innovation and competition and helps to facilitate knowledge sharing at seminars, trade fairs and on the Internet. The trade is being intensively equipped in order to be able to provide the good and fair advice that consumers want. Therefore further training programmes are being offered for employees in the retail trade. Consumers, in particular children and teenagers, are being given targeted information about the value and properties of organic products. Here it is important that large-scale kitchens are given qualified conversion advice and that the subject is adapted to the needs of day-care facilities and general schools.

Issues of organic plant breeding

More than other areas, plant breeding is laying the foundations in organic farming for economically successful and, at the same time, environmentally-sound plant production.

BSA Workshop
Consequently, this spring Minister Künast commissioned the Federal Office of Plant Varieties (BSA) to hold a workshop on “Breeding for Organic Farming” in collaboration with the Association for the Advancement of Private German Plant Breeding (GFP) as well as the relevant organic associations. The workshop took place on 10 and 11 June 2002 in Hanover and brought together scientists and breeders from both the organic and conventional paths. The results of the workshop were summarized by the BSA in a conference volume that will soon be published on the Internet. I will therefore limit myself to illuminating only the most important results here:

- Resistance to disease, pests and weeds as well as abiotic stress tolerance are important for all types of cultivation, but are of special significance for organic farming.
  The respectively relevant damaging influences must be taken into consideration here. For example – as you know - mildew plays a lesser role for organically grown wheat than for conventional production.
- Quality features are also entering the focus of breeders and farmers, whereby quality is assessed according to partly different criteria in conventional and organic farming.
- Therefore in plant breeding the importance of resistance research and quality research – both with regard to seed and consumption quality – will increase further in future.
- Breeding research must also ensure that traditional plant breeding methods are further developed for the future. Public funds and capacities must be set aside for the provision of pre-breeding material[1]. This must also be considered in light of the assessment of Professor von Witzke of Humboldt University here in Berlin, who came to the conclusion after analysing several studies, that every “research euro” pays an average “interest” of 50 cents[2].
- The question whether plant breeders will in future also select in their nurseries under organic farming conditions with regard to nutrient efficiency, disease resistance and weed suppression abilities will certainly depend upon how rapidly organic farming spreads and how the legal framework conditions are further developed.
- Regardless of this, existing results of cultivation trials in research and practice should be evaluated to a greater extent under the aspect of the needs of organic farming. In addition, prerequisites for organic testing should be created for official variety testing (VCU tests and regional variety trials of the Länder) taking into consideration additional characteristics (e.g. habitus, other quality characteristics and diseases).
- Fundamental differences also continue to exist with regard to suitable breeding methods. The question of which new methods for organic farming are tenable alongside the methods of traditional plant breeding has not yet been decisively clarified.
- However, there is consensus that the use of genetic engineering for organic farming is out of the question.
  I consider it a positive sign that the president of the Federal Association of German Plant Breeders (BDP), von Kameke, recently expressly acknowledged this in a press conference. I see the statement of the BDP president as a signal that German plant breeders, also outside of organic farming, have recognized the signs of the times and see a growing market here.
- With regard to special organic tests in the BSA approval procedure and to the addition of characteristics to the descriptive variety list, we intend to continue the discussion and work out the possibilities and requirements together with plant breeders and growers in a further workshop.

[1] Initial material for breeding new, e.g. resistant varieties

[2] Speech held by Professor von Witzke, Humboldt University, during the annual meeting of the GFP on November 11th 2002.

European Organic Farming Regulation

However, the formation of legal framework conditions involves not only variety protection and seed legislation. On the EU level, Organic Farming Regulation[3] No. 2092/91 of 1991 is the central legal provision for organic farming and plant breeding. It defines how agricultural products and foods labelled as organic products must be cultivated and produced.
Until now, this regulation allows seed that is not produced in compliance with the Organic Farming Regulation to be used in organic farming under certain conditions. As you know, there is a Commission proposal to amend this regulation as per 1 January 2004. In future the amount of "non-organic seed" should be more restricted. We wish to reduce the application of the exemptions to as small an unavoidable extent as possible.
In order to improve the transparency of the supply and demand of organic seed, the EU Commission has proposed that a database be set up in every member state, which farmers and the responsible authorities can use to determine the availability of organic seed.
Due to our federal structure, we in Germany would have to set up and coordinate 16 databases at the essentially competent Land authorities; therefore it is instead planned to centre this task with the Federal Office of Plant Varieties.

The better suppliers and demanders of organic seed are able to come into contact, the lower the need will be for exemption permits. I expressly welcome the signal of the German plant breeders to contribute to having enough seed available for organic farming.

GMO elements in seed

Food and feed containing, consisting of or made from genetically modified organisms (GMOs) is a particularly sensitive subject on the European agenda. Presently the Council of the European Communities is debating two regulation proposals: the Regulation on genetically modified food and feed, also called the Novel-Food /Novel-Feed Regulation, and the Regulation concerning traceability and labelling of genetically modified organisms and traceability of food and feed produced from genetically modified organisms. The Federal Government advocates regulating this area as soon as possible. In view of the increasing global cultivation of genetically modified varieties and international trade flows, we in Europe need reliable and suitable legal framework conditions.
After all, we want to ensure that consumers have the freedom to choose and transparency in green genetic engineering as well as to safeguard non-GM farming – both conventional and organic – for the future as well. Proper labelling of genetically modified products is decisive for consumer freedom of choice. We therefore advocate traceability and labelling with the lowest possible threshold levels.-
The European Parliament demanded a value of 0.5 percent, while the Commission, by contrast, proposed a value of 1 percent.
The decision made on food and feed will have direct effects on the regulation of threshold levels for seed, since low limiting values can only be complied with in the food and feed sector if relevantly lower threshold levels are foreseen for the seed sector.
Action needs to be taken here as well! Without such provisions, a practicable coexistence of non-GM and GM agriculture is unthinkable. The coexistence of non-GM agriculture must be ensured for the freedom of choice of both farmers and consumers.
The threshold levels for seed proposed by the Commission on the basis of scientific studies[4] (0.3 – 0.7 %) lie between the demands of the industry of at least 1 percent and that of environmental and organic associations which demand a threshold value at the detectable limit level of 0.1 percent. After the Council decision on the Novel Foods / Feeds Regulation a relevant proposal will be submitted.

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[3] "Council regulation no. 2092/91 of 24 June 1992 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs"

[4] Scientific Committee on Plants; Joint Research Centre

The following benchmark data will have to be considered when determining the threshold levels for seed:

- The threshold value yet to be set for food and feed requires a sufficiently large "safety margin,"
- Liability issues in civil law must be clarified for any possible economic damage in conjunction with the use of genetic engineering, for example in the case of outcrossings from GM cultivation in stock of non-genetically modified plants. This remains to be clarified.

Genetic resources – biological diversity
Successful plant breeding requires a sufficient genetic foundation. For this reason the conservation of broad biological diversity is a special concern in organic production. You, as representatives of organic plant breeding, make a considerable contribution with your work towards preserving a broad spectrum of "on-farm" genetic resources.
This is a necessary and wise supplement to "ex-situ" conservation in gene banks and is in harmony with international agreements for the preservation and use of genetic resources.

Conclusion

In a time when national action is no longer enough to manage the challenges of the future, coordination on the European level is urgently necessary in politics and industry as well as in science and research.

With the establishment of your organization, you have signalled your desire to help shape Europe and contribute to the protection of the environment, nature and biological diversity through the promotion of organic plant breeding. Thank you for your commitment!
I hope you have pleasant and successful discussions and am very proud to hereby open the first symposium of the European Consortium for Organic Plant Breeding *"Organic Seed Production and Plant Breeding - Strategies, Problems and Perspectives"*!

Towards New Socio-Economically Integrated Solutions for Plant Breeding

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Keywords: Organic Plant Breeding, Benefit Sharing, Cultivar Clubs, Marketing

Starting point

National and international standards for organic farming set a number of clear restrictions upon breeding techniques suitable for organic farming. These restrictions mainly concern the GMO-related issues. A comprehensive description of the most recent discussions on how organic scientists approach breeding techniques is given in Wyss et al. (2001) and Lammerts van Bueren (2002). Likewise, seed production for organic use is standardized; this involves in most cases one- or two-year multiplication of conventional cultivars under certified organic field conditions. By 2004, the EU regulation as well as the IFOAM standards will become more stringent in relation to the use of organic seeds. The way in which the implementation of the various amendments is organized and the procedures for handling and controlling exemptions are far from practicable. Recently, there has been growing interest among scientists in different breeding concepts for organic farming as well as low-input agriculture. Biodynamic breeders have been carrying out practical work on cereals and selected vegetables for the past 15 years – with growing success.

Economic restrictions upon organic plant breeding

EU and EFTA production of organic cereals (all cereal crops) totalled 1.6 million tons in 2000 (Hamm et al. 2002). This production represents an area of approx. 400 to 450 thousand hectares. To return the investment costs of a breeding program, a wheat cultivar must be produced on 20,000 hectares as a minimum. This example shows how difficult the macroeconomic framework conditions for organic breeding programs are. In Italy, there is – at least theoretically – the economic potential for 5 novel cereal cultivars; in Germany for four and in France, Austria, Denmark, Sweden and Finland for one cultivar in each of these countries. Cereal production in all other countries is below the minimum of 20,000 hectares.

As a consequence of the low density of organic production areas in Europe and worldwide, novel cultivars developed especially for organic growing conditions would have to be cultivated across huge geographical and climatic areas if ordinary economic criteria were applied. Such a strategy would obviously conflict with the major objective of organic breeding, the local or regional focus of crop-environment interactions.

Therefore, new socio-economic strategies are needed in order to get organic breeding programs off the ground.

Current socio-economic models for organic plant breeding programs

As long as organic farming remains in the niche, farmers have to take matters into their own hands. Many pioneer farmers – mainly on the biodynamic side – started on-farm selection for self-sufficiency in order to improve the adaptability of varieties to their farm and site conditions. In the long run, many farmers faced severe problems with seed quality, vitality and health. Meanwhile, on-farm selection has become tremendously professional thanks to donations. The funding provided by the German Zukunftsstiftung foundation has been a major incentive for professionalism. The on-farm selection activities of the pioneers developed step by step into modern and efficient breeding programs. Although very successful in terms of selection progress, these activities are far from being economically viable. They remain dependent on donations and are very often by-products of socially and culturally committed communities.

Who are our natural allies?

The breeding aims of organic farming match to a high degree those discussed for resource-poor farmers in many parts of the world. Zschunke (2002) summarized the breeding purpose for organic crops with a high nutritional value, excellent sensory (organoleptic) quality, the stability (not the absolute amount) of yield, field tolerance to pests and diseases (in addition to or instead of mono- or multigenetic resistance), the adaptation of N-demand of crops to the N-supply of organic soils, good competition on root, shoot and leaf levels and, finally, crops better adapted to stressful environments and low input conditions.

Ceccarelli's et al. (2000) conclusions from their work with resource-poor farmers in Syria are directly applicable to breeding work in organic farming:

- Instead of selecting for broad (or universal) adaptation, plant breeding must target the interactions between genotype and environment (GxE).
- The selection work has to be carried out in the target environment.
- It is important to make better use of locally adapted germplasm.
- The participation of farmers in the selection process is crucial in order to benefit from their huge knowledge of local varieties, appropriate production techniques and crop-environment interactions.

It is obvious that the economic concentration process of the breeding and seed industry makes it impossible to serve a growing number of similar needs of which organic farming is only one. I see a urgent need to open the current discussion among biodynamic and organic breeders and scientists towards the worldwide discussion on breeding for sustainable land and resource use.

Excursus: Cultivar (variety) clubs

Cultivar clubs offer a new strategy to profit better from novel varieties. It has become fashionable for apples recently. The Cripps Pink (Golden Delicious x Lady Williams) cultivar, for instance, is marketed as "Pink Lady ®", the Honeycrisp (Macoun x Honeygold) cultivar as "Honeycrunch"® or the Caudle (Golden Delicious x Red Delicious) cultivar as "Cameo"®. The idea of such cultivar clubs is to prolong the profit from premium prices of a novel variety by ensuring shortage of supply. An exclusive license contract ties breeder, tree nurseries, producers and traders together in a club in order to have 100 percent control over the market. "Access only for members" is the motto of these clubs. Because this system adds value to the whole chain, it guarantees a better return on investment to the breeder as well.

Although brilliant as an idea, the concept of these clubs has become doubtful recently. The most important disadvantage seems to be that it prevents innovation. The breeders try to "milk" a variety as long as possible instead of maintaining their competitiveness by producing novelties. In addition, the club system requires strict control in order to keep the partners disciplined. Therefore, it tends to secure lawyer jobs instead of a better income for the breeders. And finally, retailers have no self-interest in being admitted to such a club.

The SATIVA model in Switzerland: Fair Trade in the First World

A novel marketing concept for biodynamic seeds has been established in Switzerland by SATIVA. SATIVA is a co-operative for DEMETER seeds (www.sativa.org). SATIVA promotes the cultivars of Peter Kunz (a biodynamic breeder for winter wheat and spelt) and also intends to promote vegetable cultivars of other breeders in a later phase.

SATIVA adapts the concept of **cultivar clubs**, which was developed to market exclusive apple varieties, to market biodynamically bred and multiplied seeds. The SATIVA® label with the addition "Co-operative for DEMETER seeds" is awarded to products (single or processed) containing at least 60% raw material from SATIVA varieties. SATIVA operates on a contract basis covering all steps from selection and maintenance of seeds, seed production, grain production, milling and packaging, through to processing and selling. The license fee is twice that of common organic seeds. The marketing strategy takes into account the higher production costs of biodynamic farming and of processing practices adhering to fair trade principles in the First World.

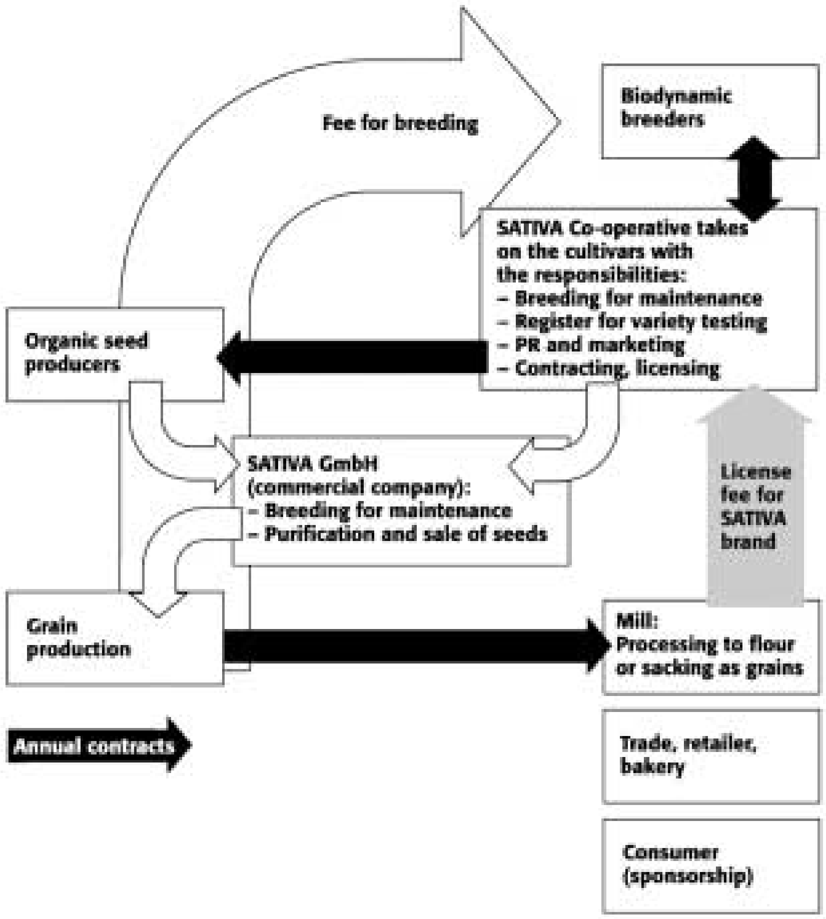

Figure 1: The SATIVA model with contracts and co-operation among partners.

First test sales have been made in wholefood shops with customers especially interested in DEMETER products. In October 2002, the Coop supermarket retailer took up the idea. Although only low promotion had accompanied the start, sales went up to 120,000 SATIVA loaves of bread during the first month. The SATIVA loaves are labelled and information on the quality of the cultivar and the special features of the whole food chain is given on the bag. In order to be listed on the shelves definitively, the minimum number of loaves will be 200,000 per month, a realistic goal for both SATIVA and Coop.

The SATIVA marketing concept based on the special quality of the breeding process is unique to date. It gives a complex view on how different the organic approach is to the conventional one. It guarantees a completely segregated organic food chain, which will be required by an increasing number of consumers in the future, especially to secure GMO-free food. On the other hand, the disadvantages of such a concept are the further splitting of the organic markets into different qualities and labels, the reluctance of the retailers to participate in the costs of developing new cultivars and the risk of irritating consumers with too complex information (distinction between breeding, seed production and crop growing under organic and non-organic conditions).

Plant breeding - a public affair after all?

In order to cope best with different organic environments (both in yield and quality), many strategies have to be scrutinized. Defining a model ("Leitbild") for organic crops has been a great pioneer work, coming mainly from the biodynamic movements. To make such models operational for commercial or public breeders, both basic and applied research work will be required. Until now, public funds have been reluctant to support organic plant breeding projects. Several applications for Concerted Actions and Shared Cost projects failed under the 5th Framework of the EU. One of the most important challenges for organic farming research is to provide scientific evidence for the concept(s) of organic plant breeding.

Both research and breeding work depend on public funding as long as organic farming represents a niche – although growing – in production and sales, too. Without special efforts of public funds, this important work cannot be tackled properly. The 6th Framework of the EU might offer an opportunity under priority 8 (support to policies). Already existing activities of Member and Associate States could become co-ordinated and co-funded within the ERA-net scheme ("Strengthening the European Research Area"). The European Consortium for Organic Plant Breeding (ECO-PB) is a crucial step forwards on the path towards making organic breeding a public affair.

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Plant breeding, ecology and modern organic agriculture

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Summary

Most of the activity in plant breeding over the last half century has been for selection of varieties adapted to prevailing industrialised systems of agriculture. The impressive gains in biomass production and the large changes in harvest index of emerging modern varieties have been matched, however, by losses in other characteristics. As a consequence, high levels of production in practice can be obtained only under intensive chemical support.

Systems of ecological agriculture can exploit the potential gains from these varieties to only a limited extent. It seems that the plant characteristics needed in ecological agriculture have often been lost in breeding for industrialised systems. These include both characteristics of individuals and the ability to succeed in polyculture. More information is needed to determine the characters that are needed, their priorities and the best methods for selecting them. Even more important, however, is the need to make rapid progress in breeding for ecological agriculture to improve both productivity and quality and so reduce the costs of production.

Keywords: Breeding, Diversity, Populations, Mixtures, Polyculture, Participation

Introduction

Organic agriculture needs its own plant and animal breeding, first because it must show that it can be a totally independent system. There is little point in having an agricultural system that calls itself holistic if it has to depend on plant and animal genotypes that come from other systems. Second, it is becoming increasingly clear that the kinds of plants and animals needed for successful organic systems are not those that have been intensively bred and selected for other, different, systems. Third, there is a strong argument for organic systems to develop away from the prevalent approach, which prioritises breeding for monoculture. The fourth, related, point is the need for exclusion of GM plants and animals.

This paper tries to summarise where we are in trying to define the genetic material that we need for organic agriculture, and second, to look at ways of developing the required material quickly and cheaply.

General considerations

The need for a different approach for organic breeding allows us to think differently about both the breeding process and the kinds of material that we need to develop. To do so, we have to be certain about the ways in which we wish to see organic agriculture develop in the future. The two main options are either a neo-conventional system, which involves high inputs applied to near-monocultural production, or an ecological system that exploits the widest practicable range of biodiversity within and outside the production system.

The potential value of the latter approach to ecological agriculture has been strengthened by practical farming experience and by accumulating evidence from the Tilman group in Minnesota. For example, Reich et al (2001) showed that a mixture of four naturally occurring grassland species produced significantly more biomass than the mean of the components grown alone. If the complexity of the mixture was increased to 16 components, then the plant community produced even more relative to the component mean. Furthermore, if the plants were subjected to an excess of carbon dioxide in the atmosphere and of nitrogen in the soil, to mimic major effects of global warming, the differential was even greater. The main mechanisms proposed for the better performance of the mixtures were: increased range of functions, wider exploitation of the environmental niche and complementation among components.

Clearly, such complex mixtures of species are not practicable for agriculture except in special cases. However, agricultural crops have been formed from simpler variety mixtures or species mixtures or a combination of both. There is overwhelming evidence from the literature and from practical experience, currently and historically, that such mixtures can be effective in buffering the crop or community against many variables. Various authors have refined the analyses of major mechanisms that are involved in restriction of diseases, of pests and of weeds (Finckh and Wolfe, 1998; Wolfe, 2000). Others mechanisms are waiting to be revealed and exploited, particularly the involvement of semio-chemicals.

