Organic Food and Farming in Flanders

Research 2011-2012

NOBL

Netwerk Onderzoek Biologische Landbouw & voeding

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Content

Organic Agriculture in Flanders 11

- Organic agriculture in Flanders, 2011 12

Research Organisation 15

- Government of Flanders supports research on organic agriculture 16
- Research and knowledge exchange for an innovative and high quality organic sector 18
- NOBL: Reflecting together on research about organic food and farming in Flanders 20
- CCBT - Coordination of applied research and extension on organic farming 22
- Organic farmers' networks (*Biobedrijfsnetwerken*) 24
- Research agenda for organic agriculture, 2008-2012 26

Arable Crop and Vegetable Production 29

Soil and soil management 30

- Organic matter management and non-inverse soil tillage for sustainable soil use 30
- Soil management and soil quality in organic cropping systems 32
- The value of compost for soil fertility 34
- Multiannual use of compost and straw-rich manure yields 36
- Optimal application of organic manure for a healthy organic crop 38
- Stable or chicken manure on grassland? 40
- Leguminous green manures: which ones to use and how? 42
- Manures and MAP4 throughout the Flemish organic sector 44
- Monitoring nitrate nitrogen in organic fruit orchards 46
- An approach to replant problems in new plantings in organic fruit cultivation 48
- How can the pH of the soil be reduced in organic berry cultivation? 50
- Fruit vegetables in greenhouses: fertilisation strategy and needs 52

Crop protection **54**

- Control of the bean seed fly in organic cultivation 54
- Flower margins in cereal crops: An ally in aphid control 56
- Flower strips for natural plague control 58
- Influence of green manure crops on the population dynamics of nematodes 60
- Combating the woolly apple aphid with entomopathogenic nematodes 62
- Efficacy of potassium bicarbonate against scab on apple 64
- Investigation of alternative beneficial arthropods for the suppression of pear suckers 66
- Insight into problems related to stink bugs and their control in organic pear growing 68
- Mycosin and Enzicur as alternative plant protection agents against fungal diseases in pome fruit 70
- Epidemiology study of phytoplasmas in pome fruit ('apple proliferation' and 'pear decline') 72
- Entomovectoring technology to combat pest insects and diseases in the flowers of small fruit crops 74
- The use of predatory mites for the control of spider mites in raspberries 76
- Biological control of fruit rot fungi of strawberry using epiphytic yeasts 78
- Management of fungal diseases by application of UV-c and hot water treatments 80
- Postharvest treatments: applications with yeast in cold storage to control storage diseases 82
- Soil cover materials in the organic cultivation of raspberries 84
- Towards sustainable and productive EU organic glasshouse horticulture 86
- Biological control of the invasive leafminer *Tuta absoluta* in tomato cultivation in Flanders 88

Cultivation techniques and systems **90**

- Potential of forage legumes on the cattle farm 90
- Triticale with forage pea or winter field beans for protein-rich feed 92
- No-tillage in organic agriculture in Flanders 94
- Replant problems with apple in organic fruit growing (existing orchard) 96
- Replant with Kanzi 98
- Development of 'Earwig Management Tool': software for organising orchard management with respect to beneficial earwig populations 100
- Mating disruption systems in pome fruit, grape and red berry growing 102
- Hoeing in "Conference" orchards 104
- The effect of mechanical thinning in apple orchards 106
- Research on the potential of organic planting material of strawberries 108
- Development of research on herbs at PCG: niche or promising diversification? 110
- What happens to a tunnel in the summer? 112
- Field experiments in organic agriculture at the PIBO Campus 114

Varieties and breeding **116**

- Attention to disease susceptibility in the admission of new varieties to the national catalogue 116
- Disease resistance is a priority when selecting varieties for organic agriculture 118
- Genetic diversity in vegetable crops in action 120
- Resistant and/or less susceptible apple varieties 122
- Early cultivation of strawberries on soil 124
- Research on crops grown under protected conditions at PCG 126
- Improving red clover as a fodder crop 128

Animal Production **131**

Feed **132**

- Towards a more efficient mineral utilisation in the feed of organic dairy cattle 132

Animal welfare and health **134**

- HealthyHens: "Promoting good health and welfare in European organic laying hens" 134
- Shade as protection against heat stress for cattle on pasture? 136
- Coccidiosis in goat kids: effect on growth and subsequent milk production 138
- Organic poultry: Countering infections of *E. coli* and *E. rhusiopathiae* 140
- Boars or barrows: Alternatives for surgical castration without anaesthesia 142

Production systems **144**

- Optimisation and innovation of organic and low input dairying through European collaboration 144
- The potential added value of a well designed outdoor run 146
- Organic poultry: responsible use of the open-air area 148
- Herbs in grassland for a healthy livestock 150

Socio-economics, market and chain issues for the organic sector **153**

- Impact of the European agricultural policy reform on organic farming in Flanders 154
- Inventory of key indicators for organic dairy and beef cattle 156
- Business figures for the organic sector: a general sector approach 158
- Organic and low-input dairy farming: false friends? 160
- Which factors determine the sustainability of fruit farms in Flanders? 162
- Networks and innovation: Connection in the broader innovation landscape? 164

Technology **167**

- Energy efficient heating with long term heat storage in organic protected horticulture 168
- RTK-GPS: an added value on organic farms 170
- Research on optimising the application of insect parasitic nematodes against the cabbage root fly 172

Food, quality and health **175**

- Do organically produced vegetables and fruit taste better? 176
- Time for innovation in organic food processing 178

Dear reader,

Research and knowledge exchange are important to innovation in the organic industry. The Network for Organic Food and Farming Research (NOBL), an all-inclusive platform for sharing knowledge, ideas and experience about organic food and farming research in Flanders, aims to contribute to innovation. NOBL brings representatives from 16 organisations from fundamental and experimental research, the (organic) agricultural sector and the government together on a regular basis to reinforce agricultural research and knowledge about organic farming.

In this edition of 'Organic Food and Farming in Flanders' researchers in Flanders were invited to present their research activities relevant to the organic sector during 2011 and 2012.

During these two years, NOBL has worked together with other networks including the 'Coordination Centre for Applied Research and Extension on Organic Agriculture' (CCBT) and the 'Organic Farmers' Networks' (BBN) to create the Flemish Research & Knowledge Network for Organic Food and Farming. By attuning their activities and cooperation, this new network strives to ensure the most efficient policy for knowledge about organic food and farming in Flanders. A close interaction between the actors of the different networks guarantees research that is sufficiently aligned with the needs of the sector as well as the dissemination of new discoveries to those who need it most.

Enjoy your read,

Lieve De Cock
Johan Van Waes

Organic Agriculture in Flanders

Organic agriculture in Flanders, 2011

Each year, the Department of Agriculture and Fisheries of the Government of Flanders publishes a set of facts and figures about organic agriculture. The report focuses on the evolutions in production area, livestock, government expenses and consumption. The report can be used as quantitative support for monitoring ongoing policy, and it provides useful information for research and educational institutions.

In Flanders, the organic agriculture industry is small, consisting of 282 production farms in 2011. The organically farmed area totals 4,563 hectares and it has less than 1% of the agricultural market share. But organic farming is growing. The market actors related to organic agriculture (processors, retailers, wholesalers) increased by 11% in comparison with 2010; they total 593 units. In Flanders, 30% of all organic area is still under conversion. This potential is also reflected by Organic Seeks Farmer ("*Bio Zoekt Boer*" in Dutch), an information and consultation service for farmers who are considering converting their farm to organic cultivation. In total, *Bio Zoekt Boer* received 460 calls, of which 72 conventional farmers decided to adopt the organic production system. The most recent data show a further increase in consumption of organically-grown products. In Belgium, consumers spent up to 435 million euros on organic products, a 3% increase. Eighteen percent of the consumers are frequent and loyal buyers and represent 77% of the total organic turnover. On average, organic products in Belgium are priced 33% higher than non-organic products. Flanders lacks production capacity. Demand exceeds the national production, which causes processors and wholesalers to buy substantial amounts of organic produce from neighboring countries.

Organic livestock production is also increasing steadily. In 2011, 370,000 organic animals were kept under organic regulations, including 1,224 dairy cows, 1,908 pigs, 3,876 sheep and more than 357,000 laying hens and broilers.

In 2011, the Government of Flanders spent 3.1 million euros on supportive measures, an increase of 5.6% compared to the previous year. Of that amount, 38% finds its way to the farmer through direct payments per

ha and contributions to the certification costs. One-quarter of the budget was spent on research, of which 39% was aimed to optimise production techniques for crop production and 37% was spent on the improvement of soil quality. Animal production, innovation and agro-economic research account for the remaining 24% of the research budget. Other supported measures included the promotion of organic products and strengthening of the organic market.

The Strategic Plan 2008-2012 has ended and a new plan is in preparation. The next Strategic Plan will mainly be a continuation of the preceding one, but pays more attention to demand-driven conversion and adaptation capacity to the market and chain evolutions.

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Research Organisation

Government of Flanders supports research on organic agriculture

The last two years of implementation of the Strategic Plan for Organic Agriculture 2008 - 2012 formed a framework for action, evaluation and planning for the coming years. Central to the strategic plan is the "Policy on research and Knowledge". At the request of and in collaboration with the Flemish organic sector, the Government of Flanders continued its support for the development of the Flemish Research and Knowledge Network for Organic Food and Farming. In particular, the government subsidised the work of: the Network for Organic Food and Farming Research (NOBL); the Coordination of Applied Research and Extension on Organic Farming (CCBT vzw) and the Bio Farmers' Networks (BBN). The core of these networks is knowledge development and extension in the organic farming sector in Flanders. International collaboration receives great emphasis.