Long-term advantages of a major increase in diversity include buffering against local development of pests and diseases, against yield variation in the locality, against variation in market price of individual crops and, not least, against major fluctuations in the populations of non-farmed organisms. This approach can provide the requirements for high level production of healthy crops and animals in a surrounding natural environment that is attractive, dynamic and actively maintained.

If this is accepted, we need to develop further, systems of inter-cropping, both in space and time. Developing such systems can be simpler and more effective if we have crop components that do well as neighbours with other varieties or species. In other words, breeding research has to include a search for components that have good ecological combining ability (though it may be simpler to identify those varieties that are particularly bad neighbours). This has not been a criterion in modern conventional breeding, which means that many relevant characteristics have probably been lost or highly diluted. Nevertheless, in our potato trials for example, we have been able to identify significant variation in neighbourliness among varieties.

The roles of individual components in mixtures or populations will be complex and will not necessarily follow predictions from the performance of the individuals grown alone. The problem is that we need mixtures or populations in which all of the relevant characters operate simultaneously and to our advantage. This will usually require field confirmation.

The main argument against such an approach lies in the perceived practical problems of handling and marketing mixed crops. However, practical experience and logic indicate that the perceived problems are often either not serious in practice, or can be dealt with through simple changes in practice. For example, critics make the automatic assumption that quality of a pure line must be better than that of a mixture. However, quality is so complex that it is impossible to accumulate all of the components required for high quality into a single genotype. There must be a considerable potential for the use of variety and species mixtures by combining plant lines that carry complementary characteristics (Osman, Welsh, this conference).

Characters of individuals

Current conventional plant breeding, and particularly the approach to genetic modification, is concerned with individual characters. Despite the relatively controlled environment of conventional agriculture, such characters have often been difficult to recognise or to utilise effectively because of the many interactions among individual genes, and between genes and environment.

In terms of organic breeding, the discussion should be focused rather on characters of individuals, which allows for complex inheritance and interactions. Among modern genetic techniques, genomic analysis is potentially more valuable than current GM methodology because it can allow for analysis of the overall genetic contrasts among different individuals.

Some important complex characters are:

a) Plant nutrition

Recent papers contrast the characteristics of old and modern varieties, or of varieties selected under low or high input conditions. A major difference lies in the ability of older varieties to thrive under low fertility conditions relative to modern varieties (extracted from Foulkes et al 1998). Possible reasons for such differences are based on whether the older varieties are more efficient at scavenging for nutrients, or whether they are more efficient at using limited nutrients. For example, older rice varieties seem better at penetrating soil than more modern varieties, suggesting better scavenging. On the other hand, Hetrick et al (1996) and Zhu et al (2001) noted that older varieties may be better at establishing interactions with arbuscular-mycorrhizal fungi, which should improve efficiency of utilisation of soil nutrients.

Currently important examples of breeding progress in this respect are some of the wheat varieties produced recently by Dr Andreas Spanakakis, which were bred deliberately under low input conditions and that appear to perform better in organic production than do other contemporary varieties bred under high inputs. In a similar way, Hungarian Sarpo potatoes, highly productive potatoes in organic trials, have also been bred under low input conditions. Biodynamic breeders in the German-speaking region have been able to demonstrate similar successes with a range of crops.

b) Disease and pest resistance

Organic farmers have observed consistently that the potential for disease under organic conditions appears to be lower than under conventional conditions (though seed-borne disease is still a crucial issue). This may be due to the higher levels of nitrogen available in plant tissues grown conventionally, but the reasons may be more complex. For example, Jens-Otto Andersen (2000) observed that under conventional conditions with high synthetic nitrogen inputs, the quantity of phenolic substances produced as secondary metabolites in barley leaves was less than that produced under low input conditions. He also noted a tendency for older varieties bred under lower input conditions to have higher levels of phenolic production leading to better disease resistance.

In a similar way, there appears to be a general tendency for older vegetable varieties to be stronger tasting because of the higher production of secondary metabolites involved in pest and disease resistance. This change occurred partly because varieties produced in older programmes received less protection from insecticides than do more modern varieties, and partly because of a trend towards production of blander-tasting food.

Some regard these levels of secondary metabolites as a negative characteristic from the point of view of human health. However, Johns (1996) points out that in the evolution of humans and their crop plants, humans have developed ways of processing plants and animals so that there is little danger from the products. Moreover, it seems likely that the occurrence of secondary metabolites in plants that have been selected for control of pests and diseases probably have these positive useful functions also in humans and other animals. As corroborating evidence, Engel (2001) noted that animals that are unwell have a tendency to eat more bitter-tasting plants than normal.

c) Weed competition

Because of the ready availability of herbicides for half a century, the resistance of crop varieties to competition from weeds has been increasingly overlooked. However, it seems that this can be rectified by selection of lines that produce vigorous, fast-growing seedlings with prostrate habit. However, the competitiveness of oats is partly due to vigorous seedlings and partly to the ability of the crop to produce allelopathic compounds from the roots that inhibit weed development. Wheat is also allelopathic to weeds, but less so than oats. To improve the productivity of organic wheat we need to find selections that produce both vigorous seedlings (wheats from the CIMMYT programme appear to be better in this respect than do modern European wheats) and that are significantly more allelopathic than currently available varieties.

But we also need to be aware of interactions among characters. For example, evidence from experiments with mixtures suggests that the disease restriction found in variety mixtures can have a useful effect in improving the competitiveness of the crop plants perhaps through an improvement in health-induced vigour; the energy saved in resisting disease can be spent in growing more vigorously relative to weeds. Relative disease resistance may also be a factor in the weed suppressiveness of oats and triticale compared with wheat.

However, high levels of weed suppression may not be beneficial. Weeds can have numerous positive advantages in providing shelter for beneficial organisms together with improved nutrient cycling and ground cover. Under organic conditions, without fungicide protection, they frequently become diseased and this can serve first, to reduce their competition potential and second to generate spores and semiochemicals that can induce resistance in neighbouring crop plants against potential threats.

d) Quality

Crop quality has many different facets additional to the common view of taste, texture and appearance. A fundamental consideration for organic agriculture is the notion of 'vitality', which has so far proven difficult to define. Phenomena such as crystallisation (or co-ordination as suggested by J-O Andersen, 2000) offer a potentially useful measure that may integrate many aspects of vitality. But there are still other characters including nutritional composition and value, which may be relatively easy to measure in terms of trace elements and vitamins but much less so in terms of more general contributions to human and animal diet and health. One aspect in this sense, noted above, is the possible positive role of disease and pest resistance characters.

Interaction with the environment

In conventional breeding, genotypic performance is compared across environments, to determine stability. This can be within a location or among different locations. Hence we have the measure of g x e – the genotype x environment interaction. If we think of populations, then we probably also need to consider p x e interactions, population x environment interactions. In other words, whether we select a particular individual or a population, we need to be aware of its performance over a range of environments.

The main question for a genotype or population that is selected for good performance in one location, the breeding station, is how far can production of that selection be extended without loss of performance and reliability? There is a perception in the organic world that it is essential to have adaptation to specific local environments. The problem is that testing for this would be prohibitively expensive. Fortunately, a number of characters may be selected for constant performance over relatively large areas, for example, daylength response, potential light energy and sensitivity to the local range of temperature and rainfall. Because these features of the environment are relatively fixed, we can select for fixed characters in the genotype that provide optimal response. For example, Swiss spring wheat breeders found that some of their selections were successful in parts of Canada, related probably to selection for short season productivity and high quality.

But many aspects of the local environment are highly variable including, for example, temperature and rainfall profiles for a particular season and the range and intensity of particular pests, diseases and weeds. Combinations of these factors will be unique to the season and locality, and largely unpredictable. To deal with such unpredictable variability requires a built-in buffering capacity of the variety or population. Again, this is achieved more easily with a variable host population. For example, within the rainfall limits, successful production within a particularly dry year will require a different range of plant characters than for a wet year. A single plant genotype that is able both to retain moisture in a dry year and to lose excess moisture in a wet year is more difficult to conceive than a plant population which contains different plants carrying these opposing characteristics. The important point here is that mixtures and populations can help to reduce the need for expensive testing over many environments because of the built-in capacity of the community to deal with the likely variation.

Methodology

Lammerts van Bueren et al (1999) have made an important start to the debate in their critique of the methodologies used in conventional breeding. This led to the development of a basic premise for organic breeding – that at each stage of the process, the plants (or animals) involved should maintain their integrity and be capable of reproducing themselves. This view may be contentious, but it provides a logical starting-point for an approach to an agriculture that recognises a primary right for organisms, other than humans, to exist without total domination by the latter. Whether this can or should be maintained is difficult to judge. Whatever the rights or wrongs of the argument, we have to be aware of the extraordinary pressure of science, and particularly of genetics, to upset such views, however commonly or deeply they may be held.

In comparison with the conventional sector, relatively little is being undertaken currently in terms of breeding and trialling. Notable exceptions include, for example, the successful programmes in the German-speaking countries concerned with cereals and vegetables. But we need much more – and we need quick results. The problem is that we need to produce a wide range of varieties of a wide range of species, adapted both to organic systems in general and to a wide range of localities. This has to be achieved without a large infrastructure either for breeding or for seed production.

a) Using existing material

Currently we cannot afford to have large series of field trials at numerous locations with hundreds of entries. Not only is the finance and organisation not available, but this form of trialling can be highly misleading. Such trials in themselves act as fine-grained diversified cropping systems that can be relatively effective in local niche exploitation (small plots have high edge:centre ratios), complementation and disease and pest control (diversification; semiochemical production). They also select for local pathogen and pest populations that are likely to be significantly different from those encountered on nearby farms. Furthermore, although they damp down disease and pest development overall, they underestimate significantly the performance of variety mixtures and populations because of high levels of plot interference: mixture plots receive far more spores and pest inocula than they would on a larger field scale.

We cannot do without such trials altogether. We need at least some indication of the performance of new varieties, mixtures and populations relative to common standards. But we also need at least two inter-dependent developments.

First, we need to develop trialling methodologies that give more realistic representations of the on-farm performance of varieties, mixtures and populations. For example, this might be through some form of rapid assessment of a number of fields of specific varieties or mixtures being grown on farms to give a more general impression of performance. This process may also help to get us away from dependence on single named varieties as ‘winners’. It is probably more sensible to recommend groups of varieties, mixtures or populations as being suitable for a particular locality.

Second, we need much more to involve farmers themselves in the process, using novel ways of capturing their experiences. Indeed, we are engaged now in two major projects in this direction. The costs to the farmer could be recouped through the up-to-date knowledge available to him/her, perhaps with a financial contribution from a local farmer group or club, and perhaps with an opportunity for seed production with a premium on seed sales.

b) Generating novel material

One method of generating novel breeding and production material is to make much more use of the different kinds of gene bank that are held either publicly or privately in different countries. These contain many developed varieties that have not been widely used but whose characteristics may be relevant to organic production. Such characteristics may not have been recorded but a thorough search of such material with appropriate field trials might reveal valuable accessions at relatively little cost.

A second, low cost method which seems to be particularly appropriate to organic agriculture, is population breeding. Such an approach was developed during the 1920s in California and generated a number of Composite Cross populations of barley whose evolution was followed over the next fifty years (Suneson, 1956). Danquah and Barrett (2002) indicated the value of such populations for low input production in the UK. A recent further example is the successful development of rice populations in Brazil (Anon, 2002).

About five years ago, a group of us proposed a wheat breeding project based on this concept for organic production in Europe. Unfortunately for us and for ECO-PB, this proposal and a subsequent modified proposal failed to gain acceptance. Our third proposal in the UK was successful and the project is now under way, involving EFRC and colleagues at the John Innes Centre. It is funded by DEFRA for both the organic and non-organic sectors and should run for six years.

For the start of the project, a number of parents were selected that represent different kinds of wheat variety that have been successful over many years, mostly in the western part of Europe. These parent varieties were crossed in all possible combinations to generate an F1 population. This is now being multiplied to produce an F2, and, at this stage, samples of the population will be distributed to a small number of sites representing different geographical conditions and agricultural systems. Subsequent field selection at these sites will be largely natural with some mass selection for height, grain size and possibly other characters. This process should involve some farmer participation.

There will be considerable scientific interest in the development of the different sub-populations, following the rates of evolution of the complex wheat population under different forms of selection. Two outcomes of particular interest will be first, an insight into the ways in which organic and conventional systems select for different populations and analysis of the characters involved in population divergence.

The second outcome will be whether or not we are able to distribute population samples directly to farmers as seed for production crops, rather than simply to regard the populations as a genetic resource for selection of new, pure lines. If so, how do we register and distribute the material? Do we need a new legal framework for this activity? Can we use the EU conservation variety rules?

As with variety trialling, we need more participation directly by farmers in these breeding opportunities. This is important in principle because farmers have a more integrated and holistic view of what is particularly suitable for their own farms or locality. In this respect, there is already a remarkable, but little known, example in the Netherlands. Starting in 1938, government, breeders, scientists and farmers collaborated in what became effectively a national potato breeding programme. F1 clones produced by the breeders were distributed to farmers to observe and evaluate. The activity continues today, but on a smaller scale than before the introduction of breeder's rights. This enterprise has clearly been successful from the leading position in potato breeding established by the Netherlands over many years. Potatoes are ideally suited to this approach because of the vegetative, clonal generation of F1 hybrids, but we should consider extensions to other crops.

Conclusions

a) a commitment to breeding for organic agriculture is essential
b) we need general agreement on what is meant by, and needed for, organic breeding
c) we need a major increase in the genetic diversity of the breeding material being used
d) we need to breed for performance in mixtures and populations
e) we need to seize the opportunity for re-thinking the methodologies to be used. This includes critical appraisal of small plot testing and consideration of alternatives, exploitation of gene banks, the potential for population breeding, and development of farmer participation
f) we need to support ECO-PB as the organisation that can bring together the interested individuals and national groups to provide the stimulus for research and funding of these activities.

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Seed transmitted diseases in organic cereal seed production – A challenge for breeding !

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Not more than three ears with smut on an area of 150m2 are allowed in fields under official certified seed production. Continued practical cereal breeding under organic farming without seed treatment of single ear descendants will lead to more or less infection with seed transmitted diseases in the breeding area. Problems will follow in organic seed multiplication. For this reason organic breeding in long term has to develop varieties with resistance to seed transmitted diseases. But in a first step an idea of a disease has to be developed from an organically point of view. Accordingly varieties and collections have to be screened for their susceptibility first. This was done for barley leaf stripe disease and results are presented. It is still under testing for loose and covered smut of spring and winter barley and loose smut of winter wheat at Darzau. First hints of smut testings are reported. In particular it has to be noticed, that for instance leaf stripe and smut need a different context. This will also be of interest for combination of resistances for different diseases. Differences between types of resistance as they are known yet should be understood for further handling of a resistance itself and their relation to other diseases. This is shown for barley leaf stripe, which seems to be common in Europe before the beginning of modern breeding. Perhaps finally it has to be changed from thinking of partial resistance accumulation to health following adapted growth related to a concrete environment.

Optimising Organic Seed Production of Carrot and dealing with *Alternaria spp.*

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Project's web address: ***www.seedcentre.nl/safe_organic_vegetables.htm***

Keywords: carrot, Alternaria, mycotoxins, organic

Rijk Zwaan Seed Company was one of the first Dutch seed companies, which recognised the demand for organic seeds for the organic vegetable production on a professional basis. Regular varieties have been tested under organic circumstances and the best were selected for this market. Hereafter organic seed production was focussed on these varieties.

Organic seed production encounters various problems of which the transmission of seed-borne pathogens is the most serious one. Reduction of such problems by input of chemicals in certain stages of plant development is not possible anymore as it is in conventional seed productions. The management of controlling the problem of seed transmission of pathogens is most complex in biennial crops, because two growing seasons are required to produce sowing seed from basic seed.

Since 2000 we participate in the European Commission sponsored project Save Organic Vegetables (QLK1-1999-0986) dealing with the *Alternaria* complex in carrots.
Main objectives of this project are to develop strategies for a healthy crop and a safe organic carrot supply by developing detection methods, identifying mycotoxin risks in the production chain due to *Alternaria spp*., determining the critical control points, and developing preventive measures. A better understanding of the pathogenesis of *Alternaria radicina* was needed, as primarily this pathogen cause rotting of the consumable product.

New methods for rapid and precise detection and quantification of *Alternaria* infection (incubation tests, PCR tests) and mycotoxin contamination (HPLC) have been developed. More knowledge about the physiological and genetic basis of production and accumulation of *Alternaria* mycotoxins has been obtained. Bioassays for testing resistance of carrot lines and accessions against *Alternaria radicina* have been developed and will be used for selecting better varieties.

An important part of the project deals with improvement of the production of *Alternaria* free carrot seeds under organic culture conditions. Because carrot is a biennial plant, there is a two-phase seed production system. The first year roots (stecklings) are produced from seeds and the second year those stecklings are planted, giving rise to flowering plants, which produce the seeds. Essential in this two-phase seed production scheme is to keep *Alternaria* out of both phases, in order to produce *Alternaria* free seed. This will reduce *Alternaria* development and mycotoxin accumulation in the organic production chain.
Improving the production of carrot seeds under organic culture conditions is aimed via:
Investigation of the effect of initial basic seed contamination on the health status of seeds in the final seed production.
Application of antagonists, microbials and plant growth promoting agents during seed production
Optimising harvest time of the seeds in relation to maturity and *Alternaria* infection.
Establishing effects against *Alternaria* by culture measures and controlling climatological conditions.
Comparison of seed production in tunnels/glasshouses versus open field.

Alternative seed treatments (hot-water treatment, natural plant extracts, priming, antagonists) will be developed to reduce seed infection. Optimising the storage conditions of carrots after harvest and the possibility of post harvest treatments, to avoid development of *Alternaria spp*. and accumulation of mycotoxins during storage, will be investigated. In the end of the project a total strategy to reduce the risk of mycotoxins in organic vegetables and derived products will be devised.

Acknowledgement: This research is supported by the European Commission, Quality of Life and Management of Living Resources Programme (QoL), Key Action 1 on Food, Nutrition and Health.

Threshold values for seed borne diseases of cereals and legumes

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Introduction

Seed borne diseases can cause serious problems in production of cereals. Especially in organic seed production where there is no control methods implemented in practice the seed borne diseases can greatly influences the production in terms of both quality and quantity. Current practice in organic agriculture is to analyse the seed and to discard the seed lot if the infection by diseases exceeds the threshold levels. There is no tolerance list specific for organic agriculture. In Denmark we use the same threshold values as recommended in conventional agriculture for seed treatment. However the increased focus upon the special conditions in organic seed production has lead to a more critical discussion of the threshold values.

Current tolerances for seed borne diseases in Denmark

The production of organic seed starts with certified seed (C1), which comes from conventional agriculture but is untreated. This will be grown organically and the harvest will be sold as organic seed (C2). Both C1 and C2 are untreated and there is a high risk of propagating seed borne diseases at these two levels. For the "true" seed borne diseases the tolerance is lower in C1 than in C2 to minimise the multiplication of seed borne diseases (table 1-3). The tolerances we are using for the moment in C1 and C2 respectively are: *Tilletia tritici* and *Urocystis occulta*: C1: 0 and C2: 10 spores/g seed. *Pyrenophora graminea*: C1: 0 and C2: 5% infected seed. *Ustilago nuda*: C1: 0 and C2: 2% infected seed. It means for example that in wheat no spores of common bunt will be accepted in certified C1 whereas in the big C2 generation sold as organic seed 10 spores per g seed will be accepted (table 1-2). With diseases where you also can have multiplication during the season there is no difference between the two seed generations. The threshold for *Fusarium spp*. is 15% in wheat, triticale, rye and winter barley and 30% in spring barley. For *Septoria nodorum* the threshold is 15% and for *Pyrenophora graminea* the threshold is 15% infected seeds.

It is obvious from different seed analysis that seed borne diseases occur regularly and that they under the right conditions quickly can multiply and spread. During the last years a large number of organic seed lots are discarded because of seed infections above the tolerance level and in some cases, the quantities of organic seed have been insufficient to supply the market. In these cases it is allowed for the organic farmers to use conventional propagated seeds. However, after December 2003 this will no longer be accepted, and only organic propagated seeds can be used in the EU. With this restriction it is the question if the requirement for healthy organic seed can be met after 2003.

The Danish ORGSEED project on organic seed

The threshold levels used are developed under the presumption that pesticides can be used in case of later disease development in the crop. There is a need to investigate the different threshold values and to verify if the threshold levels also apply under organic farming practice and if it's possible to adjust the levels without having unintended multiplication and spread of serious seed borne diseases. The Danish Research Centre for Organic Farming (DARCOF) has supported a 5-year project (ORGSEED) that will investigate these thresholds in field trials for all relevant diseases in peas and small grain cereals, and evaluate them for use under organic farming conditions. The project will also focus upon new diagnostic methods and different control measures in organic seed production. The adjustment of threshold values, improved diagnostic methods and preventive control methods will hopefully contribute to a reduction in the number of seed lots unnecessarily discarded and to a sustainable organic seed production system.

Table 1. Recommended tolerances (thresholds) for seed borne diseases in organic produced winter cereals in Denmark compared to similar threshold values for seed treatment in other countries (Nielsen, 2001).

		Denmark		**Sweden** [b]	**Norway** [c]	**Austria** [a]	**UK** [d]
Crop	**Pathogen**	**Conventional, untreated C1**	**Organic seed C2**				**Home saved seed C2** [11]
Winter wheat	Tilletia tritici	0 [13]	>10 spores/g	0 [1]		>10 spores/seed [10]	>= 1 spore / seed [10]
	Fusarium spp.	15 % [3]	15 % [8]	0-40 % [4] treatment recommended >40 % treatment necessary	15 %	10 % [2] M. nivale	>5% M.nivale
	Septoria nodorum	15 %	15 % [8]		5 %	20 %	>5%
Triticale	Tilletia tritici	0 [13]	>10 sporer/g			>10 spores/seed [10]	As wheat
	Urocystis occulta	0 [13]	>10 sporer/g			>10 spores/seed [10]	
	Fusarium spp.	15 % [3]	15 % [3]	0-40 % [4] treatment recommended >40 % treatment necessary		10 % [2] M. nivale	As wheat
	Septoria nodorum	15 %	15 %				As wheat
Rye	*Urocystis occulta*	0 [13]	> 10 sporer/g			>10 sporer/kerne	As wheat
	Fusarium spp.	15 % [3]	15 % [3]	0-40 % [4] treatment recommended >40 % treatment necessary		10 % [2] M. nivale	As wheat
Winter barley	*Pyrenophora graminea*	0 [13]	5 %	0 – 20 % [4] treatment recommended > 20 % treatment necessary	5 % (6row) 10 % (2row)	2 %	2%
	Pyrenophora teres	15 %	15 %				
	Fusarium spp.	15 %	15 %		25 %	10 % [2]	
	Bipolaris				10 %		
	Ustilago nuda	0 [13] [12]	2 %	0,3 % [5]	0,1 % [6] field	0,1 %	0.5%

Table 2. Recommended tolerances (thresholds) for seed borne diseases in organic produced spring cereals in Denmark compared to similar threshold values for seed treatment in other countries (Nielsen, 2001).

		Denmark		**Sweden** [b]	**Norway** [c]	**Austria** [a]	**UK** [d]
Crop	**Pathogen**	**Con-ventional, untreated C1**	**Organic seed C2**				**Egen udsæd C2** [11]
Spring wheat	Tilletia tritici	0 [13]	> 1 0 sporer/g			>10 spores/ seed [10]	>= 1 spore / seed [10]
	Fusarium spp.	15 % [3]	15 % [3] [8]	16-40 % [4] treatment recommended >40 % treatment necessary	15 %	10 % [2] M. nivale	>5% *M. nivale*
	Septoria nodorum	15 %	15 % [8]		5 %	20 %	> 5%
Spring barley	*Pyrenophora graminea*	0 [13]	5 %	11Ö20 % [4] treatment recommended > 20 % treatment necessary	5 % (6row) 10 % (2row)	2 %	2 %
	Pyrenophora teres	15 %	15 %				
	Fusarium spp.	30 %	30 % [3]		25 %	10 % [2]	
	Bipolaris				10 %		
	Ustilago nuda	0 [13] [12]	2 %	0,3 % [5]	0,1 % [6] field	0,1 %	0.5%
Oat	*Pyrenophora avenae*			36-50 % [4] treatment recommended > 5 0 % treatment necessary	25 %		
	Fusarium spp.	30 % [3]	30 % [3]		15 %		> 5 % *M. nivale*
	Ustilago avenae			200 sp./g C1 500 sp./g C2 [9]			

Table 3. Recommended tolerances (thresholds) for seed borne diseases in organic produced legumes in Denmark (Nielsen, 2001).

		Danmark	
Crop	**Pathogen**	**Conventional, untreated C1**	**Organic seed C2**
Pea	Pea diseases [14)]	0 in propagation 5 % for food/consumption 10 %, for others [7)]	0 in propagation 5 % for food/consumption 10 %, for others [7)]
	Pea diseases, *Botrytis, Fusarium spp.*	> 25 %	> 25 %
Lupin	Antrachnose	0	0

In Sweden seed lots must be discharged if *Tilletia tritici* occurs > 1000 spores/g
"Snowmould" (*Microdochium nivale*, syn. *Fusarium nivale*)
Most Fusarium species e.g. *F. culmorum, F. avenaceum, Microdochium nivale*
Fusarium spp., Microdochium nivale, Septoria nodorum, Bipolaris sorokiniana, Drechslera spp. together.
Untreated C1 maximum 0,3 %. For earlier generations the tolerance is: 0,1 % for pre basic, class A and 0,2 % for basic seed, class B. No special demands for C2.
% plants with attack in field.
No specific rules for other pea production but 10 % is recommended.
The sum of *Fusarium spp.* + *Septoria nodorum* is maximum 30 %, for *S. nodorum* alone the maximum is 15 %.
200 spores/g in C1 is a demand, while 500 spores/g in C2 is a recommendation.
Note that the tolerance here is per seed.
Recommended tolerances in UK for "home saved seed" C2.
Field inspection in breeder's seed (F) and pre basic seed for *Ustilago nuda* is necessary in Denmark.
Treatment is recommended if there in 20.000 plants is: Breeders seed (F): 5, pre-basic (to basic seed): 10, pre-basic (to C1): 20 plants with *U. nuda*.
Detection according to current method (0 tolerance).
Ascochyta pisi, Phoma medicaginis var. pinodella, Mycospharella pinodes.

Sources: a) Hochwertiges Getreide-saatgut erzeugen. Produktion, Aufbereitung, Qualitätssystem, In-Verkehr-Bringung von Z-Saatgut und Saatgut im Biologischen Landbau, Bundesministerium für Land- und Forstwirtschaft, Austria, 2000, b) K. Sperlingsson, 2001, c) G. Brodal, 2001. , d) V. Cockerell, 2001.

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Intercropping as solution for organic grass seed production?

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Introduction

In Denmark 3.5 per cent of the arable land is converted to organic production and 2.7 per cent is under conversion. The majority of the organic farms are specialised in milk-production and at those farms an adequate supply of animal manure is normally available. Milk-production is predominant in Western Denmark, whereas the majority of farms in Eastern Denmark, at the richer soils, rely on arable production. Recently, an increasing proportion of those are converting to organic farming. The majority of the organic, arable farms have no access to animal manure, and therefore one of the main obstacles for organic grass seed production here, is nitrogen supply.

Besides the nitrogen **amount**, seed crops are also very sensitive to the **timing** of nitrogen application. Correct timing will stimulate reproductive development whereas excessive and poorly timed nitrogen application will be in favour of vegetative growth. If a nitrogen-fixating pre-crop provides nutrients, the grass seed crop will take up nitrogen as soon as it is mineralised which will most likely lead to excessive vegetative growth. Mixed cropping of a grass seed and a green manure crop provides an option on timing nitrogen release and excessive vegetative growth can be utilised as forage.

Methods

Perennial ryegrass seed crops were established in a spring barley cover crop, at wide row spacing, 24 cm to allow for a companion crop of green manure. Seven green manure crops were tested and evaluated, against perennial ryegrass established without green manure crops at four nitrogen application rates.

Nitrogen application, degassed slurry, was performed in the seed production year at the onset of spring growth of perennial ryegrass. The green manure crops were cut (approximately 1 cm below ground level) to eliminate competition against the seed crop and to stimulate nitrogen release.

Results and discussion

Seed yields of perennial ryegrass showed no difference between 25 kg N ha^{-1} + mixed cropping with persian clover, bird's foot trefoil or black medick and 100 kg N ha^{-1} to perennial ryegrass grown in pure stand. Results from 2000 are shown in figure 1.

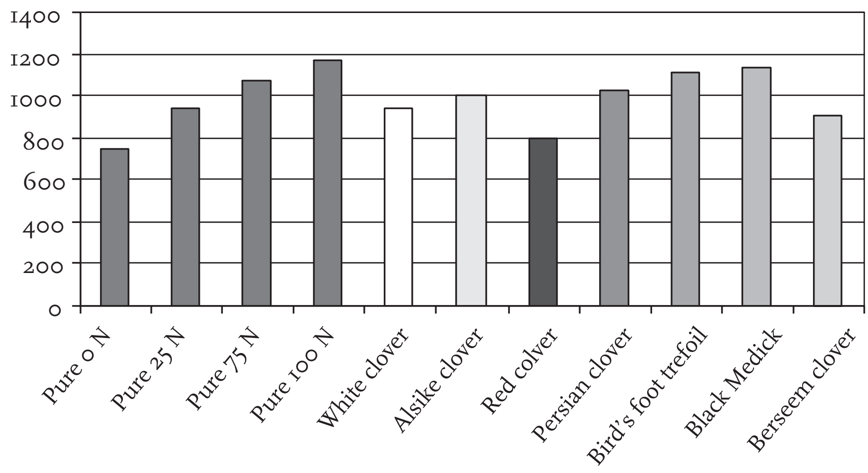

Figure 1. The effect of green manure crops in perennial ryegrass for organic seed production compared to establishment in a pure stand with different Nitrogen application levels.

In 2001 trial-site was infected with grass weeds, but the trial is replicated in 2002 and 2003.

The preliminary conclusion is, that intercropping of perennial ryegrass and green manure crops might be an solution for organic grass seed production especially on arable farms without access to animal manure but the trial also indicates interesting results with regards to the utilisation of excessive vegetative growth as forage.

An Approach to Organic Plant Breeding of Cabbage and Cauliflower

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Keywords: organic variety, biodiversity, genetic resources, Brassica oleracea, plant breeding.

Introduction

In many different species, recent varietal changes have following developments in conventional agriculture, so that the characteristics of new varieties do not necessarily correspond to the present needs of organic agriculture. In this paper, cauliflowers and cabbages are used as a model to illustrate these two points. The main question today is how to organise interactive research to begin organic plant breeding. The thoughts about organic breeding are presented here by a breeder with nearly 20 years experience in cauliflower breeding.

The history of the varietal development of Brassica species

The history of cole crops began on the European coasts where the wild forms can still be found, for example in France along the coast of Normandy and Brittany. Cultivated forms exploited one particularity of the plants to hypertrophy one organ: stem; leaves, vegetative or floral buds. The result was kale, borecole, kohl rabi, cabbage, cauliflower, broccoli, Brussels sprouts and so on.
The comparison of wild and cultivated forms gives an indication of how much breeding has in fact taken place.

In Italy, the diversification process of sprouting broccoli from cabbage took place two thousand years ago. The first distinction between heading and sprouting was made in 12th century (Crisp, 1982). Today many forms and colours can be found throughout the Italian peninsula. For four centuries, Northern Europeans have been breeding the white types that originated in Italy and other parts of the Eastern Mediterranean. Since the beginning of the 19th century people in Brittany (France) have been breeding the Roscoff type (Gray, 1989).

A review of the genetic resources of cauliflower available in Europe evidences a wide variety of shapes, colours, and tastes, many of which are not well known to consumers and producers today. The sweetest variety is the di Jesi type, which is more or less pyramidal in shape, more so than macerata but less so than romanesco. The most brightly coloured are the Sicilian cauliflowers with a mixture of green and all sorts of pink and violet curds (figure 1).

The great variability within cauliflower types is the result of agriculture practices, human traditions and also the type of soil so that a given cultivated variety can also be considered a «cultural phenomenon". Nowadays, cultivated varieties are more an "economic phenomenon". The needs of conventional agriculture have changed the relationship between the farmer and the cultivated variety. The same white cauliflower bred by seed companies is available on all the European markets throughout the year, and most farmers no longer know how to produce their own seeds.

In INRA (French National Institute for Agronomic Research) cauliflower breeding began 30 years ago. The first F1 hybrids of autumn cauliflower from seed companies were experimented in the mid seventies in Brittany. As far as other species are concerned, the main results of the 50 last years are the homogeneity and standardisation of the product with the widespread use of fixed and mono-genotype varieties, the use of biotechnologies to increase the efficiency of the breeder, and finally, separation between creative selection and seed production which increases the dependence of the farmers on the seed companies (Hervé Y, 2002).

The white form is very widespread and nearly all the new varieties available are F1 hybrids. Their homogeneity allows production costs to be reduced and ensures the constant quality of the curd. Biotechnologies are being increasingly used for Brassica breeding. Cytoplasmic male sterility (CMS) obtained by protoplast fusion ensures the security of the crossing between the 2 parents, and anther or microspore culture is a rapid way of obtaining homozygous lines, faster than selfing. In practice, this method has also produced new phenotypes that remain undetected in genealogical lines. If both techniques are combined, i.e. CMS for the female parent and haplo-diplomethods (anthers and microspores culture) for the male parent, very homogeneous F1 hybrids could be obtained.
In addition, CMS provides good protection for the breeder for his varieties. The F1 hybrids produced with CMS are also male sterile, so a restorer system is not required to produce cauliflower. The product is the floral meristem, so the fertility or sterility of the plant is not important. The Ogura cytoplasm, which confers CMS in Brassica, is protected by a patent. It could be found all over the world, in rapeseed, cabbage, cauliflower, Chinese cabbage, etc. Not only is the genetic basis of the varieties becoming narrower, but the cytoplasmic diversity is also being reduced.

The roles of organic plant varieties and the place of the F1 hybrid

An organic plant variety should play a role in the ecological adaptation of the crop and in the economic value of the product while at the same time respecting natural species characteristics.
The ecological adaptation of the crop mainly implies the preservation of biodiversity in the field and in its ecosystem. The economic value of the product also takes into account the preservation of biodiversity, but within the species, as well as the maintenance of a regional patrimony (Stolton and Geier, 2002).

As far as the cauliflower is concerned, biodiversity is being reduced and now all white F1 hybrids look alike all over Europe. Even farmers in Brittany and wholesalers are wondering whether it would be better to breed the ‘Roscoff’ type in order to reduce the strong taste of this white cauliflower. Most people prefer the taste of the autumn type. The wide diversity in shape and colour is currently mainly restricted to freezers belonging to the European gene banks, and only the green type is now beginning to appear.

With respect to the ecosystem of the field, the genotypic homogeneity of the F1 hybrid does not facilitate the establishment and maintenance of a biological equilibrium. The new cauliflower F1 hybrid also has a disadvantage with respect to natural reproductive ability because of CMS without a restorer and, in addition, anthers or microspores culture are becoming more and more common. These cell techniques go way beyond the natural limitations imposed by the floral biology of the species. Another problem is that seed production is not very easy using consanguineous lines, parents of the hybrids, due to their poor vitality, and this phenomenon is even more marked in plants propagated by anthers and microspores culture.

For all these reasons, few new varieties of Brassica species created for conventional agriculture will be suitable for organic agriculture. And the case of Brassica illustrates a general trend that applies to most cultivated species (Lammerts van Bueren et al., 1999).

An initiative for the organic breeding of cabbage and cauliflower in Brittany

The question now facing cabbage and cauliflower producers is how they are going to apply the European regulation 2092/91/EC in 2004, but even more importantly, how to apply it in the long term.
At the present time, most of the new F1 hybrids available on the seed market use CMS. Many F1 hybrid varieties are still produced by means of self-incompatibility, which is the natural phenomenon responsible for allogamy in this species. But the tendency is to abandon this natural system in favour of CMS.

This is why farmers commissioned INRA to begin a new study on cabbage and cauliflower to safeguard the future of these two crops.

The INRA project is the first step in an organic breeding programme including the evaluation of genetic resources (table 1) from several European gene banks and the definition of varietal types that are suitable for organic farming, and that will facilitate this type of production.
The INRA program was financed by the Internal Committee on Organic farming, which has initiated 20 projects since 2001 (Sylvander and Bellon, 2002). The current project has been underway for 2 years and will end in June 2003. The main project partner is IBB (Interbio Bretagne), which represents

Table 1: Population varieties evaluated during the INRA-CIAB project at the PAIS in Morlaix

Type	Origin	Years of observation	
		2001-2002	2002-2003
autumn cauliflower	Gene Bank of Wellesbourne – HRI – UK Genetic resources GEVES-France French breeding firms	31	42
winter cauliflower	Genetic resources of INRA Rennes-Le Rheu	24	30
Cabbage	Genetic resources of INRA Rennes-Le Rheu	19	16

organic farmers and organic trade in Brittany. Experimentation is taking place at the PAIS (Agrobiological experimental station of IBB at the Agricultural school of Suscinio) in Morlaix, Brittany.

Winter cauliflowers and cabbages originated in the region, and were collected at the beginning of the eighties thanks to European financing (Hervé, 1987). The seeds are conserved in a freezer in the INRA gene bank in Le Rheu. In Brittany, the cultivation of autumn cauliflower is more recent than the winter type. This crop has mostly been cultivated using commercial seeds, but the seeds used in the INRA experiment come from more diverse origins.

Experimentation was conducted in close collaboration with organic farmers, representatives of organic trade and researchers. The trial was dedicated to evaluating the quality of the products, the hardiness of the plants and the presence of auxiliary fauna. Meetings were organised regularly with the partners in the trials to define the objectives of a future breeding programme.

At the end of the first year, our preliminary results and conclusions were:

- some population varieties of autumn cauliflower and cabbage are already suitable for organic farming, and entail little additional breeding work,
- most cauliflower varieties need breeding for quality,
- cabbages have a satisfactory ability for ecological adaptation, but the question is how to introduce them on the market as consumers are no longer familiar with regional varieties.

The organic farmers were clearly interested, and some are prepared to take on breeding and seed production of one or more varieties with the support of a producers-researchers network.

How to move forward?

At the present time, organic farmers have to grow crops using conventional varieties. In the next few years, some of these varieties will be available as organic seeds. But in the long term, organic farming cannot progress without organic varieties that are specially bred for organic production.
The change to organic varieties needs a new way of thinking and a new approach to breeding research.

The definition of varietal types

Besides the evaluation of genetic resources, the INRA-CIAB project had another objective: the definition of a varietal type that will facilitate organic production. Future organic varieties of cabbage and cauliflower will combine the homogeneity of the product with the heterogeneity of their genetic background. The optimum degree of heterozygoty remains to be evaluated.
Population varieties will facilitate the ecological adaptation of the culture. However, our aim is to design a structure that allows greater heterogeneity of the genetic background and at the same time to propose a certain homogeneity of the product. Thus one projected varietal type is based on composite varieties with useful fixed agronomic and economic characteristics. The components of the composite variety would share the same economic characteristics while other characters might be different, for example, the vegetative characters that are not involved in quality.

A pluridisciplinary approach

A pluridisciplinary approach will be required to improve the ecological quality of the variety. Breeding cannot take place without considering the ecosystem of the field. Biodiversity has to be enhanced above and below the ground, taking into account both auxiliary fauna and the rhizosphere.
This last point is essential in organic agriculture. The link between the plant and the soil is the rhizosphere, and most aspects of the nutrition and the health of the plant depend on it (Aubert, 1977).

The exploration of genetic resources

Should the great variability within the Brassica species remain in the “gene banks” freezers?
In Brittany, the Roscoff type was introduced by farmers and then bred for two centuries by them and this is surely not the end of the cauliflower story. If cauliflowers in the Italian collections look and taste very good, why not adapt them for cultivation in Brittany?

Another way of enhancing the biological equilibrium is to promote species mixture (Wolfe, 2001). But the question is, how to select the mixture and which species should be used to accompany cabbage and cauliflower? So, the agronomical aspect should also be kept in mind.

Who will be responsible for breeding cabbage and cauliflower?

- Can the farmers and their professional organisations breed them on their own?
- How can seed production and distribution be organised?
- What is the role of public institutions and private breeders?
- How should the legislation be adapted?

All these questions came to light during the CIAB experiment. Farmers, the trade and their representatives are now speculating on possible future forms of organisation.

In what way could the French Agronomic Research Institute take organic farming into account?

Though the farmers are willing, and their professional organisations are ready to propose trade agreements, and legislative institutions are prepared for possible changes, the French agronomic research institute only recently acknowledged the need for investment in OA (Riba et al, 2000), and execution will be a long process (Sylvander and Bellon, 2002).
Conventional agriculture has favoured an analytic approach to living systems and by reducing species of plants and animals to their material dimension. This time, the dialogue is difficult: how to organise a pluridisciplinary approach in INRA using all the researchers able to invest in strategic research for organic breeding?

However, the research capacity of one country alone is perhaps not sufficient for organic farming, and it is probably better to ask how interactive research can be organised at the European level, involving all the partners of organic agriculture and using a holistic approach to living beings in the respect of all the dimensions of life.

Conclusion

Organic breeding is a new challenge for organic agriculture. Organic varieties will accompany changes in production techniques. Further experimentation is needed in mixing species as is deeper investigation of the rhizosphere.
Breeding for OF could also trigger a new burst of creativity. Biodiversity is inherited from the past. It is the result of human activities. Organic farming is already a manifestation of diversity and would also create new biodiversity.
Who is ready to build this future?