What happened in 2011 and 2012

More detailed information on the projects supported by the Government of Flanders can be found further in this publication; this section contains a list of only the most important contributions.

The annual subsidy for the CCBT (160,000 EUR in 2011 and 200,000 EUR in 2012) resulted in various projects in the field of applied research in organic farming. In response to a call for demonstration projects, since the beginning of 2012 a project of the CCBT, "Organic fertilisation and MAP4 throughout the organic sector", has run by a number of partners since 2012. This project received a subsidy of 100,000 EUR.

In 2012 the Sustainable Agricultural Development Division of the Government of Flanders launched a call for proposals. As a result a subsidy of 160,000 EUR was granted to the Institute for Agricultural and Fisheries Research (ILVO) for conducting a project entitled "Organic in the picture, developing indicators using system-oriented research and participatory process" for a period of three years. Within the project a number of partners will work together including Inagro, Wim Govaerts & Co CVBA, the experimental centre for Poultry (*Proefbedrijf Pluimveehouderij vzw*), Ghent University and K.H. Kempen University College.

Flanders stays connected to the European organic agriculture research. In 2011 three projects with Flemish partners were selected within the Coordination of European Transnational Research in Organic Food and Farming Systems (CORE Organic II) ERA-NET with the Government of Flanders providing a total budget of 200,000 EUR to the Flemish partners. The following projects are included: "Targeted precision biocontrol and

pollination enhancement in organic cropping systems (BICOPOLL)", a collaboration including Ghent University; "Reduced tillage and green manures for sustainable organic cropping systems (TILMAN-ORG)" and the project "Promoting good health and welfare in European organic laying hens (HealthyHens)". ILVO is involved in the latter two projects.

At the beginning of 2012 the Flemish Department of Agriculture and Fisheries participated in launching the second call of CORE Organic II ERA-NET. A budget of 200,000 EUR was provided for Flemish partners to participate in projects within the call. As a result, a European project "Organic Plant Breeding Coordinating Activities for Diversity" (COBRA) with Flemish partners Inagro and University College Ghent (HoGent) was selected. This three-year-long project will start in early 2013.

2012 was also a year in which the opportunities for cooperation between Flanders and the Netherlands in the context of knowledge extension were stimulated by the Government of Flanders. This resulted in a project aiming at publishing newsletters in Dutch via BioKenninet.nl.

What the future will bring ...

At the end of 2012 a new Organic Strategic Plan, covering the years 2013-2017, will be ready. Supporting research in function of the growth of the organic sector will remain one of the objectives of the plan. The government will continue playing its important role in research funding. Stimulating organic agriculture research at the national and international levels as well as promoting education, communication and awareness remain important factors for creating innovations and further knowledge development and extension.

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Research and knowledge exchange for an innovative and high quality organic sector

Research, knowledge and information are essential components of a competitive organic sector. To promote the development of the organic sector and to increase its production capacity, new information and techniques are required. It is undeniably important to have good coordination of research activities, knowledge exchange and to have the Flemish organic sector using that knowledge and information. Good interaction between the various actors ensures that the research sufficiently addresses the needs of the sector as well as guarantees that the knowledge reaches those that need it.

A research and knowledge network for organic food and farming in Flanders

To ensure good coordination, cooperation and management of research and knowledge exchange for organic food and farming, the Strategic Plan for Organic Farming 2008-2012 (see lever 4, annex 1 of the plan) in Flanders initiated the establishment of three networks, including NOBL (the Network for Organic Food and Farming Research, 2007), CCBT vzw (Coordination of Applied Research and Extension on Organic Farming, 2010) and BBN (Organic Farmers' Networks, 2009). Central to each of these networks is the exchange of information and experience as well as the development of new knowledge for the organic industry. Together with their partners, these three networks make up the foundation of a research and knowledge network for organic food and farming in Flanders.

In addition to their specific tasks and goals, which are oriented towards various target groups (farmers, researchers, policy), these networks stress the importance of good coordination of the activities of these networks. This ensures a coherent knowledge policy for the organic sector in Flanders. The tasks of the networks must be complementary, to make sure that each network can operate in an efficient way. For example, questions and problems addressed in the Farmers' Networks are put on the research agenda by CCBT. To perform research to answer these questions, NOBL and CCBT are searching for potential funding sources and expertise. The knowledge acquired via research finds it way back to the farmer via the information channels of CCBT, NOBL and BBN.

Strength in unity

In 2011, the strategic note for research and knowledge exchange written by NOBL in 2009 was revised, the goals were reconfirmed, and where necessary they were supplemented with new insights by NOBL, CCBT and BBN. This note visualises the necessary elements to achieve an efficient knowledge policy. Together with their stakeholders, the networks state the following objectives:

- increase support for and recognition of research on organic agriculture in Flanders.
- improve understanding of the research needs of the organic sector and address them.
- optimise the use of research and knowledge exchange capacities for the organic sector.
- disseminate and exchange research results and knowledge.

The note is used as a guideline for joint action and as a touchstone to optimise the actions taken by the various networks.

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NOBL: Reflecting together on research about organic food and farming in Flanders

Founded on the initiative of the Department of Agriculture and Fisheries of the Government of Flanders and on demand of the organic sector, NOBL, the Network for Organic Food and Farming Research, was born 5 years ago. The network was established to think about how a more favourable research climate for organic food and farming could be created in Flanders. The network has become a platform for sharing knowledge, ideas and experiences and supports activities for research and information exchange for the organic food and farming in Flanders. NOBL brings together researchers, policy-makers, farmers and consumer organisations. Currently, representatives from 16 institutes and organisations come together on a regular basis. The Institute for Agricultural and Fisheries Research (ILVO) coordinates the network.

NOBL in action!

NOBL's tasks and activities of the past few years have been diverse. Since 2012, the members visit each other regularly to learn about each other's work. In addition, NOBL is flexible enough to responds to the partners' current needs. Researchers and actors from the sector come together to find answers to current questions on a particular theme, to formulate advice on priority research topics and to explore new opportunities for the funding of new research projects. Possibilities for cooperation and knowledge exchange are also investigated internationally by actively participating in international working groups and networks (such as TPOrganic, COREOrganic II ERA-NET, Organic E-prints, and others) and by making NOBL better known as the contact point for organic food and farming research in Flanders.

NOBL is no longer alone; it can now count on the support of CCBT and BBN. A major challenge is the development of an integrated research and knowledge network for organic food and farming in Flanders. To do so, the networks NOBL, CCBT and BBN work together to create a coherent knowledge policy for the organic sector in Flanders. In addition to their specific tasks and objectives aimed at different target groups (farmers, researchers, policy) the networks are aligning their activities with each other, informing each other about their activities and defining common objectives. Together, CCBT and NOBL manage a research database with

an overview of current and past projects and results for organic food and farming in Flanders. NOBL can count on BBN to define research topics and needs.

After a successful first seminar in 2010, NOBL organised a second seminar in December 2012. During the seminar, the debate focused on the possibilities for participatory and on farm research or how farmer and researcher find and complement each other to gain new knowledge.

NOBL ahead!

NOBL keeps looking for new opportunities to improve knowledge development and exchange for the organic sector in Flanders. NOBL is open to new members wishing to reflect and cooperate for organic food and farming research.

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CCBT - Coordination of applied research and extension on organic farming

CCBT stands for 'Coordination Centre for Applied Research and Extension on Organic Agriculture'. The centre was founded in 2010 as a part of the 'Strategic Action Plan for Organic Farming 2008-2012' of the Government of Flanders. CCBT aims to coordinate and stimulate applied research for organic farming in Flanders.

Research tailored to the farmer

CCBT stands for innovative, demand driven and practice oriented research and extension. Thanks to close cooperation with the sector and the research stations, a qualitative research programme can be composed every year. The research and extension work is carried out by six applied research stations in Flanders:

- INAGRO, vegetables and arable crops
- PCG, greenhouse crops and herbs
- Pcfruit, pome and stone fruit
- *Proefbedrijf Pluimveehouderij*, poultry
- PPK, berries
- PIBO campus, arable and vegetable crops.

For organic animal production, CCBT works closely together with Wim Govaerts & Co CVBA, a private advisory service for dairy and goat farms.

CCBT itself has a budget to finance projects, thanks to subsidies from the Government of Flanders. In addition, CCBT is constantly searching for other sources of funding and project opportunities, for example through European funds.

One of the cornerstones of CCBT is to involve farmers in determining the needs of research. Together with the farmers' networks and the research stations, research needs are defined and translated into projects. Since 2010, 34 short-time projects have already been set up.

The centre pays close attention to the translation of the project results into useful and readily applicable information for farmers. For each project, a popularised report is made which contains the main conclusions and recommendations. The website contains project results and other research news. A monthly electronic newsletter is sent to all interested parties. Organic farmers can subscribe to a paper newsletter at no charge.

CCBT

Organic knowledge network

Together with the members of NOBL, the research stations, the farmers' organisations and the farmers' networks, CCBT works to expand the network of knowledge about organic farming.

This network undertakes joint actions to support the research for organic farming. Important tasks are providing advice to the Government of Flanders and updating the research agenda for Flanders. CCBT and NOBL manage a database that collects all current and finished projects about organic agriculture in Flanders. Another important strategy is the expansion of the national and international network.