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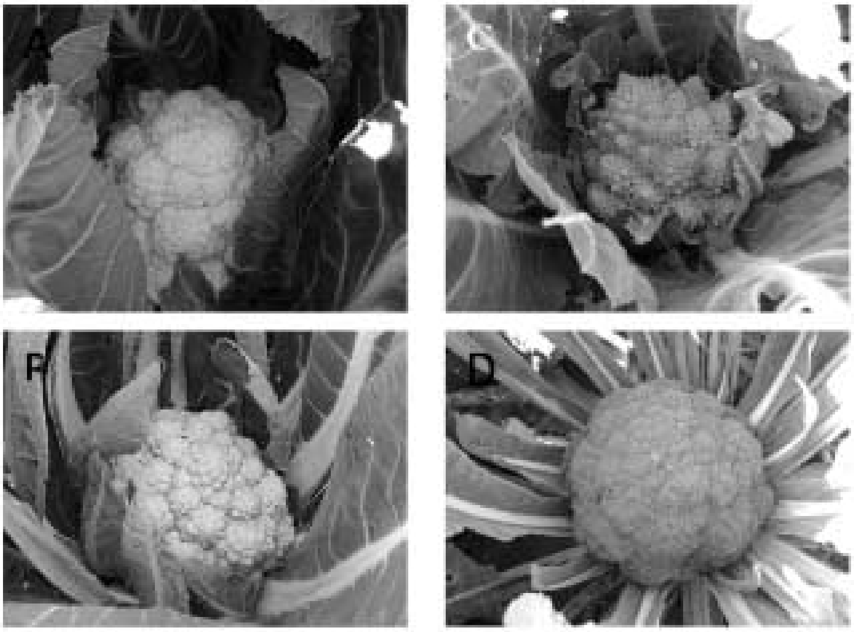

Figure 1: Biodiversity within population varieties of Italian cauliflowers (A: di Jesi, B: macerata, C: romanesco, D: violetto di Sicilia)

The performance of variety mixtures and the potential for population breeding in organic farming systems

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Keywords: Variety mixtures, composite cross populations, population breeding, cereals, organic

Introduction

It is clear that modern cereal varieties perform poorly in organic farming systems compared with conventional systems. A major reason for this is that plant breeding has focused almost exclusively on maximising yield in conventional agriculture. This is illustrated in Table 1, where it can be seen that winter wheat, probably the most highly developed cereal species, achieves only 54% of the conventional

Table 1. Average performance of arable crops in conventional and organic farming systems

	Average Yield (t/ha)		
	[1]Conventional	[2]Organic	Difference
W. Wheat	7.4	4.0	- 46%
S. Wheat	5.3	3.2	- 40%
W. Oats	6.8	4.0	- 41%
S. Oats	5.0	3.5	- 30%
W Barley	5.4	3.7	- 31%
S. Barley	4.7	3.2	- 32%
Triticale	6.0	4.5	- 25%
Rye	5.8	3.8	- 35%
W. Beans	3.5	3.5	0%
S. Beans	3.2	3.0	- 6%

[1]Nix (2000); [2]Lampkin et al. (2002)

yield when grown organically.

This discrepancy in yield may be explained by a number of factors:

Poor competitive ability against weeds. Data from one of EFRC's variety trials (Fig. 1) demonstrates the relatively poor competitive ability of winter wheat compared with winter oats and winter triticale.
Narrow range of disease resistance mechanisms within a single variety.
An inability to efficiently extract soil bound nutrients, as opposed to highly soluble fertilisers.
The lack of ability to buffer against environmental variation.

One means of overcoming many of these constraints is by increasing the genetic diversity within the crop population. This can be achieved in a number of ways, but it is the purpose of this paper to focus on two methods: variety mixtures and population breeding.

Variety mixtures

Variety mixtures are a simple yet effective way of increasing the genetic diversity within the field. A considerable body of evidence has accrued (e.g. Mundt, 2002) demonstrating the advantages that mixtures have compared with growing single varieties.

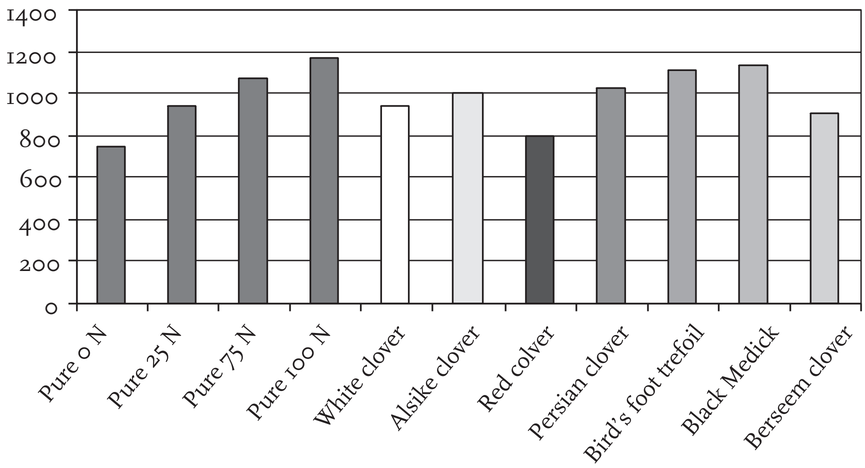

Fig. 1. The effect of cereal species, variety and variety mixture on weed cover (%).

Fig. 2. The effect of winter wheat variety and variety mixture on blackgrass (Alopecurus myosuroides) severity. Dashed line represents average of component varieties.

Take the example of weed control. It is well known that even within wheat varieties there is a considerable range in plant habit, leaf architecture and crop height. It is also clear from Fig. 1 that a single variety may not be particularly weed suppressive when grown on its own. However, if we grow three varieties together as a mixture, e.g. Hereward, Shamrock and Maris Widgeon, we are, in effect, combining a range of morphological characters together, which results in better levels of weed suppression than would be predicted from the average weed levels of the component varieties when grown in monoculture (Fig. 2)

Of course, it could be argued, why not just grow Maris Widgeon? But both Hereward and Shamrock posses higher grain yield potential than Maris Widgeon, so here we can protect the yield of both Hereward and Shamrock by using Maris Widgeon to compete effectively with the weeds. It should also be remembered that the benefits do not just apply to the current crop, since reducing weed incidence and thus weed seed return will reduce the weed burden for subsequent crops in the rotation.
Disease restriction is another prime example where variety mixtures can provide significant benefits. Figure 3 shows the reduction in Septoria tritici achieved through a mixture of the winter wheat varieties Hereward, Malacca and Shamrock. Again, it is clear that there is a positive mixture effect, as the levels of disease are lower than would be predicted from the average of the pure stands. This is because diseases, particularly those dispersed by wind or rain splash, find it more difficult to spread through a heterogeneous crop population (a polyculture) than through a homogenous crop (a monoculture).

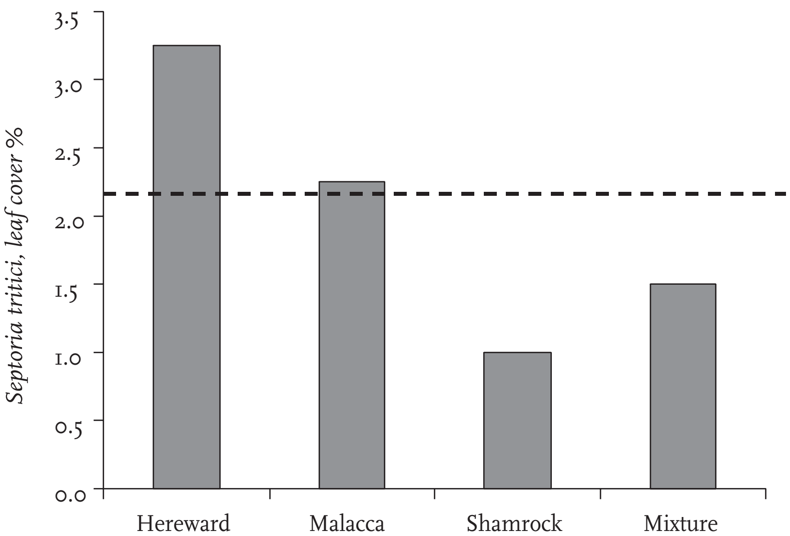

Fig. 3. The effect of winter wheat variety and variety mixture on Septoria tritici severity. Dashed line represents average of component varieties.

Grain quality is also of major importance. However, grain quality is a complex genetic character that interacts with the environment. Therefore, it is unlikely that a single variety would be able to provide optimum quality for all quality parameters in every season, particularly in the absence of synthetic inputs that can help to control environmental variation. There is now some early evidence to suggest mixtures could provide some benefit here as well. In this example (Table 2), Hereward has the highest specific weight, Malacca the highest hagberg falling number and Spark the highest grain protein content. The mixture, however, evens out these variations to produce good quality for a broad range of quality parameters. Also, it can be seen again that the mixture performs better than would be predicted from the arithmetic mean of the component varieties, suggesting a positive mixture effect.

Table 2. Improved quality provided by mixtures. Data are averaged across three sites in 2001

	Specific Weight (kg/hl)	Hagberg	Crude Protein (% DM)
Hereward	74.2	238	11.38
Malacca	71.5	258	10.82
Spark	73.1	233	11.69
Average of varieties	72.9	243	11.30
Mixture (He/Ma/Sp)	**73.9**	**269**	**11.41**

It is also possible that mixtures will be able to assist in increasing the efficiency with which the crop can extract soil-bound nutrients. In the same way that there is a range of morphological characteristics in the above ground part of the plant, it is likely that plant roots also show a range of characteristics such as rooting depth or proliferation of shallow roots and may mean that mixtures could exploit a greater proportion of the soil profile.

Therefore, it is clear that mixtures can overcome a number of agronomic problems simultaneously. But more importantly, all of this leads to perhaps one of the most important features of mixtures; yield stability.

It is well known that crop yield can vary both spatially (including regional, farm and within-field scales) as well as temporally. This is because of environmental variation in the physical environment, such as differences in soil type, and the interaction of these with the weather. Conventional agriculture attempts to control this variation with synthetic inputs. For organic agriculture, however, there is a much greater reliance on the innate ability of the crop to cope with a range of environmental conditions.

However, it is clear that these modern varieties do not cope well with this variation in organic systems. In Fig. 4, it can be seen that the single varieties Hereward, Malacca and Shamrock show considerable variation in their relative yield between seasons. The relative yield of the mixture, on the other hand, is much more stable, providing in some instances the highest yield, but more importantly, providing a reasonable yield consistently. It is also clear that there is a positive mixture effect as the yields are always higher than the average of the component varieties.

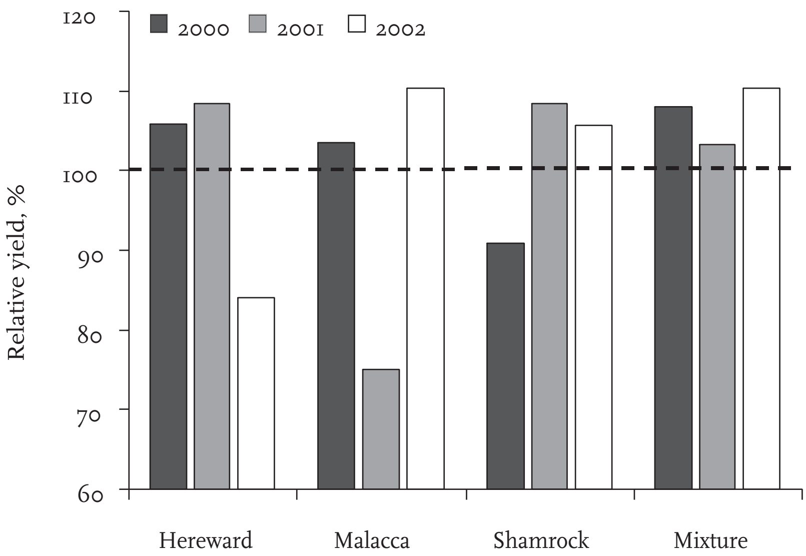

Fig. 4. The effect of winter wheat variety and variety mixture on the relative grain yield (expressed as % of mean yield of Hereward, Malacca and Shamrock in each season) over three seasons. Dashed line represents average of component varieties.

Population breeding

It is clear that a number of agronomic problems can be overcome by simply increasing the genetic diversity within the crop population. So, would further increases in genetic diversity provide further benefits? For practical reasons, variety mixtures may only contain three or four different varieties, which will ultimately limit the amount of genetic diversity that can be included. Therefore, a different approach is needed that can overcome this constraint, namely, population breeding.

EFRC, in collaboration with John Innes Centre, has just begun work on a six-year project funded by the UK Department for Environment, Food and Rural Affairs (DEFRA) that aims to investigate the potential for population breeding for winter wheat.
The approach taken by the project is to use composite cross populations. This approach is characterised by encouraging adaptation through selection to environmental conditions relevant at a given site. Naturally, this requires the availability of genetic variation and a composite cross is the best source of such variation.

Since the project has only just begun, there are no results available at present. However, this paper will provide an overview of the project and provide some indication of the anticipated benefits.

The composite cross breeding process is made up of a number of steps:

Identification of parent lines
Crossing and bulking-up
Evolutionary processes including both natural and directed mass selection

Identification of parent lines

The key to the identification of parent lines is to include the greatest possible range of genetic variation. This project has achieved this by selecting varieties from a broad range of breeding programmes, from across Europe, spanning the last forty years. However, it is here that molecular biology could also play a useful role. Recent advances in the analysis of DNA microsatellite variation mean that it is now possible to assemble comprehensive pedigree information that links varieties and breeding programmes from many different origins. From this, parent sets can be identified that include the greatest range of genetic variation possible.

The parent sets in this project were selected to include two prime characters; high yield potential and high milling quality potential:

High Quality: Bezostaya, Cadenza, Hereward, Maris Widgeon, Mercia, Monopol, Pastiche, Pegassos, Renan, Renesansa, Soissons, Spark, Thatcher.

High Yield: Bezostaya, Buchan, Claire, Deben, High Tiller Line, Norman, Option, Tanker, Wembley.

Additional crosses have also been made onto the male sterile lines: Male Sterile Plant 1, Male Sterile Plant 2, Male Sterile F2/F3 Bulk Popn 2/77, CIMMYT line: F1TOPDMSO102 NING 8201 DMS.

Crossing

The parent lines have been crossed in a half diallel or, in other words, each variety has been crossed onto each of the other varieties. This process resulted in the production of 210 cross combinations. John Innes Centre are currently bulking-up these crosses to provide sufficient seed to create the populations.

Composite cross populations

The individual crosses will be bulked together in different combinations, depending on their parents, to provide three main composite cross populations:

High yield potential
High milling quality potential
High yield + high milling quality potential

Each of these main populations will then be split to either include or exclude heritable male sterility (HMS). HMS has been included, as this will promote out-crossing so maintaining the heterogeneity of the populations.
Evolutionary processes and monitoring

The six composite cross populations will be grown and evaluated in a range of production environments (organic, integrated and conventional systems). This phase of the project will last for three years so that we will have three seasons of natural selection and two opportunities to conduct some simple directed mass selection, for example, removing excessively tall plants.

The experiments will be set up so that a number of key comparisons can be made, such as:

Composite cross vs. parent lines grown as pure stands.
Composite cross vs. physical mixtures of parent lines.
+ or – heritable male sterility.

The project also aims to consider scale effects (small vs. large plots (10 x small plot area)), to determine if the response of the populations is enhanced as the cultivated area increases.

Expected benefits

The research will deliver a unique insight into the evolution of genetically diverse wheat populations in a diverse range of environments. This will assist in elucidating the interaction between gene x environment.
From inclusion of production environments, including organic, it should be possible to determine key characters and ideotypes that contribute to successful production under these different systems.
The population material from the project will provide a valuable genetic resource for breeders, but it could also be used directly by farmers

Conclusions

It is very clear that modern cereal varieties, especially of wheat, that are bred for non-organic agriculture perform poorly under organic management.
Variety mixtures can help to overcome a number of the deficiencies of these varieties such as pest, disease and weed suppression.
The increased genetic diversity provided by mixtures can also help to buffer against environmental variation thus stabilising yield.
For organic agriculture, the use of diversity will become a central tool to ensure that productivity can be increased without the associated problems of intensification.
Population breeding approaches are one means of introducing this diversity into the organic production system.

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A participatory approach to designing and implementing organic 'Value for Culivation and Use' research

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Keywords: Value for Cultivation and Use, Variety Research, Participation, Ideotype, Spring Wheat, Organic

Introduction

Together with the organic sector we developed a research protocol for organic variety testing of spring wheat, the so called Value for Cultivation and Use (VCU) research. This protocol was recognised by the Dutch commission, which is in charge of the official VCU research. During this symposium we will elaborate on the participatory way of designing the research protocol. Since 2001 Louis Bolk Instituut and Applied Plant Research (PPO-AGV) have been conducting spring wheat variety trials according to the organic VCU protocol and comparing these with conventional VCU, in order to establish whether organic VCU testing makes a difference. We will also present the preliminary results of this comparison.

Value for Cultivation and Use (VCU)

In EU countries trading seeds of varieties of arable crops (e.g. cereals, potatoes) is regulated through EU directive 70/457/EEC. According to this directive only varieties which are on the official National Variety List, the European List or a list of another EU member state can be sold. In order to get on one of these lists a designated institution should test the variety. This is done in theVCU research.
Several plant breeders claimed that the VCU testing procedure impedes the introduction of new varieties, which are better adapted to organic farming (Lammerts van Bueren, et al., 2001). According to EU directive 70/457/EEC a requisite for passing the VCU trials, is that the new variety is "better" than the existing varieties. VCU is conducted under conventional management practices and important traits for organic farmers are not assessed. Under such circumstances one cannot determine which varieties are "best" for organic. Indeed breeders claim that in the past varieties with high levels of resistance, and hence desirable for organic farming, were rejected because of a slightly lower yield in conventionally managed fields.

Participatory approach to develop a VCU research protocol

To be able to determine the suitability of a spring wheat variety for organic agriculture, varieties should be evaluated for characteristics which are important for the organic sector. So, when we started with the design of the organic VCU the first question we raised was: which variety characteristics are wanted by the organic sector? To answer this question we invited farmers and traders to variety trials to evaluate the varieties. We gave them forms and asked them to list positive and negative traits, which afterwards were discussed together. This resulted in a list of traits and this list was further discussed during winter and finally resulted in an ideotype (see Table 1)

Our next step was to revise whether, with the conventional VCU research protocol, it would be possible to select varieties which complied with the requisites of the organic ideotype. The answer was negative, because many traits mentioned in the ideotype are not present in the Dutch conventional VCU research protocol. Among these are important traits such as early ground cover. Also the assessment of baking quality is based on conventional standards: baking performance is assessed on white bread, prepared with the addition of bread improvers, while most organic wheat is sold as whole wheat bread and bakers prefer to minimise the use of bread improvers. Besides that, it is unlikely that with conventional VCU research one can determine which varieties are best for organic, because performance is established in conventionally managed fields.

Table 1. The ideotype of Dutch organic spring wheat (adapted from Lammerts van Bueren et al., 2001).

Characteristics	Minimum	Ideal	Priority
Good Baking Quality			
• Hagberg Falling Number	260 s[1]	Optimum profit. This is yield (in kg) times the premium price for baking quality as high as possible	++
• Zeleny Value	35 ml[1]		++
• Protein Content	11.5 %[1]		++
• Specific Weight	76 kg/hl[1]		++
Good Grain Yield	Lavett = 100 (+ 6500 kg/ha)		++
Efficient use of (organic) manure	.....[2]	Desired profit to be gained with as low manuring level as possible	++
Reducing Risk of Diseases			
• Long stem	+ 100 cm (Lavett)	+ 100 cm (Lavett)	+
• Ear high above flag leaf	+ 20 cm	.....	++
• Ear not too compact	.....[2]	....[2]	+
• Last leaves green for the longest time possible (# days before harvest) = stay green index	....[2]	...[2]	++
Resistance against			
• Yellow Rust *(Puccinia striiformis)*	6[3]	8	++
• Brown Rust *(Puccinia recondita)*	7[3]	8	++
• Leaf spot (*Septoria* spp.)	6[3]	8	+
• *Fusarium* spp.	....[2]	......[2]	++
• Mildew (*Erysiphe graminis*)	8[3]	8	
Supporting Weed Management			
• Good recovery from mechanical harrowing	.....[2]	...[2]	+
• Good tillering	.....[2]	...[2]	++
• Rapid closing of canopy	Like Lavett	Better than Lavett	++
• Dense crop canopy	Like Lavett	Better than Lavett	++
Reducing risks at harvest			
• Stiff stem	7	8	++
• Early ripening	Mid august	First week of August	++
• Resistance against sprouting	7	7	++

[1] Based on the bonus system of Agrifirm (trader of +/- 75% of the Dutch organic wheat production)
[2] No values were given, because there was no quantitative information available on the item
[3] Based on the values for the variety Lavett in the Dutch Recommended List of Varieties of 2000 (Ebskamp & Bonthuis, 1999)

We discussed our findings with the Dutch Commission for the List of Recommended Varieties which supervises the VCU. They acknowledged our points and advised us to form a committee of key parties interested in organic wheat and elaborate our own research protocol. EU directive 70/457/EEC leaves space for this, because varieties can be admitted on a National List if these are an improvement for a specific region or production system. So we formed a committee and worked together with farmers, the industry and breeders to revise the protocol. The organic protocol was recognised by the Commission for the List of Recommended Varieties in 2001. The most important differences with the conventional protocol are summarised in Table 2.