CCBT is open and motivated to engage in international cooperation: to exchange knowledge about organic farming practice, agroecological innovations, participatory research methods, etc. or to work together on a project.

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Organic farmers' networks *(Biobedrijfsnetwerken)*

Since 2009, Bioforum *and* Landwijzer *work together with a wide range of partners to develop organic business networks (*Biobedrijfsnetwerken*). In these networks, organic farmers meet regularly to exchange experiential knowledge. Much of the knowledge is not the result of research in a research station, but the result of individual farmers' research on their own farm experiences. Sharing this experience – getting experience of other farms, but also bring in experiences of your own farm – is the driver of these* Biobedrijfsnetwerken*.*

Within the network, we collaborate with several partners. The leaders of the project are *Bioforum*, the Dutch *Louis Bolk Institute* and *Landwijzer*. Furthermore, all research centres and agricultural advisors involved in each industry are involved. In this way we can approach the appropriate source of knowledge for each theme that raises additional questions in the knowledge exchange. Research centres and agricultural advisors put us on track quickly to find information from earlier research, and take new research questions occurring in the networks back with them.

The *Biobedrijfsnetwerken* are embedded in the Flemish Organic Farming Knowledge Network (*Vlaams Biokennisnetwerk*). We cooperate with CCBT and NOBL. These institutions make sure that questions from *Biobedrijfsnetwerken* are included in both practical research and applied/fundamental scientific research. In this way research is more demand-driven by the industry. Conversely, they also ensure that there is feedback from research results towards the industry.

The organic farming industry in Flanders is thus placed at the peak of innovation concerning scientific research and knowledge development: collaboration of all knowledge institutions, with a central role for the farmer in the daily practice on the farm.

Currently, *Biobedrijfsnetwerken* exist for dairy farming, goat farming, beef farming, poultry farming, small fruit production and outdoor vegetable production. In 2013, we plan to start a new farm network for arable farming.

Biobedrijfsnetwerken

An initiative of BioForum, Landwijzer and Louis Bolkinstituut

We are now collaborating more frequently across the boundaries of different sectors (e.g., deliberation between livestock farms and farms with crop production for the exchange of feed and manure). Within the sectors, collaboration is happening in specific thematic groups (e.g. in the vegetable sector: short-chain, moderate vegetable crops, own seed production, etc.).

The networks are, technically speaking, reserved for established organic farmers. But they are also open to farmers in conversion or who are in a preparatory trajectory together with "*Bio Zoekt Boer*". Over the years, the network coordinators have done a great deal of work to develop the methods for farmers to exchange their experience with each other. *Biobedrijfsnetwerken* want to share this experience in the future with all those who want to work with farmer groups in research, including conventional agriculture.

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Research agenda for organic agriculture, 2008-2012

Upon request from the organic sector and the Sustainable Agricultural Development Division (ADLO), the Division for Agricultural Policy Analysis of the Government of Flanders' Department of Agriculture and Fisheries established a research agenda which serves as a guide for calls for proposals, project proposals and the evaluation and selection of research projects for organic agriculture. The research agenda is the result of a thought process that was performed together with the members of NOBL (the Network for Organic Food and Farming Research).

Organic agriculture is based on a number of basic principles. When developing a research agenda it is important to clearly define what these basic principles mean in the context of the research. The values of organic agriculture bear similarities to the sustainability values, and parallels can be drawn with regular agricultural research. However, important differences do exist compared to regular research. Examples are the systematic directives in research on organic agriculture, its interdisciplinary nature, the attention paid to social issues and the fact that the research is carried out in order to expand the knowledge base of the beneficiaries of that research. Research on organic agriculture departs from a holistic vision, but other research visions may also apply.

Research in the organic sector of the agriculture industry is about the deepening of organic agriculture. It must be progressive and innovative. Long-term research is very valuable in this context, but short-term research is just as necessary. The areas of research are very broad and can be grouped in different ways. We have opted for a subdivision into 6 main themes. Due to the nature of organic agriculture, several themes are closely related and an interdisciplinary approach will often be necessary to thoroughly explore a theme.

Below, the research themes are listed in order of priority. The (sub-)themes are briefly explained in the research agenda and for each (sub-)theme the different relevant research needs are mentioned.

- Production-related themes with regard to primary production and product quality;
- Economy and society, comprising business-economic aspects and sectoral aspects;
- Supply chain management and marketing, including chain management, market and consumer and sustainable technology;
- Policy;
- Communication;
- Organic agriculture within its surroundings.

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Arable Crop and Vegetable Production

Soil and soil management

Crop protection

Cultivation techniques and systems

Varieties and breeding

Organic matter management and non-inverse soil tillage for sustainable soil use

Sustainable soil management aims to optimise the soil quality in order to improve machinability, to minimise weed, disease and pest pressure, to optimise nutrient use efficiency and soil/water ratio and assure yield and crop quality.

Soil tillage, crop rotation (including cover crops), fertilisers (type and quantity) and the use of crop protection products have an impact on soil quality and processes and the provision of organic matter and are thus all part of soil management.

ILVO investigates how sustainable soil management can be realised, with a focus on (non-inverse) tillage and organic matter management. ILVO investigates its effect on nutrient dynamics, physical and biological soil quality, weed and disease pressure and crop yield.

ILVO and sustainable soil management research

ILVO has established field experiments in Merelbeke (BOPACT trial, since 2010) and Meulebeke (since 2009) to investigate the effect of non-inverse soil tillage and compost application on nutrient dynamics, physical and biological soil quality and crop yield. One important focus of the BOPACT trial is the impact on disease suppression, specifically on the occurrence of plant parasitic nematodes and fungi and the spread of Dyckea in potato. The rotations contain both arable crops (e.g. maize and potato) and vegetables.

The European Catch-C project focuses on best management practices. Best management practices aim at higher crop productivity, ameliorated soil quality and climate change mitigation. Besides identifying best management practices based on a screening of European long term field trials, the project investigates the compatibility of these practices with different farm types in the EU. For this, an integrated approach of interviews, questionnaires and focus groups is used. ILVO also develops a decision tool to help farmers select the best practices for their specific situation.

For a decade already, ILVO has been investigating how organic residues can be valorised by producing farm compost. The application of compost to the soil is an effective way to increase the soil organic matter content.

Since 2009, ILVO has also been investigating whether the application of biochar (a by-product of the pyrolysis bio-energy process) to the soil can have soil improving effects. Biochar has a high and stable carbon content that can effectively increase the soil organic carbon content. It is porous, which might be positive for maintaining the correct water/air balance and can retain nutrients. International research also indicates that biochar can stimulate soil life. Within the Interreg project entitled 'Biochar: climate saving soils' and the European Fertiplus project, ILVO investigates if biochar can have positive effects for agriculture in Flanders. In this research, ILVO uses a mixed approach of lab and pot trials and a field trial established in the autumn of 2011.

The Fertiplus project also investigates if adding biochar to the composting process can reduce nutrient losses and lead to a high standard soil improving product. One of ILVO's specific tasks within Fertiplus is investigating the effect of compost, biochar and compost/biochar mixtures on disease suppressiveness of the soil.

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Funding: basic endowment ILVO; EU FP7, Interreg IVB North Sea Region
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Soil management and soil quality in organic cropping systems

Soil management affects soil quality. In an organic cropping system, fertile soil guarantees a healthy and productive crop. Cultivation and rotation are the starting point in the choice of fertilisation and tillage, but those measures are also dedicated to building up and maintaining of soil fertility.

Reduced or non-inversive tillage favors soil life and the stability of the top layer. In a cropping system that renounces herbicides, this practice requires a targeted approach.

The choice for a certain type of fertilisation is related to availability and price. When organic animal manure is scarce and the use of manure of conventional origin is restricted, it is important that fertilisation can be based on plant products. Cover crops play an important role in this. They can be applied as green manure or be mowed and subsequently used as a fertiliser product or as a feed stock material for composting.

ILVO and research in soil management in organic cropping systems

Since 2005, ILVO has been investigating soil management measures that may favour soil quality in organic agriculture.

A multi-year field trial (2005-2009) considered differences between fertilisation with compost based on plant material and application of animal manure types in terms of their effect on soil quality. This investigation actually addressed two soil management strategies, because the application of compost was combined with non-inversive tillage and land was ploughed after application of animal manure. At the end of the four-year rotation the total organic carbon content (TOC) of the 0-10 cm soil layer was ca 20% higher for the compost treatment compared to the treatment with stable manure (same organic matter input for both treatments). Acidity (pH) in this soil layer was half a unit higher for the compost treatment. TOC and pH are two soil quality parameters. For the treatment in which the application of slurry was combined with green compost application, the total organic carbon content of the 0-30cm soil layer was ca 15% higher compared to the stable manure treatment.

In a two-year trial (2012-2013) done as part of the European TILMAN-ORG project, the use of green manures in a reduced tillage system is

under examination. In the first growing season a grass-clover sward was mechanically destroyed without ploughing before planting a leek crop. This non-inversive tillage practice, was compared to ploughing in another treatment. In one variant, the grass-clover sward was destroyed early in the season (March), on the other, late in the season (May). For this latter variant, another distinction was made, namely the removal of a full grass clover cutting versus a repeatedly mulched grass-clover sward. The nitrogen and phosphorous release from the green manure and use by the leek crop are examined. No additional fertilisation was applied. In 2012, two consecutive grass clover cuts were harvested from a part of the field not destined for leek cultivations and ensilaged. This plant material will be used as a fertilisation product in 2013. Inagro has a parallel demonstrative field trial used in this project.

The TILMAN-ORG project will compile research and practical experiences with non-inversive tillage and green manures and disseminate these findings to growers and extension workers in order to optimise the organic production method.

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The value of compost for soil fertility

Composting is a natural process in which micro-organisms transform fresh organic material into a stable and humus-rich substance. This process always happens under aerobic (oxygen-rich) conditions. ILVO executes controlled windrow composting, a method which is particularly suitable for on-farm composting.

In organic agriculture, the idea of recycling is very important. The composting of organic residues from the farm environment is an ideal way to return nutrients to the field. With the proper composition, aeration and watering, nutrient losses are limited during composting. Compost is a slow release organic fertiliser: the risk of losses from the nutrient input via compost application is very low. Nutrients are incorporated in the microbial biomass built up during the composting process or are adsorbed on the humic substances.

Research questions explored by ILVO concerning the preparation and application of compost

One aspect of ILVO's research in regard to compost composition is the availability of the woody component as a carbon source and as structure material. The feedstock used is wood chips, bark or straw. High concentrations of heavy metals occurring in the bark of certain woody species (also related to the locality) pose a risk of exceeding the maximum allowed concentration of these metals in the end product. As the availability of the woody, 'brown' component is sometimes limited, it is interesting to investigate if and how the part of the nutrient-rich, 'green' component (e.g. vegetable byproducts) can be increased.

Besides the current parameters with regard to the quality of the compost, other methods for quality judgment are investigated in order to improve the quality of the compost. The biological compost quality can be assessed by determining the beneficial micro-organisms as fungal biomass and nematode community, which are related to the product maturity. The deactivation of weed seeds and pathogens is another research item addressed in compost trials. Nutrient content and ratios as affected by the choice of the starting mixture are an important focus of the research.

The significance of compost application for the nutrient balance, building up soil organic matter and the soil food web are subjects of research on sustainable soil management.

Compost research at ILVO to match the needs of the stakeholders

Valorisation of chicken manure in composting was investigated in the context of an ADLO research project for the organic agriculture sector.

Composting is also one of the components of the transdisciplinary research project entitled GeNeSys. GeNeSys focuses on the valorisation of secondary flows from agriculture and fisheries. This project began in 2012.

The European project called Fertiplus considers how, through composting and making of biochar, nutrients in waste products from urban areas (among others) can be recycled in agriculture.

Results and experiences of this research with regard to the composting process and technology, the evaluation of compost quality and the effect of compost application are significant for organic agriculture in which compost is an element in the pursuit of good soil quality.

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Multiannual use of compost and straw-rich manure yields

Maintaining and building up sufficient organic matter in the soil is essential for good soil fertility, which is a keystone of organic agriculture. For this purpose, straw-rich animal manure, green manure and green compost are used in organic crop production. In doing so, the producer has to meet both the nutrient requirement of the crops and the legal fertilisation standards according to the organic farming specifications and the fertilisation legislation. Many opinions exist, but there are only few unambiguous recommendations. Growers are left with many unanswered questions. The aim of the trial described below is to examine the potential contribution of multiannual compost and manure use in organic agriculture.

Multiannual effect investigated

This trial was established in 2003 and will be maintained for a period of at least 12 years to be able to assess the long-term effect. In consultation with the organic farming sector, we opted for six practice-oriented objects using stable manure, slurry or compost as main fertiliser. In addition to green compost (VLACO vzw), farm compost is investigated. During the rotation, the fertilisation is aligned as much as possible with the needs of the plant. The following fertilisation strategies are compared:

1. Stable manure and slurry in function of the crop's needs, with a maximum of 170 kg N/ha at rotation level.
2. Stable manure and slurry (idem object 1) supplemented with 10 tonnes of green compost/ha/year.
3. Slurry and organic granular fertilisers with a maximum of 170 kg/ha at rotation level
4. Farm compost (20 ton/ha/year on average) supplemented with organic granular fertiliser in function of the crop's needs.
5. Green compost (20 ton/ha/year on average) supplemented with organic granular fertiliser in function of the crop's needs
6. Stable manure up to maximum 170 kg N/ha at rotation level

The trial was incorporated into the six-year crop rotation of the experimental organic farm at Inagro. In this crop rotation system, the rotation consists of leeks, carrots, wheat with under sow with white clover, cabbage, potato and grass clover. The trial started in 2003 with leeks.

Organic fertilisation pays off

After completing one and a half rotation (9 years) we can conclude that the different manure strategies lead to similar results in the short term. This is partly the result of the fact that the fertilisation is adapted to the crop's needs as much as possible. The objects with the highest effective nitrogen fertilisation do not always result in the highest yield. In the short term, other production factors (including previous legume crop or greenmanure, phytophtora infestation, etc.) seem to have more influence than the actual fertilisation strategy. Sustainable fertilisation must therefore be seen in this broader perspective.

When the carbon content of the soil is seen as a reference for the soil fertility on medium to long term, clear differences become visible. The object with slurry (object 3) shows a declining trend in the carbon content. In contrast, green compost building up the carbon content in the soil. The other objects show a stable to slightly increasing trend.
Notable is that the object with only slurry (object 3) recorded the past three years the highest nitrate residue. This conclusion underpins the need for more research on the relationship between organic matter, mineralisation dynamics and nitrate residue.

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Optimal application of organic manure for a healthy organic crop

Organic farmers face the challenge of applying available organic manure in the best possible way. This includes the difficult balance between bringing in sufficient organic matter to build or maintain soil fertility while providing enough plant nutrition, in compillance with the current rules and regulations. Furthermore, there is a high probability that at least part of organic fertilisation will have to be of organic origin within the next few years. Optimal use of the existing supply of organic manure forms a crucial link in the evolution towards a 100% organic cycle. The question is, how big will that supply be and what quality will it be? Furthermore, could treatment of manure prior to application improve that level of quality? The overall idea is to facilitate plant growth and development, to achieve better crop health and also higher soil quality.

Focus on organic manure from poultry and ruminants

An important point of attention in this project is to facilitate transportation of organic manure from one organic farm to another. Chicken manure is a nutrient-rich fertiliser that ought to be applied in moderate doses, which is difficult in practice. Composted chicken manure may be particularly suited for organic vegetable production. However, chicken manure is less attractive for application on soils rich in available P due to its low N/P ratio. Combining chicken manure and a carbon-rich feedstock for co-composting or temporary storage may overcome these disadvantages and may reduce nutrient (particularly N) losses during storage and after application. A number of chicken manure processing techniques have been considered, including a process of conversion and storage of municipal waste compost in the deep litter yard of a chicken stable.

We have also studied how the use of straw-rich goat manure from a deep litter housing system could be optimised by mixing the stockpiled material with a compost turner, which might enhance its decomposition. The heating occuring in the stockpile may also counteract the survival of parasites and pathogenic bacteria.

In addition to treatment of various types of manure, our objective was to evaluate the fertilisation value of the developed compost and manure products of differing quality. To do so, a fertilisation trial was set up using dosage as limited by the future P input standard of 55 kg ha-1 year-1 for vegetables.

A mixed approach of desk study and empirical research

A desk study was done to complement the practical research. In this study, we examined the availability, origin, marketing and use of different types of manure on organic farms. Are there enough resources available at the right time for organic crop or animal production? Would it be possible to further improve fertilisation strategies within the legal constraints regarding nutrient input? What about the balance between the different organic subsectors, practical applicability or composition of different types of manure and compost, distance between farm enterprises, etc.?

The desk study serves as a baseline for the empirical research and is used to identify and evaluate a set of alternative scenarios for the allocation and use of organic manure. Finally, each particular practice is scored upon efficiency and measured against sustainability criteria.

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Litter or chicken manure on grassland?

Over the past decades, organic agriculture in Flanders has become increasingly subsector-oriented and specialised. As a consequence the link between the different sub-sectors has faded. This has partly dislocated the nutrient cycle.

Closing the nutrient cycle by fertilising grassland with on-farm cattle litter

In organic livestock farming, slurry from conventional sows is still frequently used for the spring fertilisation of grassland. This practice is increasingly questioned because the manure does originate from land-based agriculture. Organic livestock farmers are therefore looking for alternative fertilisation strategies for their grassland. The use of (conventional) cattle slurry is a potential alternative but it gives an increased risk of paraTBC. The use of stable manure from the own farm is questioned because of the slow N release, which could have a negative impact on the grass yield and quality of the first cuts. On the other hand, organic chicken farms need to allocate heir organic manure on organic fields. But because of the unfavorable N/P-ratio this manure is not popular among organic crop farmers.

Long term evaluation

A long-term trial is initiated in 2011. The main objective of this trial is to stimulate a more closed nutrient cycle within the organic agriculture by evaluating different types of animal manure on pasture. Use on grassland of straw-rich goat manure from a deep litter housing system, chicken manure and pig slurry are compared. Also the effect of time of application (autumn or spring) of stable manure was taken into account.

Litter manure offers perspective

The first results of 2011 show that stable manure or litter manure compost of goats applied in spring provide a slow nitrogen release. This causes a slower grass/clover growth and a lower protein level in spring. However this is fully compensated by a higher yield in summer. The effect of fertilization with litter manure on the content of fermentable organic matter (=indicator for fast digestible carbohydrates) was low in this trial. Manure needs to be well spread for a good digestion of the manure by the time of the first cut.