Conventional breeders were quite active in discussing how to evaluate certain characteristics but also immediately drew attention to the financial issue. In the Netherlands VCU is paid for partly by the breeders and partly by the farmers. Breeders did not want to invest in organic, because the organic wheat acreage is too small and also returns from cereal seeds are too low. So a large acreage is needed to earn back breeding investment. Also because of the low returns, breeders strategy is to put only a few different varieties on the market. Therefore, apart from the varieties they sell to conventional farmers, they are not eager to bring distinct varieties for a small group of organic farmers onto the market. The economic aspects of VCU are an important constraint, because the organic sector is also unable to bear the costs of a complete VCU system for all arable crops. This has to be taken into account when designing an organic VCU system.

Table 2. Comparison of the approved organic and conventional protocols for VCU testing for spring wheat. (Lammerts van Bueren et al., 2001).

	Organic Protocol	Conventional Protocol
Research site	Managed organically, in accordance with EU regulation 2092/91, for at least three years	• Managed conventionally with mineral fertilisers; chemical pest and disease control
Seed	• Not chemically treated	• Chemically treated
Crop husbandry	• According to organic farm management practice	• according to conventional management practice; part of the trial is conducted without chemical protectants
Plant characteristics, whichare not observed in conventional spring wheat VCU *	• recovery from mechanical harrowing	• not observed
	• tillering	• not observed
	• speed of closing the crop canopy	• not observed
	• canopy density	• not observed
	• stay green index	• not observed
	• distance of ear-flag leaf	• not observed
	• compactness of the ear	• not observed
	• resistance against sprouting	• not observed
	• black molds in the ear	• not observed
Evaluation baking quality	• evaluation on whole wheat bread without artificial bread improvers	• evaluation on white bread with addition of ascorbic acid

* Other aspects that are observed and listed in the conventional protocol as well as in the organic protocol are not mentioned.

Preliminary Results of organic spring wheat VCU

Louis Bolk Instituut and Arable Crop Research (PPO-AGV), the institute which also conducts the conventional VCU in The Netherlands, began implementing the organic VCU in 2001. It is set up as a comparative study but as an important by product results will be considered for the Dutch Variety List. We compare organic VCU with testing the same varieties in conventional fields. This is to determine if conducting VCU on organic fields makes a difference and also whether a combination of organic and conventional VCU is possible. It could be that for some characteristics evaluating in a conventional or organic field gives the same results. In that case organic and conventional VCU could be combined, which would make it cheaper for both systems. This would partly address the economic concerns mentioned earlier.

At present we are still processing the second year data and therefore cannot yet present final results. Some preliminary findings are as follows:

- the use of chemical seed treatment has an important impact on outcome, especially in a year with bad conditions during germination. In 2001 some varieties in the organic fields showed very poor germination, while the same varieties showed a perfect stand in the conventional field, where we applied chemical seed treatment.
- In our trials disease pressure in organic fields was lower than in the conventional field. Diseases such as brown rust and septoria appear later and develop more slowly. So it could be argued that by relying on natural infection, conventional fields are better for selecting for disease resistance.
- Lodging, an important argument for not admitting varieties on the National List, occurred in conventional fields while in organic fields it did not. This suggests that for varieties which are suitable for organic farming, one could consider setting a lower standard for the minimum level of lodging resistance which is required for admittance on the National List.
- Differences between varieties for vegetative characteristics, such as early ground cover, are clearer under organic conditions than in conventional fields. Probably these characteristics should be evaluated under organic growing conditions.

Conclusions

Through the discussions on the ideotype the end-users influenced the characteristics which are used to evaluate the varieties in the organic VCU. Besides that they were involved in designing the organic research protocol, which defines how the evaluations are conducted and sets the criteria for selecting research sites. This guarantees that the research addresses the needs of the end-users. Conventional breeders showed concerns for the economic feasibility of organic VCU. Ultimately they do participate in the research by sending in new varieties, which are not yet admitted on a National List. The official status of the organic VCU is important for getting access to this new material. With the actual implementation of the research we still invite the breeders and end users to the fields and discuss the development of the research during winter. It remains important, because a protocol, once developed, needs revision every year, as we get new insights and because organic farming keeps on developing.

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Is organic plant breeding a public affair?

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Introduction

What do I mean with "public affair"?
On one hand seeds are commercial goods, are sold and bought as agricultural input. On the other hand not only breeders and farmers are interested in the quality and characteristics of seeds and the process of plant breeding. For example 70% of all EU citizens don't want genetically modified organisms (GMOs) in their food. Some of these people do not only oppose GMOs but develop or support an alternative path: organic agriculture and organic plant breeding.

In some way, plant breeding is even more a public affair and a public good than agriculture in general. It takes two years to get the EU certificate as an organic farm. It takes several years to bring a soil up after agronomic faults. But it takes at least 10 years to breed a new variety. And varieties that have disappeared, will never be brought back. Therefor the public should be interested in breeding and in many cases really is.

This is the background why the Zukunftsstiftung Landwirtschaft (Foundation on Future Farming), that has chosen organic plant breeding as its main topic. In the last 6 years organic plant breeding in Germany, Switzerland and the Netherlands has been funded with 250.000 to 600.000,-- EUR per year. These funds are raised from many individual donors and some foundations. We would not be successful in fund-raising, if breeding was not a public affair.

Sometimes it appears easier to explain to laypersons that organic agriculture needs it's own seeds than to convince organic farmers and experts. Everybody can understand that a different agricultural system requires also different seeds. Yet the farmers are under economic pressure and stick to the seeds they are used to, if organic varieties don't offer a higher income in the short run.
But breeders like Karl-Josef Müller, Peter Kunz in Switzerland and the members of Kultursaat have shown that after about 15 years of work organic breeding can lead to very interesting varieties. The spelt and wheat varieties of Peter Kunz do meet a good demand. The private but non-profit initiatives gave important contribution to the development of breeding - for example by introducing taste as selection criteria or regarding the plant architecture. The first organic varieties show good results, but there is still a lot of work to do.

I follow the definition of Organic Plant Breeding in the IFOAM Basic Standards: *"The aim ... is to develop plants which enhance the potential of organic farming and biodiversity. Organic plant breeding is an holistic approach which respects natural crossing barriers and is based on fertile plants that can establish a viable relationship with the living soil."*

To-do-list

We are convinced that the potential of organic agriculture is just beginning to unfold. Organic plant breeding will bring up plants that fit better in a regionally oriented agriculture with low external input and high product quality.

The German Federal Department of Agriculture organised a workshop “breeding for organic agriculture” in June 2002 in Hannover. Most participants agreed that organic breeding is suitable to improve organic agriculture. They described a large variety of important basic and applied scientific projects that have to be done. As soon as breeding and maintenance are conducted under organic conditions typical problems arise, e.g. seed diseases and have to be solved with organic methods. Actually the proceedings of this workshop can be read as a to-do-list for organic seed production and plant breeding with about 20-30 scientific projects.

Financing organic plant breeding

Usually breeding is financed by licence fees.
For organic breeding two questions arise:
How can a new breeder start his work, when it takes at least 10 years to develop a cultivar?
Can organic plant breeding be financed from licence fees? Is the market strong enough?

Foundations support pioneer projects

The biodynamic agriculture has started with breeding activities in the 20iesof last century. The discussion about GMO has pushed this work since about 1990. In 1995 the Saatgutforschungsfonds (Seed Research Fund) has - together with other foundations like Software AG Stiftung - taken the initiative to support these biodynamic and organic plant breeding initiatives.

The donors have a wide range of reasons for supporting organic breeding.
They want to keep organic seeds free of genetic modification.
They feel that organic agriculture should be independent on that important field.
They want to keep a wide range of diverse varieties.
They see that breeding and breeding related science is a fascinating topic. New breeding methods and quality aspects are good examples for a future holistic approach to plants.

After about 7 years of non-profit funding “the question whether the used capital should be considered as starting capital or whether the initiatives will need a continuous financial support is difficult to answer as long as these initiatives do not have an own portfolio of organic seeds of different varieties.”

Urs Niggli already pointed out that organic breeders need state funding as long as organic farming is a niche. The foundations can not raise enough money for breeding activities in all relevant species. And it will be shown that we are far away from a situation that organic breeding can be financed by licence.

Licence fees

As there exist only few organic breeding projects, the following calculation is rather an estimation.

Table.1: Financing organic breeding (e.g. cereals)

	Costs of breeding per crop p.a.	75.000 EUR
	Costs of maintenance And administration per crop p.a.	15.000 EUR
	Total costs per crop p.a.	90.000 EUR
	License / dt (conventional level)	6 EUR
	License / ha (on 50% of the area)	12 EUR
	Cultivated area necessary to cover the breeding costs	15.000 ha
	Cultivated area organic winter wheat in Germany in 2000	27.000 ha
	Cultivated area organic winter wheat in Germany in 2010 (+ 20% p.a.)	167.000 ha
	Cultivated area organic oat in Germany in 2000	13.000 ha
	Cultivated area organic oat in Germany in 2010 (+ 20% p.a.)	80.000 ha

Usually the costs per cereal variety passing the official tests sum up to about 400.000 EUR to 2 Mil. EUR. The German Plant Breeders Association (Bundesverband Deutscher Pflanzenzüchter) indicates an average amount of 1 Mil EUR per new variety.
This calculation is based on the costs of a plant breeding project with 4 staff members breeding two crops and succeeding in raising one variety per crop every few years with a constant income of license fees. The cost and income level of the breeding projects is modest / moderate.
The license per dt differs a lot, 6 EUR is an average. At the moment licences for organic seeds are higher, but we assume that in the medium term organic seed licence will have the same level as conventional varieties.
The licence per ha depends on the sowing density (200 kg/ha)
If 50% of the seeds are certified seeds and 50% farm saved seed (calculated without licence), a cultivated area of 15.000 ha is needed to cover the breeding costs. I suppose Urs Niggli calculated 20.000 ha because of higher costs in Switzerland.
The licence income can be increased by direct agreements between breeder and farmer as the basis of licence fees for farm saved seed. This is a way farmers can co-operate with breeding projects developing seeds which meet their expectations and can easily be saved on farm.
The total cultivated area of winter wheat in German organic agriculture in 2000 was 27.000 ha. With an estimated growth of 20% per year, 67.000 ha are expected in 2005 and 167.000 ha in 2010, if the share of crops within the rotation system remains unchanged. The total cultivated area of oat in German organic agriculture in 2000 was 13.000 ha. With an estimated growth of 20% per year, 32.000 ha are expected in 2005 and 80.000 ha in 2010. The chances to get reasonable licence income from crops like oat are very low.
To estimate the licence potential we have to consider at least 10 different wheat varieties and three different oak varieties necessary to accommodate different climate and soil conditions and markets. In organic agriculture the specific local and regional circumstances are less streamlined by fertilizers and pesticides, so more different varieties are needed. With the extension of the organic market the seed market will change too. As more cereals will be used as fodder, other varieties will be necessary.

This simple calculation leads us to the fact that licence fees can only cover a rather small part of the breeding budgets of most crops. Only breeding winter wheat or winter rye could be substantially financed by licenses within the next 10 years - depending on the growth of the organic market. For all other crops self-financing is not to be expected.

It may be argued, that there will be seed companies who were ready to invest 500.000 to 1 Mil EUR per variety and wait until the organic market share grows to sustain a return on investment from the fees. Until now in Germany one breeding company has started to sell a organic variety of wheat. Personally I doubt, that this will happen for a wide range of crops. Only a market share of more than 20% would change the situation decisively.

But even if family owned and multinational breeding societies are going to enter the organic seed market and some of the existing breeding projects are taking the chance to finance their activities by licence there will still be a need for basic and applied science, which can only be funded by the state and foundations. And I suppose that "free" breeding will continue to play a role not only as pioneer work.

Public breeding programs

For decades breeding and breeding-related research in universities and industries has focused on high yields in an intensive farming system. Even research on genetic modification has been supported by public funds.
To reach the political goal of more organic agriculture, public financial support of organic breeding is necessary. I would like to compare the situation with breeding of grape varieties. In many countries only public institutes are developing grapevines. As the breeding period lasts very long and the cultivated area is small no private business offers new grapevine varieties.

It will be difficult to obtain governmental support, as in Germany and Switzerland public breeding programs have been reduced during the last years.
The Swiss spelt-breeding program for example has been given to the private breeding initiative of Peter Kunz. As there are no public funds, foundations have to finance the former public programmes. During the workshop in Hannover several breeders and scientist pointed out that public pre-breeding and breeding programmes e.g. on potatoe resistance against *phytophtera infestans* have been given up for financial reasons MÖLLER (2002).

To ask the government for financial support in these times seams to be naive. It will only be successful, if funds given to conventional projects in the past will be spent for organic projects in the future. This will only happen, if the organic movement declares plant breeding to be a decisive point of development and convince politics that investment in organic science has a high return.

The plea for public funding of plant breeding does not mean support of foundations, donors, enterprises should decrease. Foundations will probably continue their activities but feel encouraged by official support. It seems unlikely that foundations continue financing a wider breeding program if there is no public contribution at all.

Profit and non-profit approach in breeding

Most of the important scientific research in organic agriculture is not private because it will not lead to a product that can be sold on the market. Its not for lack of success that breeding projects need public funds. Following the organic standards organic breeding will not be a shooting business, even when it is very successful.

We have to consider that in organic agriculture all science and development is closely connected with the farmers. In organic agriculture the solutions for most problems have to be found without pesticides and fertilizer, if possible on the farm itself. A system that reduces the input lacks the scientific power and support of companies selling these inputs. Therefor it is crucial to strengthen the capacity of farmers for innovation.

Traditionally and still in many countries world-wide breeding is in the hand of farmers. In Germany in the 18th century professional breeding developed. During the 19. century both existed side by side, breeding on farms and on professional level, this lead to a maximum of varieties. (BARTA)

Maybe for the future development of organic agriculture we need a double strategy too - a strategy of private and of public or non-profit breeding.

Some of the existing breeding projects will probably take the chance to finance their activities by licence fees. Soon or later - depending on the organic market share - breeding companies are going to enter the organic seed market. Like the first organic bakeries were family owned, the first private organic plant breeders will be family owned. Unfortunately, the actual concentration process reduces the number of small and medium sized breeding companies rapidly. The moment for multinationals to invest in organic breeding seems to be quite far away.

I assume that the publicly funded breeders not only play a role as pioneers, but will continue to innovate plant breeding and science. For me the problem resembles a discussion on the quality of films from Hollywood versus Kaurismäki. What ever your preference is, Hollywood draws masses of visitors into the cinemas while Kaurismäki can not be produced and presented without public funds. Both together makeup a diverse and interesting cultural live.

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The economics of Bejo's organic seed programme

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Statement

Any important organic seed programme for biennial crops, such as ours, will fail if the organic chain is not closed soon, either by law or self regulation.
Therefore the movement should concentrate on this problem.

Who is Bejo?

Bejo is a vegetable seed company, involved with breeding, production, processing, enhancing and sales. The company are specialists in cross-pollination of biennial outdoor vegetables and is market leader in Europe with carrot, onion and brassicas. In addition the company is active in 30 other species. Bejo was formed in 1978 by a merger of the family companies Jacob Jong (1899) and Beemsterboer (1912). Nowadays Bejo has 18 companies world wide and is still a family owned company.

Bejo Organic Department

The company has always had an impressive market share in the organic sector on the basis of non-chemically treated, conventionally produced seed. Anticipating changes in EU regulations by 2004, Bejo started their trial productions of organic seed in 1996. During the following years the organisation developed a specialised department purely involved in organics.
The Bejo Organic Department controls and organises the research, production, processing and sales of organic seed and uses skills and facilities of the Bejo company in a matrix structure. Five full time employees are working for this department.

Boundary conditions for a successful organic seed programme

a) Availability with suitable varieties of organic seed
b) Market size
c) Acceptance of increased price for biennials
d) IFOAM breeding context
e) Obligatory use of organic seed

Availability

Bejo
At the moment there are 150 varieties in the organic production program which are intended to be available in 2004. At first glance it seems impossible to run a profitable organic seed program. How then can a company develop and maintain 700 varieties for 97% of the market (conventional) of which

approximately 450 are delivered inside the EC and yet run an organic seed program of 150 varieties for the remaining 3% (organic) marketplace?

ESA (European Seed Association)
According to the ESA survey for most species there will be enough vegetable seed and varieties available. The number of varieties will quickly increase if rules and regulations will be clear.

Market size

Table 1. Market size illustration

Crop	Hectares EU Total	Organic 5%	Market segments	Ha. per segment	Kg seed
Brassica's *	100.000	5.000	45	112	28
Carrot	75.000	3.750	30	120	240
Onion	100.000	5.000	35	140	564

* Exc. cauliflower and broccoli Source 'Total figures: FAO

Acceptance

Cost index figures
To explain the price increase of organically produced seeds we show you some tables.
We compare the production of 1000 kg conventional onion seed with the production of 1000 kg organic onion seed .

Table 2. Onion seed production

Cultivation of hybrid onion seeds	Conventionally grown		Organically grown	
Net seed to produce (kg)	1000		1000	
Gross seed weight kg/ha	420		200	
Hectares of seed production	2.4 ha		5 ha	
Amount of bulbs per ha	8 ton		5.6 ton	
Required amount of onion bulbs (2nd year)	19 ton		28 ton	
Onion bulb production (1st year)	0.44 ha		0.9 ha	
Basic seed to produce onion bulbs	2.2 kg		4.5 kg	

We produce less bulbs/ha and those bulbs need extra treatment before planting. When organically grown the production of seeds/ha appears to be 52% lower. The yield (seeds) per plant is lower, because we start with smaller sized onions. More hectares are used for organic seed production and we pay a higher price per hectare.
Twice as much expensive basic seed is used to produce enough onion bulbs.

Table 3. Cost index hybrid onion seeds

Cultivation of organic hybrid onion seeds	Organically grown	
		Cost index
Total up to and including seed production		3.05
Processing: cleaning, waste, NCT treatment,		
Quality control, packaging and logistics		0.15
3.20		
Small scale effects and accreditation		0.15
3.35		
Sales costs		0.10
Total		3.45

Most important cost increasing factors:
- We need more basic seed
- Higher price per hectare in the first year
- More hectares needed
- Higher price per hectare in the second year
- Lower seed production / more hectares needed
- Costs of processing
- Small scale effects

Some more cost index figures: carrot 2.3, brassica's 2.3, cauliflower 1.7.

IFOAM breeding context

IFOAM Draft Plant Breeding
There may be a difference of opinion between the growers of organic produce and the regulators. Whilst the IFOAM is already looking ahead to topics such as fertile hybrids and organic varieties, many organic farmers may not yet be committed to the use of organic seed.
The recent drafts from the EU show provisions for further derogation. This makes the economic base for organic seed programs even more uncertain, it is already a long-term investment. Future implementation of IFOAM discussions will be very difficult and will lead to higher prices.

Obligatory use of organic seed

The EU draft seed regime after 2003, doesn't close the organic chain. Derogation's and unwanted escape possibilities remain possible.
There is a complex situation of databases per country foreseen.
At the moment there are no crops in the annex for obligated use of organic seed.

Summary

a) Availability:
   Bejo`s involvement in organic a long term strategy.
b) Market size:
   Organic market should grow to 10%
c) Acceptance:
   Price of organic seed of biennial crops will be much higher.

d) IFOAM:
   Introduction of “organic varieties” means another price increase.

e) Obligation:
   EU draft doesn’t stimulate organic seed production.
   Growers hardly use organic seed.

Discussion points presented at the end of the presentation

- How to achieve transparent and strict EU regulations (and world wide)?
- how to achieve commitment of organic partners to use organic seed?
- Is the IFOAM draft on organic varieties a bridge too far at the moment?
- Are opinion leaders sufficiently aware of the economic value of varieties?

Conclusion

The organic movement is facing an historic challenge to take a new step in closing the organic chain. Commitment of all parties is needed. If ‘2004’ fails will there be a second chance?

Part B
Posters
(alfabetical order of institute)

Organic seed in the Nordic countries

Background

Huge differences are seen in the use of organic seeds in different countries. In some countries, the majority of organic farmers use organic seeds of the domination crops, while organic farmers in other countries predominately uses conventional seeds. The IFOAM basic standards, the EU-regulation, and standards in most countries worldwide request organic seeds to be used if such seeds are available. If not, the certifier can accept the farmer to use conventional seeds. Before 2004, the EU regulation of organic agriculture will be revised. The current analysis is conducted as a background paper for this revision.

Conclusion

The main factor for the overall development of the organic seed sector in the Nordic countries has been the inspection procedures actually controlling that organic seeds are used whenever available.

The seed certification system does not ensure that certified seeds are healthy. As organic seeds are not treated with fungicides, the seed health issue comes more into focus. A huge proportion of the organic seed lots are discarded because of seed borne diseases.

Recommendations:

1. *Availability and suitability*

the possibility to grant derogations to use non-organic seed in case or shortage of organic seed should be prolonged.

IF

a)_ there is no variety on the market

b)_ the varieties available does not fit the purpose of the in the area of production

c)_ there is an appropriate variety registered, BUT the holder of the registration does not deliver to the area of the user.

d)_ the varieties available is infected/contaminated with seed borne diseases above the recommended threshold levels in the area of production

2. *Database*

all competent authorities makes or have some one else to make an updated national list of available seed lots in the country in a database.