Chicken manure and chicken manure compost are a source of quickly available nitrogen. No differences were observed in nutritional value compared to grass fertilized with cattle slurry. Further research is necessary to confirm these results. When using chicken manure, however, caution is necessary. A good knowledge of the origin of the chicken manure and good arrangements with the poultry farmers about removing dead animals (risk on botulism) are essential. Also the storage and treatment of the manure on the farm require special attention.

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Leguminous green manures: which ones to use and how?

Green manures are becoming increasingly important for limiting erosion and nitrate residue in the soil. In conventional agriculture, green manure is mainly used as catch crop after the main crop. In organic agriculture, green manures play a vital role in the crop rotation. Besides functioning as a catch crop, green manures are used to maintain the soil structure and as a fertiliser of the subsequent main crop.

Legume green manure investigated

MAP4 (the 4th Flemish Manure Action Plan) steers the farmer towards the use of grassy and leafy green manures. Depending on the nitrogen and phosphorus standards in MAP4 and the intention to close cycles, legume green manure is gaining more and more importance for organic agriculture. The question then becomes, which leguminous green manures can best be used?

In the current CCBT project '*Leguminoos – grandioos!*', various leguminous green manures are tested on three sowing dates, namely under-sowing in a cereal crop, sowing in August after an early harvesting crop or sowing in October after a late cultivation. In under-sowing, white clover and some other clover types are tested. For the sowing in August we have chosen mixed cropping of a legume with Japanese oats. In the October sowing we investigate if it is possible to sow legume after the harvesting of late crops and which legumes are most suitable for this purpose. In this experiment we will assess the development of the green manure and the nitrogen availability in the soil for the following crop. The crop development will be evaluated as well.

Proper incorporation of green manure in the soil

Leguminous green manures and their management have to be adapted to the following cultivation and the type of soil tillage. Using the wrong green manure or incorrect management can cause a great deal of trouble in the following cultivation. Many ambiguities still remain about the incorporation of green manure, especially grass/clover, on organic horticultural farms with early spring crops. The question here is, how and when can grass clover be destroyed without a loss of nutrients?

In a second experiment, different strategies for the incorporation of grass clover are compared. In particular, we investigate the best time on which grass clover is incorporated and how it influences the nitrate residue. Should grass clover already be incorporated in the soil during summer or in autumn, and is this possible without excessive levels of nitrate residue? Are there possibilities to destroy and incorporate the grass clover during winter or the early spring? In this experiment we will also monitor the nitrogen availability in the soil and the extent to which the grass clover digests and thus to what extent the soil is ready for an early spring cultivation.

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Manures and MAP4 throughout the Flemish organic sector

Organic farming relies on a land-related production and a closed nutrient cycle with an exclusive use of organic fertilisers. Nitrogen, phosphorus and carbon are inseparable. In the past, nitrogen was a limiting factor, but with the new manure legislation (MAP4) phosphorus has become the limiting factor. The impact of this change varies from sector to sector. In the first place, fertilisation strategies (type of fertiliser, volumes, time of application, etc.) need to be adjusted. As a result, shifts will occur in the placement of organic manure. In addition, all organic manure should be deposited on organic fields. This project addresses the most important sectors of Flemish organic agriculture. It has two aims: to respond to a number of new questions and challenges in the context of MAP4 and to form a bridge between sectors to achieve a more closed organic nutrient cycle over the entire Flemish organic farming sector.

New fertilisation strategies

As a starting point in the project we used the results of the desk study from the ADLO research project "Optimal use of organic manure from poultry and ruminants for a healthy organic crop", performed by ILVO. This study gave an overview of the current availability and actual use of animal manure (organic and conventional) in the organic sector. Given the growing technical needs, the current practice, MAP4 and the trend towards a more closed mineral cycle, the different partners visualised possible (new) fertilisation strategies for their respective sector.

Several fertilisation experiments are now underway for vegetable farming. At PCG, plant manure is being compared to animal manure for cucumber. Using wells and tensiometers, soil moisture and water movement are also being monitored. In addition at an organic vegetable farm a cucumber cultivation is being monitored on-farm.

For pome fruit, two trials (one on apple and one on pear) have been set up at an organic farm, where a standard fertilisation with poultry manure was supplemented with an organic nitrogen fertiliser (Eco-mix). Also for berries, animal manure as fertiliser is being studied.

In grassland, Inagro demonstrates the use of own-farm manure and the use of poultry manure. The standard basic fertilisation in potatoes is 20 to 25 tonnes of manure per hectare. This level of fertilisation is no longer possible due to the new standard for phosphate. For 2012 and 2013, Inagro has set up trials in which four strategies (standard manure, slurry combination compost, supplemented with organic fertilisers, etc.) are compared.

Finally, demonstrations for vegetables have also been set up. On the one hand, manure and slurry + compost are compared to each other, on the other hand, three regimes of additional fertilization are compared (0, KNS conventional, KNS adjusted for organic). For each trial, yields and quality are monitored and also a financial calculation is made.

For poultry, measures to maximise the N/P ratio of the manure are listed for the organic poultry farmer.

At the end of the project, the results will be compared to the goals described at the beginning of the project. The prospects and constraints will be mapped, both by sector and for the Flemish organic farming sector as a whole. No project results are available yet.

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Funding: Government of Flanders, Department of Agriculture and Fisheries
Location: Different locations in Flanders
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Monitoring nitrate nitrogen in organic fruit orchards

Until now, little research has been done on fertilisation in organic fruit growing. But with the introduction of MAP4 and the stricter requirements concerning issues such as nitrate nitrogen in autumn, questions about fertilisation are being raised in organic fruit growing. Because of the higher humus content in the organic orchards, it can be expected that more nitrogen is released in autumn via mineralisation as compared to integrated fruit production. As a result, it is conceivable that the limit of 90 E residual nitrogen could be exceeded, even without heavy fertilisation. It is important to get a better understanding of this process to reduce the risk of penalties and restrictions from the Government of Flanders.

It is also important that the organic fruit growers improve their view of the needs of the crop. The question is whether organic fertilisers can ensure that the trees absorb enough of the nutrients they need.

Description of the project

In MAP4 (the 4th Flemish Manure Action Plan), both nitrogen and phosphorus fertilisation are under pressure. Organic fruit growers face two main constraints: knowledge of the nitrogen reserve (including residual nitrogen in autumn) and the restriction of the phosphorus fertilisation by 2018, to reach the goal of a maximal fertilisation of 55 E P_2O_5.

In spring 2012 eight parcels were chosen in agreement with the "*Vakgroep Biologische Fruitteelt*" to follow the evolution of the nitrate nitrogen during the growing season. Per parcel, a comprehensive soil analysis is performed to determine the humus content and the content of nutrients at the start of the project. The fruit growers concerned are asked to make detailed records of all cultivation measures such as mechanical weed control and spreading of organic manure, so that these data can be included in the interpretation of the results. Finally, by means of leaf and fruit analyses, the mineral composition shall be determined to compare the uptake of nitrogen with the values in the soil.

In addition, in spring 2012 a parcel was chosen to follow a trial with different nitrogen levels. In this trial also the fruit quality (firmness, sugar content, starch value and colouring) will be determined at harvest and after storage.

Results

At *Pcfruit npo - Proeftuin pit- en steenfruit* we have already started limited monitoring of the nitrate nitrogen (N-min) in the soil for a number of organic fruit parcels. Preliminary results suggest that there are large differences in nitrogen reserves during and after the growing season. Furthermore, it appears that in organic fruit orchards, the residual norm of 90 kg NO_3-N may be exceeded. The results of 2012 and 2013 will reveal whether this was due to the abnormal distribution of the rainfall in 2011 or whether this is an annually recurring phenomenon.

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Location: Reinrode Fruit, Reinrode 77A, 3460 Assent + 8 parcels from organic fruit growers
Partners: Vakgroep Biologische Fruitteelt, Ghent University
Funding: CCBT project (Government of Flanders, Department of Agriculture and Fisheries)

An approach to replant problems in new plantings in organic fruit cultivation

Replant diseases are an increasing problem in all crops, both in organic fruit cultivation and in integrated fruit growing. In recent decades fruit farms have become specialised, effectively eliminating crop rotation. Unlike integrated fruit growing, organic fruit growing cannot rely on chemical soil disinfection. This has led to a great deal of research on this problem in the last few years.

Although equally important, soil structure is receiving too little attention in practice. The only opportunity to thoroughly change soil structure is just before planting. In existing orchards it is not possible to incorporate organic material and/or soil conditioners to improve soil structure and moisture balance.

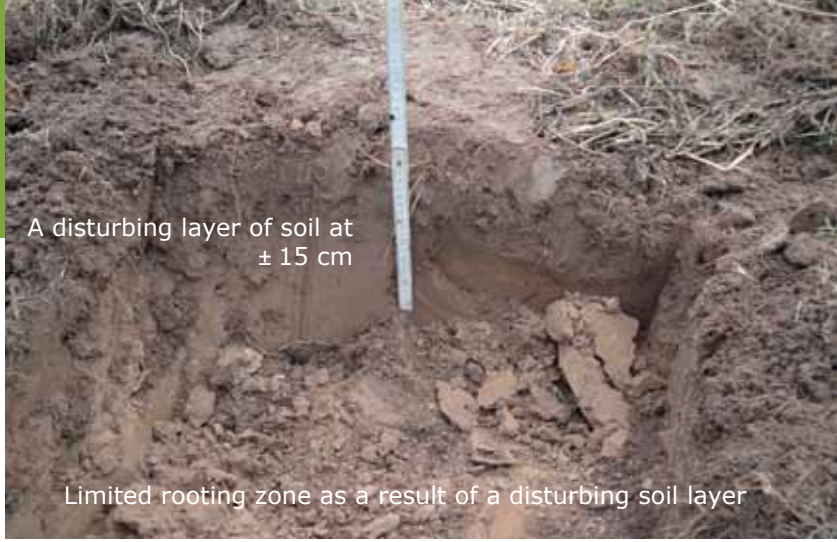
Possible solutions

Symptoms arising from poor soil health only become visible after the trees have been planted. Because apple is a perennial crop, this problem is difficult to solve (see also "Replant problems with apple in organic fruit growing"). Organic fruit growers are further constrained by the small range of products available to them.

Several possible solutions have been proposed:

- Mycorrhiza strains. These cultures, which live in symbiosis with the root system of the trees, can improve the uptake of water and nutrients.
- Seaweed lime preparations would improve the soil structure, which would improve the trees' rooting.
- Other commercial soil conditioners. All of these products claim better rooting and a better uptake of the essential nutrients.

Because of the high cost of most of these treatments, the fruit grower must have confidence that the chosen treatment will be successful. In spring 2012 a comparative trial with 12 different objects was started in a parcel of an organic fruit grower (Janssens – Glabbeek). From the beginning, this old orchard has had problems with vigour and yield. A soil sample taken in



Limited rooting zone as a result of a disturbing soil layer

2010 showed infestation of nematodes (mainly *Pratylenchus penetrans*) as well as heavy infections of Fusarium and Pythium. The soil also has poor structure, which plays an important role. This parcel therefore requires a thorough approach and is an ideal parcel to test the different products (mycorrhiza strains, seaweed lime and soil conditioners).

Because this trial is performed in a new planting, it was possible to break the disturbing layer with a subsoiler. Also the organic material and/or soil conditioners could be incorporated. (In our project "Replant problems with apple in organic fruit growing" this was not possible.)

Results

No results are yet available. We will wait for the growth and the yield of 2013 to see if these products are as efficient as they are claimed to be.

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Funding: CCBT project (Government of Flanders, Department of Agriculture and Fisheries)

How can the pH of the soil be reduced in organic berry cultivation?

At the request of farmers, PPK performed research projects on soil pH in berries. For many years we have determined that the cultivation of organic berries is becoming increasingly difficult. Various berry cultivations demand a slightly acidic to very acidic soil. For blackberries and raspberries this is a pH of 5.8 - 6.5; blueberries require an even lower pH, between 4.0 and 5.0.

These cultivations also require a humus-rich soil and sufficient water. In practice, many problems are caused by the use of compost (own-farm compost or green compost) and the use of irrigation watering. Both involve alkaline agents.

The soil pH of berry orchards is often too high

Compost and watering can cause the pH in berry cultivations to rise. In conventional farming, acidic acting fertilisers are used and the irrigation water is also acidified. The organic farmer does not have an allowed organic alternative, however. The organic fertilisers do not have acidic qualities. This cultivation ultimately becomes unprofitable because chlorosis arise. At the preliminary stage, this can be treated with allowed foliar fertilisers, but this does not address the structural problem, i.e. the pH of the soil.

Where is the problem located?

The goal of the project was to map the problem of increasing pH in the organic cultivation of berries and investigate potential solutions that are allowed in practice.

To find a solution, we had to investigate both the soil and the irrigation water. While initially we thought that compost was a potential cause of the increasing pH, we now have to conclude that compost cannot cause pH increases of this magnitude on its own. The observations and analysis increasingly point toward the irrigation water used. We have taken samples on the farms and additionally provided an overview of the potential solutions. These solutions were checked in the organic regulation to subsequently create a list of allowed solutions.

Listed solutions

In the continuation of this project, we will perform on-farm trials to test the efficacy and feasibility of the solutions identified in the previous project in practice.

One goal of this project is to monitor the evolution of pH on several farms by supporting the farmer in the regular measurement of pH and in the registration of related cultivation operations.

The soil can be acidified by adding sulfur in the form of elementary sulfur, or by using crop residues of crops with a high sulfur content such as rapeseed. To reduce the pH of the water, experiments are set up with products based on *Lactobacillus* spp..

However, it remains difficult to predict the reaction of the soil. All interactions between the different elements in the soil food web are difficult to grasp in a calculation model. This research will continue to evolve by trials and experiments and hopefully will offer a solution to reach the desired soil pH in the end.

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Fruit vegetables in greenhouses: fertilisation strategy and needs

Organic greenhouse growers are facing many fertilisation questions, especially in light of the CAP reforms. Examples are: "Can fertilisation be aligned better with the crop needs?", "Does the crop react differently to another kind of fertilisation?"

Nature, types and varieties

The grower usually adds a basic fertilisation before planting. According to the organic specifications, this is limited to 170 E animal manure. Under CAP guidelines, a farm bigger than two hectares is bound to a more stringent legislation. If animal material is used, it is important to ensure that it is sufficiently digested. However, plant fertilisation is also possible using green compost. Moreover, growers are exposed to numerous kinds of additional fertilisation, which vary in origin and cost.

Plant vs. animal fertilisation

The trial setup, which has been running for two years, tests different fertilisers. In 2011, the cultivation of tomatoes was monitored, in 2012 the cucumber cultivation is monitored. In 2013 the trial is set up in peppers. In one section we use animal manure; in another plant fertilisation. The animal manure consists of a basic fertilisation of digested cattle manure. One half of the cultivation is extra fertilisated with blood meal. The other half with chicken manure granules. The plant fertilisation trial is built up in an analogous way: basic fertilisation with green compost, extra fertilisation with either soybean meal or malt. For reference, we maintain a section of each trial where only basic fertilisation is given.

Soil and leaf juice analysis

Using soil analysis, it is relatively easy to investigate the amount of nitrates in the soil. This does not show the amount absorbed by the plant at that point, nor the needs of the plant. Leaf juice analysis, whereby the nitrogen and potassium contents are measured from the oldest vital leaf and youngest adult leaf, helps to envisage what happens in the plant. By mapping these data during the whole cultivation we try to adjust the fertilisation to the needs of the crop.

Using leaf juice and soil analysis results, we determine the moment of fertilisation. Specific fertilisation is then added to all sections of the experiment until the same amount of nitrogen is reached in the soil.

Measuring tube and tensiometer measurements

Fertilisation is expensive and the environment is even more precious. There are many reasons to prevent fertilisers leaching to the groundwater. Using frequent measuring we monitor whether fertilisers are leaching under normal watering conditions.

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Control of the bean seed fly in organic cultivation

*The larvae of the bean seed fly (*Delia platura*) can damage germinating seeds of several crops, including beans, pumpkins and maize. The white maggots tunnel into the germinating seeds and attack the germ, destroying or causing it to rot as a result of of secondary diseases. The symptoms of infestation by seed corn maggots are a reduced emergence rate, holes in the leaves or cotyledons, damping off and weak, deformed seedlings. In case of heavy infestation, re-sowing of the crop is needed. The period in which the crops are susceptible for damage is limited to 3 to 4 weeks after sowing or planting.*

In the conventional cultivation of broad beans, seed corn maggots are controled by coating the seeds with insecticides. In organic cultivation, only preventive control measures can be applied to avoid damage to seeds and seedlings. In 2010 and 2011 Inagro conducted on-farm research to investigate the effect different organic control measures in the cultivation of dwarf French beans.

Row crop covers

By covering the crops with an insect-proof mesh or fleece during the period of egg laying, damage can be avoided. The covered soil has to be free of eggs or pupae of the bean seed fly, however. In the field experiment the effect of variations in timing and duration of covering the seed bed on bean seed fly attack was investigated.

The seed bed was covered with a thermal net (Howicover 38, Howitec Netting) on two timings: (1) from a couple of weeks before sowing until two weeks after sowing and (2) from sowing time till two weeks after sowing. The experiment was repeated in different sowings. At all sowing dates, seedling emergence in the covered objects was 9 to 10% higher than in the uncovered control. As no damage to the seeds by seed corn maggots was found, this improved emergence was probably caused by the more favorable microclimate under the cover. On the covered seed bed, some seedlings were damaged by seed corn maggots, but not significantly. A difference between the two covering periods could not be proven. The dry and hot spring in 2011 limited seasonal damage caused by the seed bean fly in the field trial.

Effect of entomopathogenic fungi

The microbial insecticide 'Bio1020' (Bayer Cropscience) contains spores of the entomopathogenic fungus *Metarhizum anisopliae*. In Belgium this product is allowed for use to control the vine weevil. Good control results have also been demonstrated against other insects. In 2011, a treatment with Bio1020 was included in the onfarm trial. No effect could be demonstrated on damage by the bean seed fly due to low infestation pressure in the field. In field trials in the Netherlands however, positive effects with Bio1020 were demonstrated.

French bean varieties with coloured flowers less susceptible

The trial results of Inagro also showed a significant effect of the variety choice on the damage caused by seed corn maggot. The French bean varieties Rio Dulce and Rio Grande (Agro Seed Service) with purple flowers seemed to be less susceptible for damage than the white flowering variety Proton (Holland Select) in this trial. Hence, choosing for coloured flowering French beans instead of a white flowering variety seems to be a good control measure to limit the infestation risk by the bean seed fly.

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Flower margins in cereal crops: An ally in aphid control

In the context of the SOLABIO project (types and landscapes as carriers of biodiversity, an INTERREG IVA project), the Flemish Land Agency (VLM) coordinated research on the presence, distribution and function of beneficial insects in field margins. The role of grassy field borders and flower strips for beneficial insects had barely been investigated in Flanders. The research presented here was conducted by Inagro during 2009 – 2011 on three arable farms in West and East Flanders.