3. *Propagation*

organic seed should be used whenever available in relevant variety and generation of multiplication, i.e. organic seed shall be preferred also for seed propagation.

The project report (about 50 pages) will be published in TemaNord later this year. TemaNord is an official journal of the Nordic Council of Ministers. Please see www.norden.org for further information

Scanagri

Organic seed in the Nordic countries

A sector analysis by
Anders Borgen, Scanagri*), Denmark,
Ann-Marie Dock Gustavsen, Jordbruksverket, Sweden
Juha Kieksi, Kasvintuotannon tarkastuskeskus, Finland
Torgun Johnsen, Landbrukstilsynet, Norway
Ragni Andersson, Jordbruksverket, Sweden
Rasmus Ornberg Eriksen, Plantedirektoratet, Denmark

Recommendations:

4. *Seed health thresholds*

the competent authorities must define national quality criteria including criteria for seed health for untreated seed relevant for their region and crops. Organic seed shall be preferred only, if organic seed meeting these standards are available.

that public funds are allocated for trials to define thresholds for such health standards.

that each country uses harmonised seed health testing methods such as ISTA-rules

5. *Variety testing*

field trials relevant for selection of varieties for organic farming are planned in cooperation with neighbouring regions (and/or countries) in order to improve the possibility to select varieties marketable in more than one country or region.

The seed producers selects varieties able to be marketed in neighbouring regions in cases where there is a risk of overproduction in one region. This will improve the possibility to supply neighbouring regions.

6 *Seed mixtures*

a legalisation on the marketing of ley seed mixtures within the EU-countries even if the mixtures contain both organic and non-organic seed in cases where not all relevant ingredients are available as organic seed.

7 *Potatoes*

focus is put on potato production by intensified advisory, research and derogation practice not allowing the use of non-organic seed potatoes if organic seed tubers of the same or an equal variety are not available. We recommend that exemptions to use non-organic seed potatoes are administered on a species level unless for special purposes (e.g. stark production, early production)

8 *Vegetables*

there is an intensified communication between seed companies, organic advisors researchers and organic vegetable producers in order to insure that the seed produced by the seed producers actually reflects the variety and quality requirements demanded by the users

9 *non-organic seed treated with pesticides*

the possibility to use non-organic seed treated with pesticides not listed in the EU regulation, Annex IIb shall not be prolonged.

Scanagri is one of the largest Rural Development Consulting Groups in Europe with some 100 staff members. Scanagri works with the key issues of our time within food, rural livelihood, environment and natural resources, and provides a wide range of services in capacity building, technology and management for sustainable solutions. Scanagri has 6 consultants working exclusively with organic farming issues, such as certification, marketing, production, sector development and research. The focus areas are Asia, Africa and eastern Europe, but projects are placed in other regions too, as this presentation shows. Please contact Scanagri if you need assistance.

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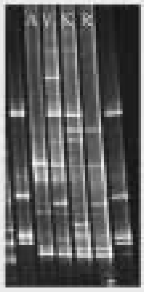
Scanagri

PLANT RESEARCH INTERNATIONAL

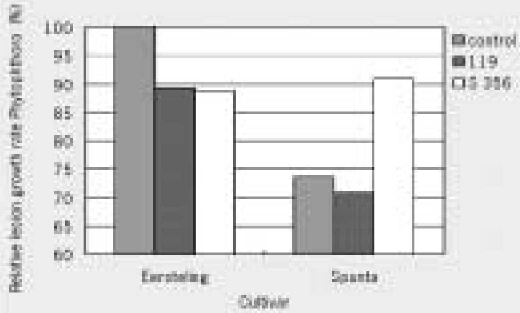
Breeding a potato that benefits from endophytic rhizobacteria in organic soils

Leontine Colon, Leo van Overbeek, Anneke Balkema, Dick van Elsas & Huub Löffler



Cultivar
A = Aziza
V = Vento
K = Karakter
R = Robijn

Quick and reliable identification of endophytes by DGGE.



The endophyte E119 increased resistance to late blight.

Plants select their own favorite endophytic microflora

- Many rhizobacteria colonize roots
- Only some of these cross the root-stem barrier and colonize the plant
- The plant genotype decides which species will colonize

Potential beneficial effects

- Plant growth
- Antagonism to pathogens
- Induced resistance to pathogens

Applications

Cultivars

- Breed new potato cultivars that interact better with beneficial microflora
- Choose the appropriate cultivar to match the local microflora

Accurate scoring of resistance to potato late blight in inoculated field trials

Crop husbandry

- Use a specific crop rotation to improve soil microflora
- Add favorable rhizobacteria to seed tubers or to soil

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WAGENINGEN UR

Cereal Cultivars Innovations adapted to Organic Production : a new challenge

D.DESCLAUX [2] ,Y.CHIFFOLEAU [1] , F.DREYFUS[1], J.C.MOURET[1].

[1] : INRA- UMR Innovation – Place Viala – 34000 Montpellier
[2] : INRA- UMR Diversité et Génome des plantes cultivées- Domaine de Melgueil- 34130 Mauguio
corresponding author: desclaux@ensam.inra.fr

To face and better manage the development of new varieties in a society calling for more and more transparency, the French National Agronomic Research Institute (INRA) has get involved in an ambitious reflexive programme about the question of "impacts, acceptability and management of varietal innovations", engaging all its thematic research departments. New collaborations between social and technical sciences are promoted to produce, from exemplary case studies, generic concepts and tools to assess the different types of impact of a new variety.
Breeding and management of new genetic materials adapted to organic farming conditions constitute an appropriate theme to develop such an integrated process. A pluridisciplinary research team, associating plant breeders, soil scientists, ecologists, agronomists, economists, sociologists, in close collaboration with professionals, will try to assess both the agroenvironnemental and socioeconomic impacts of changes, by studying current dynamics around original durum wheat and rice cultivars adapted to organic production in different territories, especially in Camargue.

This action-research programme is built around thematic activities in relevant domains :

Plant breeding
- Varietal types: to study the interest of mixed lines or populations compared to pure lines commonly used under conventional conditions, in order to ensure pathogene resistance durability.
- Breeding method : to find alternative breeding methods to increase and manage genetic variability, like recurrent and participatory breeding methods. Genealogical breeding method currently developed on cereals lead to a decrease in genetic variability because of the early and severe screening that is mainly done on too centralised trials.

Agronomy
- to understand soil organic nitrogen dynamics
- to elaborate agronomic diagnosis to characterise each environment in order to better understand G x E Interactions.
- to manage cropping systems and rotations.

Socio-Economy
- to assess social and economic factors of organic conversion by producers
- to analyse sociological and economical mechanisms of innovative collective action assuming economic practices embedded in social systems.

Management
- to build a collective learning network at territorial level by linking different "roles" relative to the cultivar innovation project.
- to develop a co-breeding program involving producers

These thematic researches aiming at specific evaluation tools are combined with collective activities designed for a generic and pedagogic integration of results in a co-constructive interdisciplinary process.

Keywords: *Durum wheat, Rice, Organic Production, Participatory Plant breeding, Impact Assessment Interdisciplinarity.*

Cereal Cultivars Innovations adapted to Organic Production : a new challenge

INRA CENTRE DE MONTPELLIER

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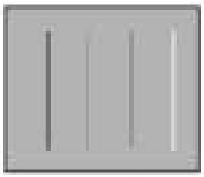
J.C.Mouret, Y.Chiffoleau, F.Dreyfus, - INRA- UMR Innovation – Place Viala – 34000 Montpellier - **France** (mouret@ensam.inra.fr)

Plant breeding

• varietal types



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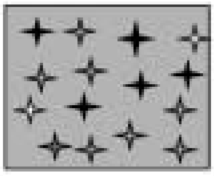


?

Pure lines **Populations**

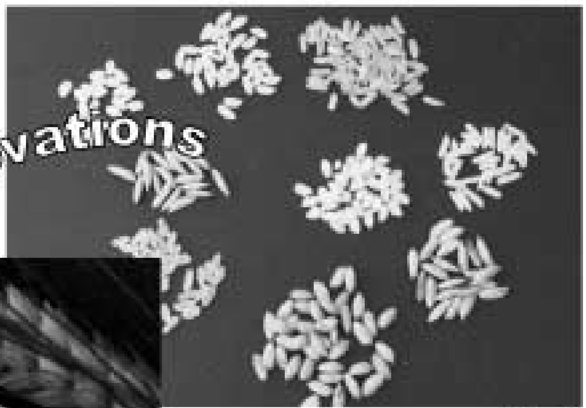
• Breeding method:
Finding alternative methods to increase and manage genetic variability:
- Introgression from wild species
- Recurrent breeding method
- Participatory breeding method

Agronomy

• Agronomic diagnosis to characterize each environment

• Soil organic nitrogen dynamics

• Manage cropping systems and rotation



On Rice and Durum wheat

Socio-Economy

• To assess social and economic factors of organic conversion by producers

• To analyse sociological and economical mechanisms of innovative collective action assuming economic practices embedded in social systems.

Management

• To build a collective learning network at territorial level by linking different ' roles ' relatives to the cultivar innovation project

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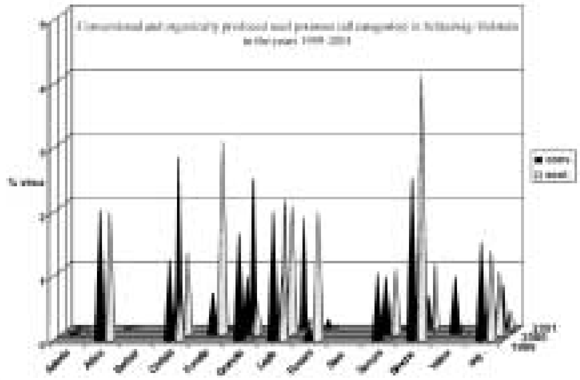
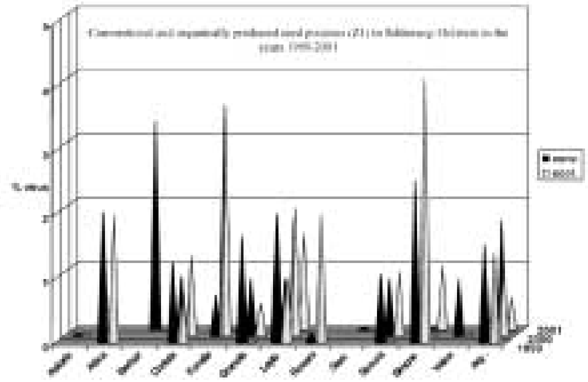
Keywords: *Durum wheat, Rice, Organic Production, Participatory Plant breeding, Impact Assessment Interdisciplinarity.*

Assessment of Seed Potato Production in Organic Farming

Dipl. Ing. agr. Susanne Fittje, H. Bremer, Dr. Herwart Böhm

Comparison of organic and conventional seed potato production in Schleswig-Holstein





- In Schleswig-Holstein successful production of organic seed potatoes takes place. The contents of virus infected tubers are very low. In an investigation, the content of virus infected tubers for the years 1999-2001 was evaluated.
- A comparison of the results of conventional and ecological seed potato production showed that in average of the three years (all categories: conv. 1,33/ecol. 0,96; Z1: conv. 0,84/ecol. 0,61) ecologically grown seed potatoes had less fractions of virus infected tubers. There are differences between the varieties and between the years.

Green Crop Lifting

1. Haulm cutting

- with transportation of haulm and stalks besides unlug rows

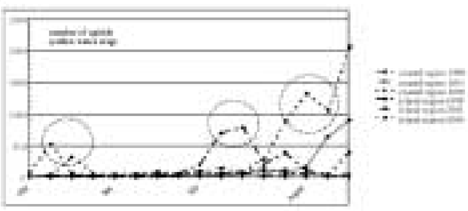
2. Green crop lifting: lifting and covering over

- careful lifting because of the high susceptibility to peeling of the immature tubers

3. Potato harvesting

- with usual technics after skin setting

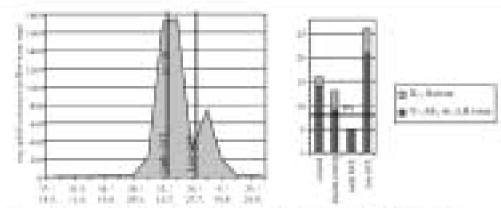
- Green crop lifting was tested against its suitability for minimizing viral infection of seed potatoes.
- Its advantage over haulm cutting is the instantaneous and definitive cut of haulm and separation from tuber without the possibility of regrowth and reinfection.
- Disadvantages are yield losses and skin damages on the immature potato tubers.



Aphid occurrence in yellow water traps at two regions in the years 1999-2001

- In the coastal region a very low pressure of aphids was observed over the three years. In contrast there was a higher pressure of aphids in the inland region.
- Only 1999 brought an early and outstanding pressure. In peak times (middle of July 1999) the number of aphids was more than 12 times higher compared to the coastal region.
- In the year 2000, heavy flight occurrence emerged not before the end of july. At this time, the haulms were already dead. The danger of virus infections caused by spring flight of aphids like in the year 2000 can not be fought by GCL.

- On 7 farms in northern Germany (4 sites in the coastal region [Schleswig-Holstein] and 3 sites in the inland region [Lower Saxony]) the green crop lifting at two different dates was checked during 3 years against the traditional process (haulm cutting) and a control plot (natural senescence) with regard to the effect of presprouting.
- The focus of the investigation was the amount of viral load. Yield reduction and tuber damage was recorded. Flying activity of aphids was monitored.



Influence of green crop lifting, haulm cutting and natural senescence on virus diseases at one site at the inland region 1999

- At site 5 (inland region) with high aphid pressure virus diseases were reduced by the early green crop lifting and fell short of the threshold of 8% (German limit for certified seed potatoes). However 20% of the yield had to be eliminated.
- In the coastal region with low numbers of aphids there were very few virus diseases without any differences between the tested treatments.
- Caused by the early date of GCL the total tuber yield reduction averaged out at 18,8 % over the three years compared to the control. Related to the marketable seed potatoes (28-58 mm) the yield reduction amounted 14.1 % only.

- Green crop lifting is an effective way to reduce virus infection in years with early and outstanding pressure of aphid occurrence.
- Further investigations are necessary to define aphid occurrence thresholds in order to ensure an economical green crop lifting in organic seed potato production systems.

Dep. of Ecological Agriculture • Inst. of Crop Science & Plant Breeding • Christian-Albrechts-University, Hermann-Rodewald-Str. 9, 24118 Kiel, Germany • sfittje@gmx.net

PLANT RESEARCH INTERNATIONAL

Initiative for a COST project:
Plant propagation material for organic farming

Steven P.C. Groot

The need for high quality propagation material
In all farming systems the quality of the propagation material has a large influence on the productivity of the crop. The genetic potential is laid down in the variety purchased, but healthy and vigorous seeds or other planting material are needed for a good start. Suppliers of material put much effort in achieving this.

Organic propagation material
According to the European regulation Nr. 2092/91 all plant material used for organic farming should have been produced under organic farming conditions. At this moment organic farmers frequently use material from regular productions without chemical treatments, due to lack of organically produced material. However, these deviations have a deadline of 1 January 2004. It is expected that at that moment organically produced seeds will be available for the main vegetable crops, but for small crops and ornamentals it is highly doubted. Moreover it is questioned if the available varieties are the most suited genotypes for organic farming?

Scattered research
Much research is needed to support a cost-efficient production of seeds or vegetative propagation material. At this moment research is performed at several places in Europe. Unfortunately, this research is highly scattered and relative little international collaboration has been established. This is very much in contrast with the European broad and urgent need to find solutions.

COST
To stimulate the co-ordination of European research activities, the European Commission provides the COST program. COST stands for *'Co-operation in the field of Scientific and Technical Research'*. Almost all European countries (EU and non-EU) can participate in COST projects. COST projects provide funding for meetings (including travel and subsistence of participants), organisation of workshops, joined publications and short term scientific missions. However, COST projects do not support the research itself. Detailed information regarding the COST program can be obtained through the web site: http://cost.cordis.lu/src/home.cfm.

Initiative
Our intention is to initiate a COST project on plant propagation material for organic farming The main objective of such a project should be to increase the knowledge required for the production of high quality seeds and vegetative propagation material for organic farming.

The project should stimulate the interaction between ongoing research and the initiation of new projects. The latter either in the frame of the EU FP6 programme or nationally. The proposed COST action should also closely interact with ongoing activities from ECO-PB and IFOAM.
All interested researchers, institutions and companies are invited to contact me with suggestions and to join this initiative.

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WAGENINGEN UR

Regeneration of elder breeding varieties and landraces of wheat, barley, oat and rye

On-farm-conservation and development with organic farmers in north-eastern Germany

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16225 Eberswalde

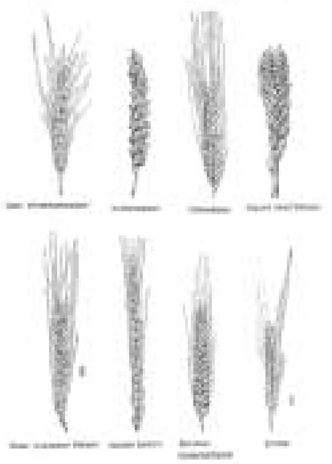
Herbert Lohner,
Verein zur Erhaltung und Rekultivierung
von Nutzpflanzen in Brandenburg e.V.
16775 Greiffenberg

Introduction:

On-farm-conservation of adapted landraces and former breeding varieties of cultivated plants is task of international treaties and conventions (CBD 1992, Rio; FAO-GPA 1996, Leipzig;..)
Additionally it is also task for a modern and sustainable landuse planning in areas dedicated for nature protection and mangement of endangered species.
A cooperation of local authorities for biosphere reserves and nature parks (LAGS) with national genebanks (IPK Gatersleben, BAZ Braunschweig), governmental parts (administration for seed control, field trial station - LVL), interested farmers and the local non-governmental organisation for on-farm-conservation of neglected cultivated plants (VERN e.V.) deals for evaluation and reestablishing elder breeding varieties and landraces of regional origin in organic and low-intensive production systems.

Since 2000 the project is part of the agro-environment programs of the state Brandenburg, sponsored by the EC (acc.EC decree 2078/99).
Samples of genebanks have been identified for regional origin, regenerated, evaluated and descripted. Successful cultivars were given to farmers and also tested under experimental conditions together with modern cultivars.

[illegible] varieties of wheat (SCHLIPF 1920, Manual of agriculture)



Objects of the project:

Identification and description of useful elder cultivars adapted to the mainly poor sandy and dry conditions of wide parts of North-east Germany.
Promoting farmers in nature protected areas for taking care for own seed production and using it for purpose of environmental management in wider areas of biosphere reserves and nature parks. Identification and development of advantageous material for regionalized plant breeding in a more participatory way.

Material and methods:

Identification of important regional cultivars in the history (resulting expertise for the EC-Program in 1999)
Searching for available samples under rule of gene banks and other collections,
Regeneration and smallplot testing (started 1996),
Distribution to farmers, organizing advise and governmental control by a network of governmental and non-governmental organisations (additional part of the EC-Program 2000-2006),
testing of harvest quality and processing suitability (2000-2002),
comparing yield of chosen elder cultivars to modern varieties under conditions of less intensive regional ecofarming by field trials (2001-2002).

Results:

Some historic cultivars of regional breeding origin from north-east Germany were successfully tested for the use in modern ecological farming methods and for specific agro-environment management.
A network of farmers and gardeners was established and takes care furtheron of the selected cultivars as homestead cultivars, available also for other interested farmers.

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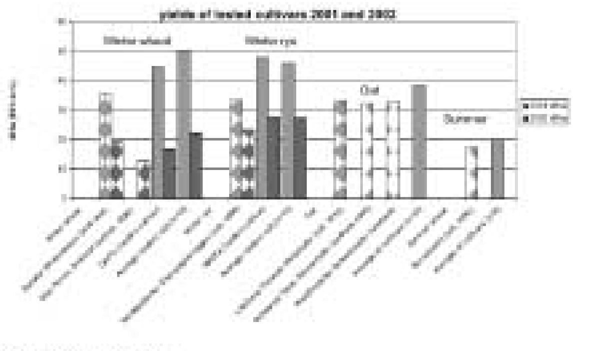
Quality characteristics

Cultivar: 'Kuverts ostpreussischer Dickkopf' about 1900, Ostpreussen-Poland
Triticum aestivum compactum
4 years results from a farm site in Brandenburg 1999-2002, organically grown

Year	protein % (of 100% d.m.)	gluten %	glutenindex %	sedimentation
1999	16,3	34,3	42	
2000	13,2	30,1	43	23
2001	12,8	25,3	38	
2002	17,3	38,8	50	23



Further informations:

http://www.brandenburg.de/land/mlur/politik/foerder/zukula16.htm
http://www.brandenburg.de/land/mlur/l/pflanze/oekbau.htm
http://www.brandenburg.de/land/mlur/l/pflanze/oek_wwei.htm
http://www.brandenburg.de/land/mlur/l/pdf/oek_ha01.pdf
http://www.brandenburg.de/land/mlur/l/pdf/oek_sw01.pdf
www.vern.de

Special thanks to BIOKORNTAKT GmbH (Trading agency for organic cereals) for the financial support of quality testing and marketing arrangements.