Flowers feed natural enemies of pests

Natural enemies of pests are very useful because they help to protect the crop against potential damage by pests. Ladybugs, larvae of syrphid flies or lacewings can consume hundreds of aphids during their life. These are but a few of many examples. To enable optimal functioning and presence of these natural enemies in crops, they need additional food besides prey. Mainly the adults need sugars and proteins for their flight activity, for survival and for their reproduction. One of the most important resources for these nutrients are nectar and pollen from flowers.

Support in aphid control

With the support of the Flemish Land Agency, single and perennial flower mixtures were sown alongside arable fields on three arable farms during the project. The research performed by Inagro confirmed that these flower margins promote the presence of natural enemies. Particularly more syrphid flies and flower bugs and often more lacewings are living in the flower strips compared to regular grassy borders. It was also shown that these beneficial insects do effectively help in aphid control in the adjacent fields with winter wheat. If there are enough natural enemies present, the use of insecticides even becomes unnecessary. In the experience of the farmers concerned in the project, this decision didn't had a negative effect on the wheat yield. The untreated fields yielded even more per hectare because of the savings on insecticide costs.

Crop scouting: the key to reduced insecticide use

Flower strips offer opportunities to reduce the use of insecticides in cereals and to grow towards a more integrated pest control. To achieve this, we must invest in knowledge and regular scouting of the crops. This is not only important for a more integrated pest control, but also to give natural pest control a chance in the field. Without field observations, farmers often decide to spray too early. Such spraying can be counterproductive because it also kills the natural enemies and therefore enables the aphids to rebuild up even faster. In crop scouting, one should thus look for the abundance of both the pest and the natural enemies. As long as the predator-prey ratio is balanced, we can leave the pest control to nature without taking a great risk of yield reduction.

Support for flower strips on its way

Flower strips are not included in the agro-environmental measures that farmers can adopt on their fields through management agreements. The results of this study can be used to create new management agreements for flower strips for the upcoming PDPO (Flemish Program document for rural development) (2014-2020)

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Flower strips for natural plague control

Many useful organisms, like natural enemies of plague insects, have a hard time surviving in an intensive farming ecosystem. The research on this topic is focused on how these organisms could be stimulated and involved in an ecological farming system. The presence of a suitable habitat is of major importance, for providing the most crucial needs like food (for all developmental stages) and cover. The installment of flower rich field margins, may meet those needs. Research is performed to determine the success of stimulating useful organisms, and furthermore to what extent a natural plague control can be achieved.

Effects on plague organisms and their natural enemies

Research performed in 2010, as part of the SOLABIO project, pointed out that one year old flower strips, even with a limited extent of 3 meters, can contain significant numbers of useful insects. Moreover, they proved to have an added value compared to grass verges, with significantly higher numbers of particular groups of insects like carabid beetles and ladybirds.

In a subsequent research project on a farm in Huldenberg, we installed a flower strip of 3.2 m width. Because of a long period of drought in spring of 2011, the development of the flowers was delayed. This is a possible explanation for the limited observed effect of natural plague control in the adjacent winter wheat crop. Only in the month of July, the population of plant lice (*Aphididae*) was suppressed on a distance of up to 18 m from the flower strip, with a declining effect up to 36 m. Furthermore, we discovered a clear increase in the number of thrips (*Thripidae*) in and around the flower strip. These observations plead for more in-depth research in the conditions for a successful natural plague control of all relevant plague species.

Conclusions

The current situation does not allow farmers to rely on in natural plague control with the installment of one or more flower strips. A multitude of factors and ecological relations make a complex whole that is – to a certain

degree – still unpredictable. We are convinced, however, that flower strips could be part of a system of integrated crop protection. The farmer then has to monitor his crops on a regular basis and only, when appropriate, intervene with the right chemical agent. This way the farmer could reduce the number of treatments and could even do without in some years. These potential savings should be weighed against the cost for installing flower strips and the loss of production area.

A flower strip is not only useful for natural plague organisms, but also stimulates pollinators like (bumble)bees and many other forms of biodiversity, as well as contributing to a beautiful landscape scenery.

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Influence of green manure crops on the population dynamics of nematodes

Green manure crops can prevent erosion and leaching of nitrogen in surface water during the intercrop season. Green manures can also be used to control nematodes and reduce the damage they cause on subsequent susceptible crops. Soil incorporation of green manures can enhance this effect. However, there are many nematode species, different green manures and cultivars, and their incorporation can be performed in different ways and at different times. We examined the influence of certain green manures on the development and numbers of nematodes.

Root-knot nematodes (*Meloidogyne* spp.)

Root-knot nematodes can multiply on many crops and weeds. Therefore, it is important to know the host plant status of green manure crops to avoid high population build-ups during autumn and winter. Lab experiments showed that resistance against the quarantine nematodes *Meloidogyne chitwoodi* and *M. fallax* is present in certain cultivars of fodder radish. In a field test, the decrease in the population density of *M. chitwoodi* was similar using these cultivars as when applying black fallow. Incorporation of fodder radish before the frost period did not show an additional nematicidal effect.

Green manures can also be used as trap crops. Nematodes penetrate the roots and remain there. By destroying the plants before the nematodes complete their life cycle, their population density decreases substantially. Research on the life cycle of *Meloidogyne* spp. on green manure crops in controlled conditions allows to determine the ideal time to destroy the plants.

Potato cyst nematodes (*Globodera* spp.)

Potato cysts are persistent enemies of potato growers. Cysts survive for many years in the soil and only resistant potato cultivars can substantially reduce their population densities. In lab experiments we exposed cysts to root diffusates and plant extracts of fodder radish, yellow mustard and rape seed. Then, cysts were transferred to potato root diffusate, the normal stimulus for hatching of juveniles from the eggs. Some green manures enhanced the hatching. However, juveniles exposed to plant extracts had trouble finding potato roots; their sensory perception was disturbed.

These results indicate that in a field situation, green manures will stimulate the hatching of juveniles, but these will fail to find a food source (potato plant) and will eventually die. In a field experiment with yellow mustard this effect could not be confirmed. Incorporation of green manures before the winter and covering the soil with plastic foil had no effect on the invasion of juveniles into potato roots. However, after incorporation of yellow mustard, the numbers of beneficial bacterial-feeding nematodes increased. In addition, the proportion of plant-parasitic nematodes in the total nematode fauna decreased. This indicates an enriched soil fauna that, in the long run, can lead to a more suppressive soil that provides better protection against plant pathogens.

Applied research

In collaboration with agricultural extension organisations we study the influence of mustard, fodder radish and arugula on nematode populations under different crop rotations.

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Combating the woolly apple aphid with entomopathogenic nematodes

*The woolly apple aphid (*Eriosoma lanigerum*) is one of the major damage causing agents in apple production. An infestation can result in loss of harvest through smeared and smaller fruits. Infestation also leads to deformations (cancer tissue) and weakening of trees in the long run. During summer, two natural enemies contribute to the control of the woolly aphid: the parasitic wasp* Aphelinus mali *and the earwig* Forficula auricularia*. At the start of spring, however, the woolly apple aphids defeat their natural enemies as they quickly build large aphid colonies which can lead to damage for the apple growers.*

Can other natural enemies be deployed against the woolly red mite?

In other continents it has been found that in autumn a part of the woolly aphids population migrate to the roots to hibernate, The aphids can also cause important damage to the roots during this period. In spring, the woolly apple aphids migrate from the roots to the branches of the apple trees to form new colonies. An underground treatment with a third natural enemy could, given this knowledge, offer a solution for the emergence of new aphid colonies in the spring.

Biological pest control with entomopathogenic nematodes (EPN)

The most successful group of biological control organisms against underground pest organisms are EPN. This group has already successfully been applied against gnats, leatherjackets, grubs and many other harmful soil organisms. EPN spend their whole lives under the ground. They detect a host, invade it, kill the host and multiply inside its body. The biocidal effect of the EPN is based on their symbiotic bacterium. The EPN transport and protect the symbiotic bacterium and as a reciprocal service, the bacterium kills the invaded host with toxins and breaks down the host into suitable food for the EPN.

Can EPN be deployed against the woolly red mite?

We screened all commercial EPN species for biocidal efficiency against the woolly apple aphid. In laboratory and field experiments, we observed that the EPN did invade the aphids, but did not kill them. This is explained by the fact that the symbiotic bacteria of the EPN cannot grow inside the apple aphid and consequently are not able to create the biocidal toxins. During field research we have observed that the apple aphids in Belgium do not hibernate on the roots, but rather creep beneath the bark of the apple trees to shelter from the cold. This means that we should look for an above-ground biological control agent, in combination with the parasitic wasp and the earwig, for the biological control of the woolly apple aphid in the apple orchards.

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Efficacy of potassium bicarbonate against scab on apple

In organic farming the use of chemical products is not allowed and only a limited number of products are available to treat pests and diseases. Furthermore, the use of copper is now under discussion. In order to be able to cope with all the pest and diseases, research into alternative strategies is necessary. We have investigated the efficacy of potassium bicarbonate for the control on scab on apple.

What, when and how to treat?