"Organic farming needs organic plant breeding" – a network for independent seed production and plant breeding

CHRISTINA HENATSCH

Association for bio-dynamic breeding research and development of cultural plants – "Kultursaat" e.V.; Auguste Victoria Str. 4 D-61231 Bad Nauheim

Keywords: Organic seeds – network propagating and plant breeding activities – participative breeding

Motivation:

Developments in conventional breeding (its multinational structure, use of biotechnology, gene technology and the disappearance of open pollinated varieties) and the current discussion about organic breeding standards show, that the organic movement must go its own way and face up to the challenge of developing its own methods and strategies.

The Initiative Group for Bio-Dynamic Vegetable Seeds in Germany and the Association for Bio-Dynamic Vegetable Plant Breeding, "Kultursaat", have built up a network for developing bio-dynamic plant breeding and seed production through the close cooperation of farmers/gardeners, breeders and the association. An organic seed company (partly owned by the propagators) is looking after cleaning, testing and draw off.

Gardeners	Breeders (mostly gardeners themselves)	Association "Kultursaat"
-Propagation -Testing of new varieties - Ideas/feed back	- Breeding in association with the gardeners - Research into: - new breeding methods - nutritional quality	-Coordination of plant breeding - Financial support - Payment of registration and testing fees - Owner of new varieties

The idea is for plant breeding to be returned to the gardeners/farmers themselves. The practical agricultural/horticultural experience and care of crops and the relationship between human being (breeder/gardener) and plant are the main prerequisites for successful plant breeding.

The following breeding and selection methods used and worked with by "Kultursaat"- breeders, are effective and simple enough to be applied directly at farm level:

Breeding methods are:

- Consistent and rigorous selection from a large stock base.
- Single plant selection.
- Cross fertilisation.
- Creating variation and developing special characteristics through:
  - Geology, geography and mineral provision
  - Effects of planetary influences and the bio-dynamic preparations.
- Influence of human and cultural conditions.…more to develop

Breeding aims are:

- Good development and root growth
- Growth through organic fertilisers
- Ability to interact with the environment
- Tolerance and resistance to adversities
- Develop species-typical growth patterns and maturation processes
- Good, species-typical taste and nutritional qualities

...

During regularly held meetings (3/year) and more frequent regional ones, we train ourselves through studying background information, practical aspects and methods of breeding and comparing each others work and procedures. Together we then develop our skills and evolve new ideas and methods.

In the course of the last 15 years, Kultursaat has bred more than 20 new (registered) varieties. The first qualitative results we have had include better taste and higher nutritional quality of our own carrot, cabbage and spinach varieties.

Outlook

A further step will be to share ideas and experiences on an international level along with the varieties and breeding lines in order to provide a widely available open pollinated assortment of vegetable seeds and hence food of high nutritional quality and flavour.

In Europe we are actively building up such a network. For more information, seminars about breeding and selection contact: Christina-Henatsch@gmx.de and look at: www.Kulturssat.com ; www.abd.org

JAHN, MARGA[1]; NEGA, EVA[1]; ULRICH, ROSWITHA[2]; WERNER, SIGRID[3]

Control of seed-borne pathogens in vegetable crops by hot water treatment

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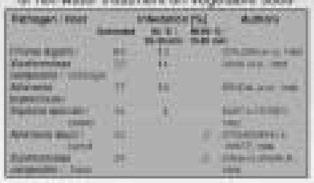
[2]Hesse State Office, crop protection service, Frankfurter Str. 69, D-35578 Wetzlar
[3]HILD samen gmbh, Kirchenweinbergstr. 115, D-71672 Marbach/Neckar

Introduction

In the future, conventionally produced seed will not be allowed for organic farming. Therefore, effective non-chemical methods are necessary to control seed-borne diseases. Physical as well as biological methods can be a possibility. Such methods are necessary also in conventional production for pathogens which cannot be controlled by chemical agents. From 1999 to 2001, the methods of hot water treatment and treatment with a microbial plant strengthening product (PRORADIX) have been examined in a project founded by the German Federal Ministry of Consumer Protection, Food and Agriculture. The aim was find the most suitable method for practical use and develop it until practicability.

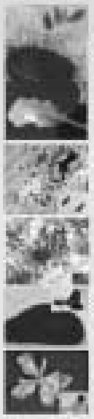
Examples from literature on the effect of hot-water treatment on vegetable seed



Materials

➤ Five important vegetable crops with their most important seed-borne pathogens:

Naturally infected vegetable seed	Pathogens
Carrot	*Alternaria species*, *A. dauci*, *A. radicina*, *A. alternata*
Carrot, Cabbage	*Xanthomonas campestris*
Cabbage	*Alternaria species*, *A. brassicicola*, *A. brassicae*, *Phoma lingam*
Celery	*Septoria apiicola*
Parsley	*Septoria petroselini*, *Alternaria radicina*
Lamb's lettuce	*Phoma valerianella*, *Peronospora valerianellae*



Methods

➤ Hot-water treatment

Immersion of seeds in hot water at various treatment temperatures and lengths of time by the company HILD samen gmbh

➤ Germination ability

Assessment of the germination ability (on filter paper) and vigour (in soil)

➤ Seed health

Assessment by determination of seed-borne pathogens (mostly ISTA-methods) and by model trials in climate chambers

➤ Treatment with PRORADIX

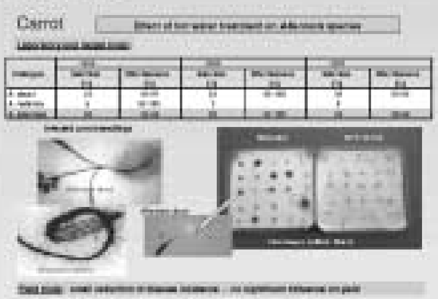
Infiltration of seeds by a special facility of the producer of PRORADIX (*Pseudomonas fluorescens*) (results not demonstrated)

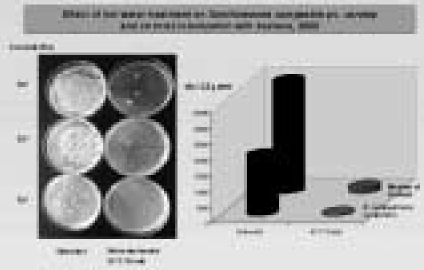
➤ Field trials

In a randomised block design with 4 replicates

Results

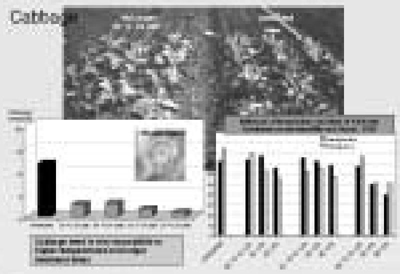
Carrot



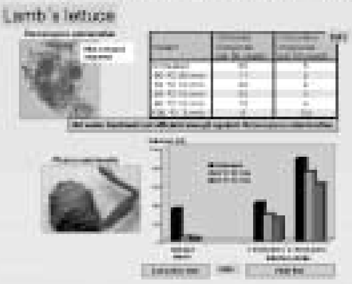


Treatment temperatures of 50 to 53 °C and treatment times of 10 to 25 min had good effects against *Alternaria* species (> 95 % efficiency), *Phoma* species (80 - 90 % efficiency) and *Septoria* species (64 - 91 % efficiency; reduction of the number of spores). With these parameters no, or very slight, inhibition of germination was observed. First results about *X. campestris* are promising. Treatments in the range of 40 °C are not sufficiently effective.

Cabbage

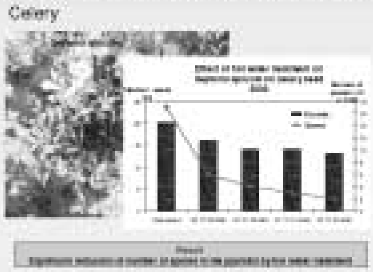


Lamb's lettuce

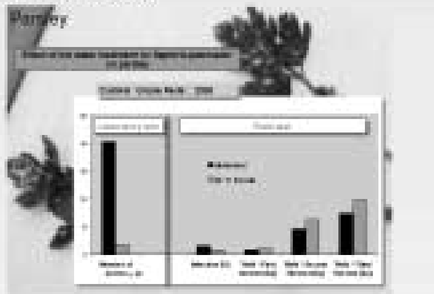


The reduction of the pathogen on seed by hot-water treatment correlated with the degree of infection of plants in the field. Also the yield was increased, especially at the first harvest time of parsley and celery.

Celery



Parsley



Conclusion

- It can be established that an effective control of seed-borne pathogens without significant damage on the plants of the above mentioned important vegetable crops is possible by hot water treatment in a temperature range of 50 to 53 °C with treatment times of 20 to 30 min. However, at high temperature a lower time of treatment should be realised.

Characteristics of spring barley varieties for organic farming

Hanne Østergård, Plant Research Department, Risø National Laboratory, Roskilde, Denmark

Background

Modern spring barley varieties are developed with the aim of combining high productivity and standardised product quality under high-input conditions using pesticides for control of weeds, diseases and insects as well as heavy application of nutrient-rich and water-soluble inorganic fertilizers. In the organic growing system, biotic and abiotic stresses have to be overcome by growing appropriate varieties (including variety mixtures etc.) and by practicing good farm management based on detailed knowledge of the biological processes going on during the crop development.

An important question is whether modern spring barley varieties possess the right combinations of characteristics such as disease resistance, weed competitiveness and nutrient uptake efficiency to ensure a stable and acceptable yield of good quality when grown under different organic growing conditions. A further question is in which way genetic diversity may contribute to ensure this.

We know that varieties often perform and yield differently in different environments due to genotype-environment interactions, so it may be important to evaluate characteristics of varieties in organic as well as in conventional farming systems. However, it remains unclear to date whether the differences between the conventional and the organic growing systems are large enough to justify breeding and testing of varieties in both environments.

The aim of a newly started inter-institutional Danish research project within The Danish Research Center for Organic Farming (DARCOF) is to investigate these questions. The project is organised as indicated to the right. Results from the first year of field trials are shown in Table 1, Fig. 1 and Fig. 2. The trials were at three locations (Flakkebjerg, Foulum and Jyndevad) with a conventional (Conv.) without fungicide treatment and/or an (or two) organic (Org.) growing system(s). Further information can be found on

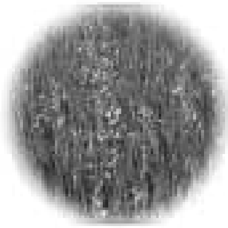
http://www.planteinfo.dk/dinparcellerforsj2002.html
http://www.darcof.dk/research/darcofii/vi2.html

Variety trials:

Evaluate variety performance under conventional and organic farming methods

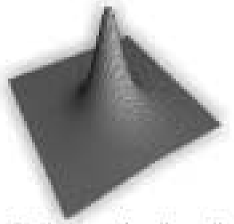
Disease complexes:

Investigate competition between scald and netblotch



Weeds:

Develop variety index for weed competitiveness

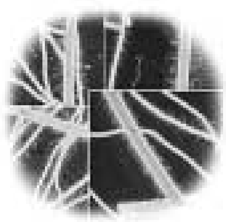


Statistics and mathematics:

Develop genotype-environment analyses and epidemiological models

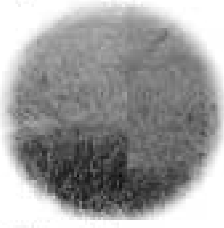
Molecular markers:

Identify varieties and perform association mapping



Plant Nutrition:

Evaluate nutrient uptake efficiency of varieties and mixtures



Variety mixtures:

Evaluate mixture effects on yield in interaction with diseases, weeds and nutrition

Table 1. **Yields of the best 45 varieties and mixtures among 123 tested. Varieties are ranked within each trial (column). The yield (hkg/ha) of the standard variety is given for each trial for comparison (in red). Variety mixtures are indicated in blue.**

(Deneken G, Willas J)

Conv. Flakkebjerg	Org. Flakkebjerg	Conv. Foulum	Org. Foulum
[illegible]	[illegible]	[illegible]	[illegible]
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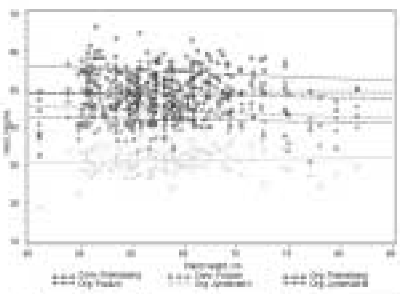

Fig. 1 **Correlation between yield of cultivars and plant height. Each point is the average over replicates for each variety/variety mixture in each trial. When cultivars are grown conventionally, high plants are slightly disadvantageous (negative slope). This is not the case when the varieties are grown under organic growing conditions. The slopes are significantly different. As there is much variation around the lines, height is not sufficient to explain the variation in yield.**

(Kristensen K, Willas J, Deneken G)

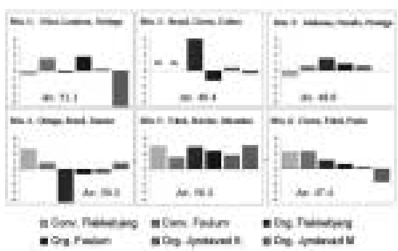

Fig. 2 **Mixture effects (deviation from mean of the three components) on yield (hkg/ha) for each of six variety mixtures grown together with their components in the six trials. The average yield is indicated on the graph for each mixture. Only for Mix. 5, the overall mixture effect is significantly greater than zero. For Mix. 1, the mixture yields better than any of the components on Org. Foulum (see also Table 1).**

(Østergård H, Kristensen K, Willas J and Deneken G)

Project members
Hanne Østergård (Head of project), Gunter Backes, Jeanette Vollmer, *Risø National Laboratory*
Gerhard Deneken, Jacob Willas, Preben Klarskov Hansen, Ilse A. Rasmussen, Hans Pinnschmidt, Mogens Hovmøller, Jørgen E. Olesen, Jørgen Berntsen, Ingrid K. Thomsen, Kristian Kristensen, *Danish Institute for Agricultural Sciences*
Lise Munk, Niels Erik Nielsen, *The Royal Veterinary and Agricultural University*

Multiple diseases, host resistance and the role of variety mixtures for disease control in organically grown spring barley

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Background and objectives

One of the most important disease management components in organic farming is the use of disease resistant varieties. It is challenged by the simultaneous occurrence of more than one disease in farmers' fields. While many modern spring barley cultivars possess good resistance to individual diseases, cultivars resistant to multiple diseases are still scarce. Using mixtures of cultivars possessing high levels of resistance to individual diseases may therefore be a viable option to control multiple disease complexes in organic farming. To ensure an efficient use of variety mixtures in managing multiple disease problems, the presence, nature and effects of interactions among the genotypes used in mixtures as well as among the occurring pathogens must be understood. Research was initiated in Denmark in 2002 to study the effects of resistance properties of individual spring barley varieties and their mixtures on the disease development of two important foliar pathogens, leaf scald (*Rhynchosporium secalis*) and net blotch (*Pyrenophora teres* [conidial stage *Drechslera teres*], Fig. 1). The objectives of this work are to:

1) Evaluate the effects of variety mixtures, as compared to pure stands, in controlling the disease development of competing leaf pathogens.
2) Examine the interactions among competing leaf pathogens and their effects on the development of disease complexes and crop performance.
3) Describe and model the dynamics of epidemics caused by competing leaf pathogens as affected by host resistance diversity.

Materials & methods

In a field trial with spring barley conducted on the organically cultivated area of the DIAS research farm in Flakkebjerg, Denmark in 2002, three variety treatments (1 - pure stand of variety Golde, 2 - pure stand of variety Punto, 3 - Golde and Punto in a 50%-50% mixture) were combined with four disease treatments (1 - non-inoculated control, 2 - net blotch inoculated, 3 - net blotch inoculated + scald inoculated at early tillering stage, 4 - net blotch inoculated + scald inoculated after tillering) in a two-factorial randomized complete bloc design with three replications. The plots were 2.5 x 2.5 m and surrounded by a 2.5 m border of oats. Net blotch inoculation was done by spreading infected winter barley straw after crop emergence. For scald inoculations, conidia suspensions were sprayed onto the plots. From tillering until flag leaf emergence, the plots were sprinkler-irrigated 3 x per day. Crop growth stage, % diseased leaf area and % healthy leaf area were visually assessed in each plot 5 x during the growing season. The % net blotch- and scald severity as well as healthy leaf area averaged across observation dates were subjected to analyses of variance (ANOVA).

Results

Net blotch developed most rapidly in the plots inoculated with net blotch alone, followed by the plots inoculated with net blotch plus scald (Fig. 2, upper part). Substantial net blotch levels developed also in the non-inoculated control plots. Scald levels remained comparatively low in the whole trial. However, the late scald inoculation resulted in highest scald levels (Fig. 2, middle). The healthy leaf area was clearly higher in the non-inoculated control plots throughout the whole season, compared to the treatments inoculated with net blotch or net blotch plus scald (Fig. 2, lower part). The disease treatment thus had a dominant, highly significant effect on all independent variables (mean net blotch severity, mean scald severity and mean healthy leaf area) while the effect of the variety treatment was less pronounced (Fig. 3, Tab. 1). The severity of the predominant disease net blotch was highly negatively correlated with the healthy leaf area. Interactions between the treatment factors were non-significant (Tab. 1). Parameterising the disease treatment effects indicated that the inoculation with net blotch alone clearly resulted in highest mean net blotch severity and lowest mean healthy leaf area, followed by the treatments that included scald inoculation (Tab. 2, lower part). The late scald inoculation resulted in the highest mean scald severity levels. The parameterisation of the variety treatments (Tab. 2, upper part) indicated a lower mean net blotch severity and a higher mean healthy leaf area of the variety mixture, as compared to the average of the pure stand treatments.

Conclusions and outlook

The first years' results showed that occurrence of both diseases in combination led to less-than-additive effects on disease severity of the predominant disease (net blotch) and crop performance (healthy leaf area) as compared to single-disease scenarios. This indicates antagonism between the two pathogens and has direct implications for disease-yield loss relationships and yield loss appraisal. There were hints for higher-than-additive effects of variety mixtures in reducing disease severity and improving overall crop performance. This indicates potential benefits of using variety mixtures, as compared to pure stands, in controlling disease complexes. The study will be expanded and the data will be used to develop a simulation model for the development of the two competing diseases as affected by resistance properties of individual varieties and variety mixtures. Decision aids for optimising the use of variety mixtures in managing multiple diseases will be derived.

Figure 1. Simultaneous occurrence of net blotch and leaf scald on a spring barley crop during the generative phase.

Figure 2. Development of % net blotch severity, % leaf scald severity and % healthy leaf area (HLA) by disease treatment across variety treatments.

Disease treatment:
control (non-inoculated)
net blotch inoculated
net blotch + early scald inoculated
net blotch + late scald inoculated

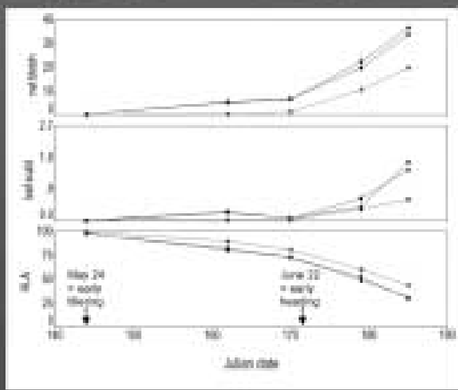

Figure 3. Relationships between net blotch-, leaf scald-, total diseased leaf area (DLA = net blotch + scald) and healthy leaf area (HLA) averaged over observation dates by disease treatment and replication across variety treatments. All variables are measured in %.

Disease treatment:
control (non-inoculated)
net blotch inoculated
net blotch + early scald inoculated
net blotch + late scald inoculated

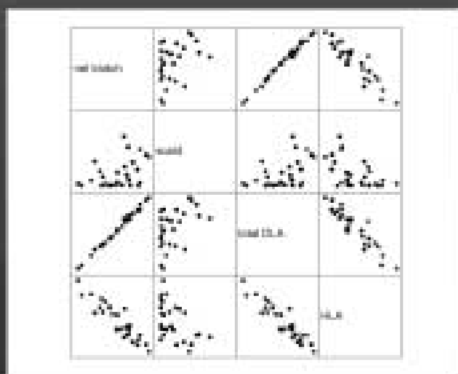

Table 1. ANOVA results: significance levels (p) of F values of variety- and disease treatments and replication with respect to net blotch- and scald severity and healthy leaf area averaged across observation dates.

source of variation	dependent variable: net blotch severity	leaf scald severity	healthy leaf area
variety treatment (V)	0.026	0.613	0.067
disease treatment (D)	0.000	0.015	0.000
replication	0.393	0.002	0.018
V * D	0.145	0.154	0.411

Table 2. ANOVA results: parameters to quantify treatment effects as compared to the reference treatment.

treatment	dependent variable: net blotch severity	leaf scald severity	healthy leaf area
variety:			
Golde	-1.579	-0.538	-0.889
Punto	3.066	0.202	-2.000
mixture (= reference)	0.000	0.000	0.000
disease:			
control (non-inoculated)	-2.587	-0.696	3.660
net blotch	5.044	-0.616	-5.044
net blotch + early scald	2.100	-0.514	-2.733
net blotch + late scald (= reference)	0.000	0.000	0.000

Baking quality of spring wheat variety mixtures

A.M. Osman and F.F.J. Schaap

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Introduction

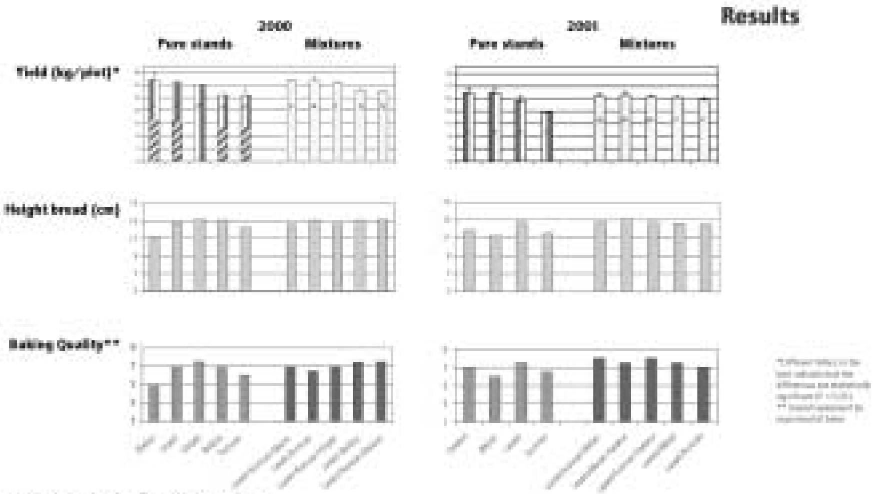
Experiences in the past with inferior baking quality is one of the reasons for farmers for not mixing varieties. The challenge for this research is to find mixtures, which combine good yield with good baking quality. Research questions were:

- How does the yield of mixtures compare to the pure stand of the highest yielding variety?
- How does the baking quality of mixtures compare to the best baking variety?
- Is it possible to combine high yield with good baking quality in mixtures?

Materials and Methods

Pure stands of spring wheat varieties with good baking properties and different mixtures of these varieties were sown in the commercial wheat field of an organic farmer. The farm is situated on a nutrient rich young clay soil and managed bio-dynamically since 1984. We used a randomised block design with two replications in 2000 and three replications in 2001. The test baker of a bio-dynamic wheat merchant carried out the baking tests.

Results



The results in the figure show that:

- Yield of three of the five mixtures was high in both years. Yield of these varieties was not statistically different from the highest yielding variety (Melon and Pasteur in 2001; Melon in 2000)
- Baking quality of all mixtures was good. In 2001 four mixtures and in 2000 two mixtures were at least as good as the best pure stand (Lavett in 2001 and Vinjett in 2000). In both years all mixtures produced better bread than the highest yielding varieties Melon and Pasteur.
- Remarkably, in 2001, the baking quality of the mixtures Lavett-Sunnan-Melon and Lavett-Sunnan-Pasteur was superior to the quality of the individual components. In 2000 this was true for Lavett-Sunnan-Baldus and Lavett-Baldus.
- In both years the mixture Lavett-Sunnan-Melon combined good yield (not statistically different from the highest yielding varieties) with good baking quality. In 2001 two other mixtures of three components showed similar promising results.

Conclusions

In the past Dutch organic farmers experienced that the baking quality of mixtures was inferior. Yet, the two years of our research show the opposite: with the spring wheat varieties, which are currently available in The Netherlands, it is possible to assemble mixtures which combine good yield with good baking quality. We hope, that the results of the experiment of 2002 will confirm these findings. This would open the way for farmers to reconsider growing mixtures and, in this way, enhance the level of genetic diversity in their fields.

LOUIS BOLK INSTITUUT
natuurwetenschappelijk onderzoek

Bringing farmers, traders and plant breeders together to develop better suited varieties

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Louis Bolk Instituut, The Netherlands, e-mail: a.osman@louisbolk.nl

Carrots: different farmers, different ways to find solutions
For this crop we worked with two groups of farmers: members of the cooperative Nautilus, who produce for supermarkets and export and members of a regional study club, who directly sell to consumers (through box schemes, farm shops).
The variety ideotype of the Nautilus farmers is highly dominated by the demands of supermarkets. Cosmetic characteristics like shape and size were more important than e.g. taste. The discussions on the ideotype helped to put taste and food quality on the agenda. The next step will be to involve supermarkets in the discussions.
The regional group finds taste and agronomic characteristics more important than cosmetic characteristics. For ideological reasons they also are looking for open pollinated (OP) varieties instead of hybrids. The bigger conventional seed companies are not developing OP-carrots anymore. So these farmers are not helped by involving breeders of the bigger companies. They should seek alliances with smaller seed companies or start their own selection programmes. The ideotype which they developed will be helpful in setting breeding priorities.

Approach

A better understanding of organic farming and the needs of farmers and market parties may stimulate conventional plant breeders to develop better adapted varieties. First steps in our approach to facilitate communication between these different parties are:

- Developing a variety ideotype
  During field visits farmers and traders are invited to evaluate existing varieties. Discussion on the evaluations leads to a list of desired plant traits. In a second meeting the characteristics are further elaborated and priorities are set. Table 1 gives an example of a spring wheat variety ideotype.
- Feeding the ideotype back to breeders
  The ideotype is presented to seed companies with a request to send in seeds for a variety trial. The latter is important because it moves the discussions from a paper list to real seeds and plants.
- Setting up variety trials in farmers' fields
  The varieties which according to breeders fit the ideotype are evaluated in the field.
- Inviting farmers, traders and breeders to asses the trials
  These visits form a lively platform for discussions as breeders are confronted with the performance of their own varieties and seeds of their colleagues.

Table 1

IDEOTYPE OF AN ORGANIC SPRING WHEAT VARIETY

Characteristics	Minimum	Ideal	Priority
Good Baking Quality			
[illegible]	[illegible]	[illegible]	[illegible]
Good Grain Yield	[illegible]	[illegible]	[illegible]
Efficient use of (organic) manure	[illegible]	[illegible]	[illegible]
Reducing Risk of Diseases			
[illegible]	[illegible]	[illegible]	[illegible]
Supporting Weed Management			
[illegible]	[illegible]	[illegible]	[illegible]
Reducing risks at Harvest			
[illegible]	[illegible]	[illegible]	[illegible]

Application of Approach

The first steps are similar for all crops and user groups, but how we continue is specific for each situation. Factors influencing variety choice and availability are crucial. Examples of wheat and carrot make this clear.

- For wheat (and other arable crops) official regulation on variety release determines which type of varieties make it to the market. Adaptation of official variety release procedures is essential to stimulate the development of varieties which are better adapted to organic farming. We used the ideotype to re-design official variey testing.
- For carrot (and other horticultural crops) we do not work on official procedures because these do not influence variety release. Market parties limit farmers' options to choose varieties for farmers who produce for supermarkets. Therefore these parties should be involved in the process. Farmers and breeders were aware of that, but our approach helped to put the involvement of traders in improving variety choice high on the agenda (see box).
- Different types of farmers need different solutions. Small user groups with specific demands can not be served by big seed companies. Therefore, these farmers should seek alliances with small breeding companies or start their own selection schemes. Also, here the ideotype helps to set breeding priorities (see box).

Conclusion

This approach has proved to be useful for farmers and traders to formulate their demands to breeders an d for the latter to better understand, what kind of varieties are needed to optimise the organic sector. The discussions stimulated by this approach also give insight on the following steps. These should be tailored to the specific characteristics of the crop and user group.

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Evaluation of wheat and triticale genetic resources for organic farming :
first agronomic results from an INRA trial network

Évaluation en agriculture biologique des ressources génétiques blé tendre et triticale, issues d'une sélection pour l'agriculture intégrée.
Premiers résultats agronomiques du réseau expérimental INRA en 2002.

Rolland B.[1], Charrier X.[2], Faye A.[3], Gardet O.[4], Oury F.-X.[3], Doussinault G.[1], Meynard J.-M.[5]

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Introduction

The need for new genotypes adapted to low input agriculture was recognised by INRA and CTPS, subsequent to the release of the cultivar Renan in 1989. Our selection methods, and our genetic pool, permit us to create genotypes for integrated farming. Ten years after registration of c.v. Renan, new winter wheat cultivars (e.g. Balthazar, Cézanne, Farandole, Oratorio, …) originating from public and private breeding programs combine, as never before, resistance to diseases with satisfactory yield potential. These disease resistant cultivars permit a reduction in fungicide protection and contribute to improved economic returns, with lower wheat prices, and improved environmental sustainability. However we have yet to determine if these cultivars are suitable for organic farming.

The present study, undertaken by INRA, aims to evaluate genetic material, originating from integrated farming breeding programs (high disease resistance, low seeding rate, good nitrogen uptake and nitrogen-use-efficiency, standard quality) under organic farming crop system. We also aim to define cultivar types adapted to organic farming and identify important agronomic characteristics, in collaboration with ITAB.

INRA Institut national de la recherche agronomique; CTPS : Comité technique permanent de la sélection; ITAB : Institut technique de l'agriculture biologique

Materials and Methods

This study is being conducted in a multiple-site (Bretagne, Ile de France and Poitou), multiple-year trial network (3 trials in 2001-2002 and 2002-2003) with 30 varieties of winter wheat and 8 varieties of triticale (figure 1). Wheat controls are : Apache, Cézanne, Malacca, Moldau, Renan, Soissons. Plots are assessed for weed and disease (eyespot), Nitrogen Nutrition Index, yield and grain quality.

The research involves a multidisciplinary team including geneticists, agronomists and quality specialists.

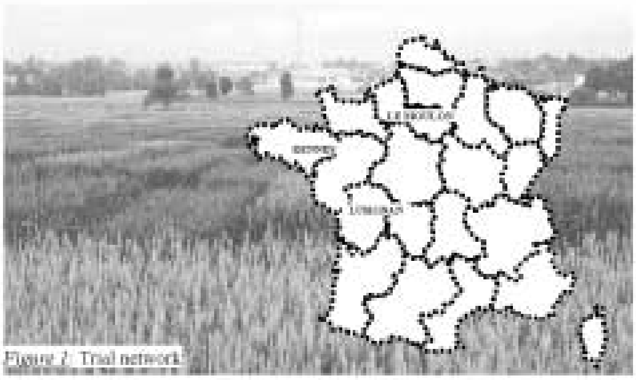


Figure 1: Trial network

location	crop system	previous crop	sowing rate	Nitrogen fertilization	crop yield *	[illegible]	S.D.*	proteins
Le Moulon	cash crops	clover		70 kg/ha	[illegible]	[illegible]	[illegible]	[illegible]
Lusignan	cash crops	bean		70 kg/ha	[illegible]	[illegible]	[illegible]	[illegible]
Rennes	mixed farming	maize		0	[illegible]	[illegible]	[illegible]	[illegible]

* t/ha

Table 1: Crop management systems in organic farming cereal trials

Results

Crop yield

In 2002 in Rennes and Le Moulon, weather and soil fertility were favourable for high crop yield in low input crop management plans (table 1). Diseases, such as eyespot, yellow rust or *Septoria tritici*, were adequately controlled by resistant varieties. Winter triticale and wheat both provided average yields of 5.6 t/ha in Le Moulon and Rennes. This compare quite favourably with low input averages of 8 t/ha for wheat.

Data could not not be pooled due to the high SD in Le Moulon trial which could be explained by soil heterogeneity, more frequently found in organic farming.

In Lusignan, fertility was very low so crop yield was about 3 t/ha. In these conditions triticale was better than wheat : 3.7 t/ha average yields.

A character as weed competitiveness was lacking : in 2002 trials were in fields without weed. Main limiting factor seemed to be nitrogen.

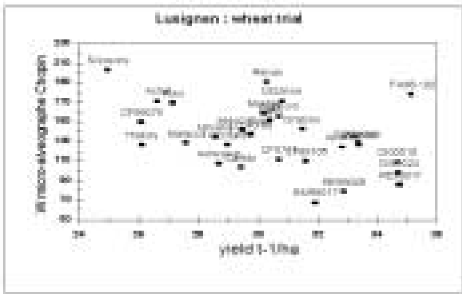
Quality

Protein levels were low and high quality varieties in conventional agriculture conditions were not the best with high nitrogen stress (figure 2). None mycotoxin were detected in Rennes.

Comparison with integrated crop production

Just one location was available to compare yield result for the two cropping systems (figure 3). Others results will be useful to conclude in 2003.

Yield and quality (Lusignan and Rennes)



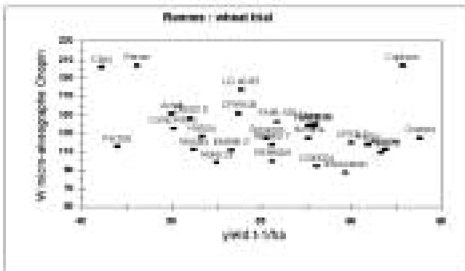


Figure 2: Yield and quality (W microalveographe) in 2002 trials

Compared yield results between integrated and organic systems

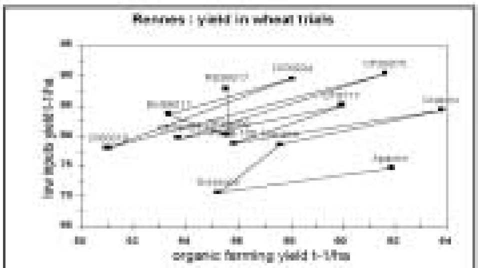


Figure 3: Yield in 2002 trials. Integrated farming system used a few inputs (150 seeds/m^2, 2 herbicides, no fongicide, no insecticide, no growth regulator, 40 kg N/ha).

Prospects

These trials provide background information for potential breeding programmes, identifying priorities and providing relative performance data for wheat and triticale under organic systems. Additional studies (agronomic diagnosis) are planned in order to design new cultivars suited to organic farming. This will lead to an improvement in economic and environmental sustainability of cereal production.

Financial support from INRA CIAB and ONIC (CPER Bretagne).

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Special thanks to GAEC La Mandardière, Dr Robert (Bioplante), C. Abelard and Dr Jahier (INRA).

Evaluation of bread wheat and triticale genetic resources for organic farming : first agronomic re-sults from an INRA trial network

Evaluation en agriculture biologique des ressources génétiques blé tendre et triticale, issues d'une sélection pour l'agriculture intégrée. Premiers résultats agronomiques du réseau expérimental INRA en 2002.

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The object of the INRA program is to evaluate genetic material, originating from integrated farming breeding programs (high disease resistance, low seeding rate, good nitrogen uptake and nitrogen-use-efficiency, standard quality) under organic farming crop system. We also aim to define cultivar types adapted in organic farming and priorise important agronomic characteristics.

Our selection methods, and our genetic pool, permit us to create genotypes for integrated farming. Ten years after registration of c.v. Renan, new winter wheat cultivars (e.g. Balthazar, Cézanne, Farandole, Oratorio, …) originating from public and private breeding programs combine, as never before, resistance to diseases with satisfactory yield potential. These disease resistant cultivars permit a reduction in fungicide protection and contribute to improved economic returns, with lower wheat prices, and improved environmental sustainability. However we have yet to determine if these cultivars are suitable for organic farming.

This study is being conducted in a multiple-site (Bretagne, Ile de France and Poitou), multiple-year trial network (3 trials in 2001-2002 and 2002-2003) with 30 varieties. This study involves multidisciplinary team including geneticists, agronomists and quality specialists.

The results of the first year are presented. Preliminary yield and quality results showed that some varieties developed for integrated farming are also suitable for production under organic conditions.

1st International symposium on organic seed production and plant breeding, ECOPB, Berlin, 21-22 November 2002

organicXseeds - Database as an Inspection Tool for Organic Seed Regulation

Future EU seed regulation

- Derogations beyond 2004
- No derogation for chemic. treated seeds
- Seed registration in a EDP-database
- Annex 1: species without derogation
- Derogations restricted to emergency or for research and conservation purpose
- Annual reports of member states

Conditions of inspection bodies to seed database

- no Internet constraint for farmers
- no Internet constraint for inspectors who visit the farm
- easy handling of the inspection during usual farm visits
- no additional paperwork for the inspectors
- farmers and inspectors should have easy access to the seed-data by phone

3-step model for derogation

1) **Species or subspecies listed in Annex 1:** no derogation
2) **Species with top (professional) varieties:** derogation possible, but well justified and subject to fee
3) **Species without "professional" offer:** Simplified derogation procedure, database download sufficient

Future derogation procedure

1) farmer requests at his usual seed distributor
2) if seeds are not available: search on oXs
3) if not available on oXs: download pdf-form
4) forward pdf-form to authorisation bodies
5) on farm inspection of: pdf-form, derogation form and invoice of conventional seeds

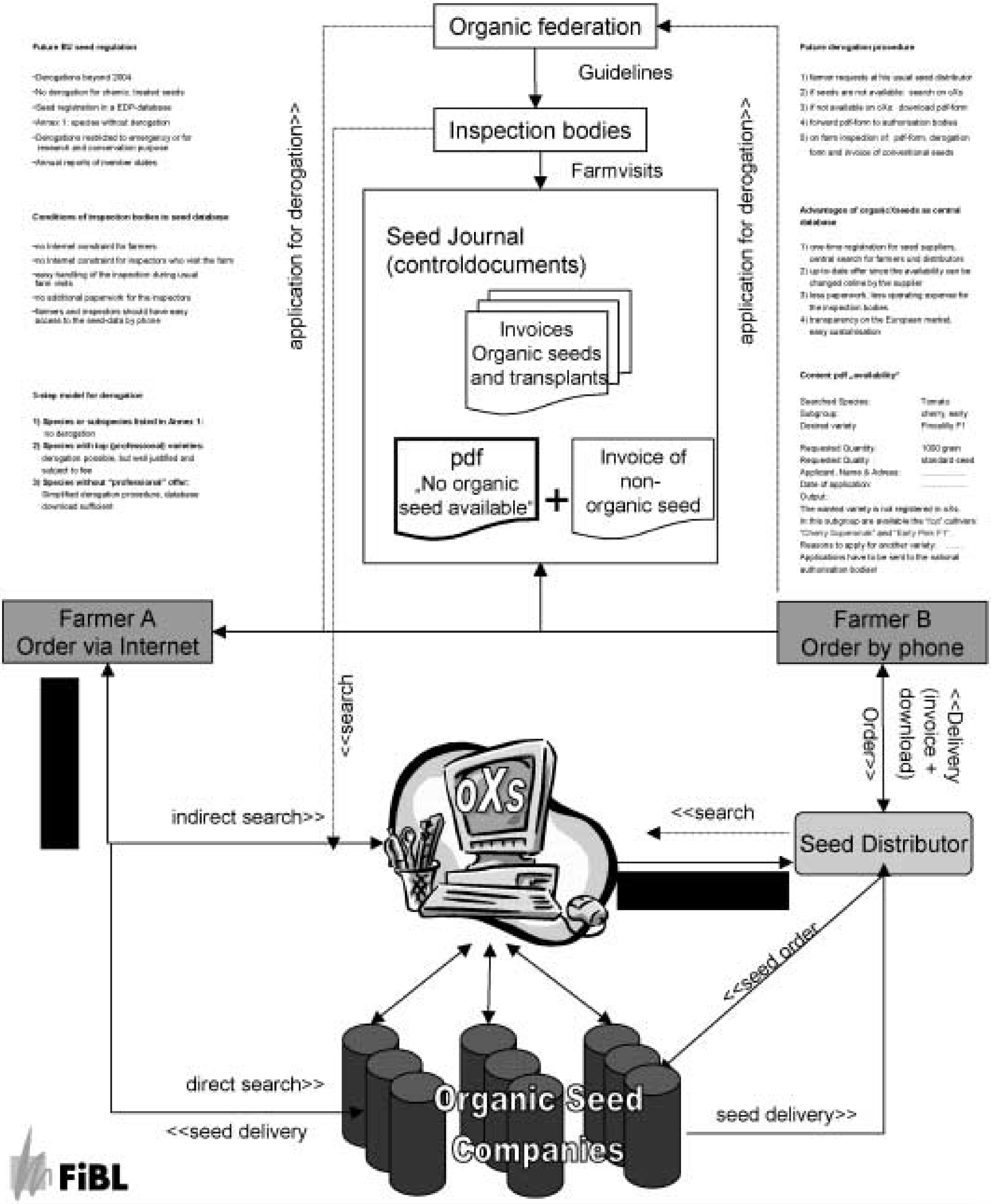
Advantages of organicXseeds as central database

1) one-time registration for seed suppliers, central search for farmers and distributors
2) up-to-date offer since the availability can be changed online by the supplier
3) less paperwork, less operating expense for the inspection bodies
4) transparency on the European market, easy contextualisation

Content pdf „availability"

Searched Species:	Tomato
Subgroup:	cherry, early
Desired variety:	Possibly F1
Requested Quantity:	1000 grain
Requested Quality:	standard seed
Applicant, Name & Adress:	....
Date of application:	....

Output:
The wanted variety is not registered in oXs.
In this subgroup are available the "top" cultivars "Cherry Supersweet" and "Early Pink F1".
Reasons to apply for another variety: ......
Applications have to be sent to the national authorisation bodies!



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