Potassium bicarbonate, also known as baking powder, is considered harmless from an ecotoxicological and toxicological point of view. This product has already been introduced on the list of active substances which may be used as plant protection products in organic farming. At the research station of Pcfruit npo, research concerning the efficacy of this product against scab on apples was conducted, only during the primary infection period (ascospores). This research showed that the product has a fungistatic activity and that the best efficacy was obtained with curative applications. The applied dose rate was 5 kg/ha standard orchard. Timing of the application is the most crucial factor. The best results were obtained when the product is applied at 300 degree hours (= sum of the temperatures starting from the infection moment) after infection. The rainfastness of this product was however not very good. After each rain event, trees should be treated again.

A new biological product against scab on apples

In addition to or instead of copper, application of potassium bicarbonate seems to be a good alternative management strategy to control scab on apples. The crucial factor for success is the optimal timing of the product. Nonetheless, the exact mode of action of potassium bicarbonate on the scab fungus is still unknown.

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Investigation of alternative beneficial arthropods for the suppression of pear suckers

*For many years now the pear sucker (*Cacopsylla pyri*) has been the most important pest insect in the Flemish pear growing regions. It is mainly notorious because of the phenomenon of 'black pears', in which sooty molds develop in the honeydew secreted by pear psyllids on the fruits. In addition to these unsellable pears, psyllids are able to transmit phytoplasmas and weaken the flower buds emerging in the next season.*

Natural suppression of pear psyllids: what can we learn from organic pear growing?

Thus far, integrated pest management of pear psyllids has predominantly focused on predatory bugs (*Anthocoris* and *Orius* spp.). These key beneficial arthropods are not host-specific, however, and they often come into the orchard too late to prevent damage from pear sucker populations that have already developed. Consequently, many growers are left to hope and pray that the predatory bugs will show up, and often they are obliged to treat multiple times with chemical crop protection agents to avoid production losses. The many problems and current poor sustainable control throughout the season necessitates the development of new control strategies.

We have noticed that pear sucker populations in organic pear growing are often naturally suppressed. A possible reason for this might be the presence of alternative beneficial arthropods –in addition to predatory bugs- that could play a key role in the biological control of pear psyllids.

Which beneficial organisms prefer to predate on pear psyllids?

In this research project, we aim to develop a substantial improved integrated pest management strategy by maximising the natural suppression of psyllids in (early) spring and autumn, when predatory bugs are absent.

First, based on an inventory of knowledge and specific field trials we make a selection of beneficial arthropods which could play an important role. Second, we analyse their consumption of pear psyllids with the aid of a new research technique: prey-predator PCR. This is a molecular detection

technique which enables us to determine whether or not a predator has eaten pear psyllids and how much they ate. Subsequently, for the most important predators some important aspects like their migration characteristics and their persistence in the current orchard management are studied. Finally all data are gathered into a mathematical model. This model will enable us to predict and develop optimal orchard management, which allows a maximal suppression of pear suckers throughout the year.

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Insight into problems related to stink bugs and their control in organic pear growing

For the last few years, stink bugs have become a serious problem in Belgian organic pome fruit growing. These large bugs pierce into pears for feeding, which leads to deformed fruits. Some organically managed pear orchards suffer from more than 50% production losses because of stink bug damage. Several growers indicate that they will have to stop growing organic pears if this problem is not resolved soon. Besides the significant financial losses for these growers, this problem also threatens the image and the market position of the Belgian organic pear growing sector.

Which stink bugs are responsible for the damage?

The first step toward effective control measures was first to gain more knowledge about these insects. The stink bugs are a collection of tree-, shield- and forest bugs with different species (*Pentatoma, Palomena, Carpocoris, Acanthosoma, Coreus, Gonocerus* sp, etc.). At the start of this project it was unclear to which extent the various species are occurring and which species are mainly responsible for the damage. As a consequence, nearly nothing was known of the life cycle/population dynamics of the harmful species in organically managed orchards. Due to this lack of information, it was simply not possible to work out control measures such as the determination of correct timing of crop protection sprayings. From the results of our research we learned that the forest bug *Pentatoma rufipes* is the most active stink bug in organically managed orchards. In addition, the mottled shieldbug (*Rhaphigaster nebulosa*) and the green stink bug (*Palomena prasina*) were also shown to be able to damage pears.

What, where, when and how to control?

How is the life cycle of the notorious forest bugs throughout the growing season? When do they lay their eggs, how fast is the development of the nymphs, when do the first adults appear, and how do they overwinter? This is all important information with respect to their control. One has to know the best possible time(s) to execute a control action. From the population dynamics study we learned that, in contrast to most of the other stink bug species, the forest bug *Pentatoma rufipes* overwinters as a nymph (N2). These bugs are therefore present as small nymphs (N2-N3) in early spring and autumn. This opens perspectives to focus the timing of control actions toward these periods, because nymphs are generally more vulnerable to crop protection agents than adult bugs are. Based on the knowledge of the

life cycle of the forest bug, we have organised field trials in which sprayings (with spinosad and natural pyrethroid) were specifically timed against the most sensitive life stages. In post-harvest sprayings (directed towards overwintering nymphs) the best control effects were observed for pyrethroid treatments. In the case of treatments throughout the growing season, the best control effects were obtained where sprayings were executed twice (before and after flowering).

How can we win the war against stink bugs?

The results from the field trials indicate that with a well-timed treatment the battle can be won against the stink bugs. However, we did not obtain consistent control results in all trials. Sometimes control efficacy was very poor (dependent on factors which we cannot control such as the climatological conditions). Further research is required in order to find other effective control measures so that the problem of the stink bugs can be sustainably solved in future.

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Mycosin and Enzicur as alternative plant protection agents against fungal diseases in pome fruit

The research on alternative plant protection products is growing fast due to the increasing demands concerning residues requested by retailers and the export industry and the new European directive relating to the sustainable use of pesticides. Therefore it will become a big challenge for conventional growers to produce qualitative fruits with only minimal pesticide inputs. For this purpose it is urgently necessary to investigate the feasible alternatives to reduce pesticide use. Based on initial research, some products have a potential to be used in organic farming.

Mycosin as alternative product against storage diseases in pome fruit

Fungicides like Bellis and Switch are the most commonly used pesticides against storage diseases in pome fruit. The application of both fungicides results in approaching the limit of four residues, even without counting the other treatments performed against other fungal diseases and insect pests. This increases the need for alternative treatments in the spraying schedules for storage diseases. One treatment with potential against storage diseases is Mycosin, a product based on an acidified clay substance. The advantage of such products is that they can be applied until shortly before harvesting without leaving any residues on the fruit. When Mycosin was applied 5 times, beginning at six weeks until one day before the harvest, a very good effect (60%) against Neofabraea (ie. Gloeosporium rot in apples) was obtained.

This positive effect is substantially comparable to the effect through the application of chemical products during the pre-harvest period. Unless this effect is still considerably lower than the optimum fungicide treatment (post-harvest treatment through dipping), this opens perspectives for the use of this product as an alternative against storage diseases.

Enzicur against powdery mildew in strawberries

Enzicur is the first natural fungicide based on enzymes. The product is fully natural and safe for humans, the crop and the environment. Enzicur intervenes in different ways on the metabolism of the mildew, therefore it cannot built resistence against Enzicur. The treatment is exclusively curative and is allowed in Belgium since October 2011 for the treatment of powdery mildew in the cultivation of tomato, cucumber, eggplant and pepper.

In our research on the effect of Enzicur against powdery mildew in strawberries, a proper functioning of this product was determined. The product was applied four times in this experiment from the start of the bloom. Although chemical products had the best results against powdery mildew, this product scored very well with its result of 67%.

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Epidemiology study of phytoplasmas in pome fruit ('apple proliferation' and 'pear decline')

Several important diseases can occur in fruit growing including apple proliferation and pear decline, which are both caused by a phytoplasma Candidatus Phytoplasma mali *and* pyri*, respectively. During the past few years, more and more symptoms attributable to an infection with these cell-wall-less bacteria have been noticed in our neighboring countries. Especially for organic fruit growing these diseases are a real threat, as no chemical crop protection agents can be sprayed as control measure (these chemicals target the insects that transmit the phytoplasmas).*

Are apple proliferation and pear decline present in Belgium?

Phytoplasmas infect the phloem of their host plants, leading to growth disturbances. The many symptoms are not always visible on any part of the plant. Most typical symptoms are witch broom and early red coloring of leaves for apple proliferation and pear decline, respectively. A large-scale monitoring was executed, in which samples of "suspected" orchards (low-stem (IPM, organic), high-stem) were collected and analysed for the presence of phytoplasmas using PCR, a molecular detection technique. The results revealed that not only in trees with symptoms, but also in apparently healthy trees, *Candidatus Phytoplasma mali* was present (up to 50% infection in one of the sampled orchards). Also *Candidatus Phytoplasma pyri* was recently found in a first screening of pear orchards.

How do the phytoplasmas disperse in the Belgian fruit growing regions?

In future research we will investigate which insects are acting as vectors of phytoplasmas in Belgian apple and pear growing regions. The major focus will be on apple and pear suckers (psyllids), but also other piercing/sucking insects (e.g. stink bugs) might play a role. The first results pointed out that apple suckers (*Cacopsylla mali*) collected in a diseased orchard were also infected with *Candidatus Phytoplasma mali*. However, despite several laboratory tests, it could not be shown that these insects are also able to transmit the pathogen to other trees. Further research is required to find out which insects are effective vectors, and what their migration characteristics are.

Prevention of further spread by effective control measures

Based on profound insights into the current presence of both phytoplasmas in Belgium and the insects responsible for their distribution, we aim to develop a range of control actions. This will stop the further spread of the phytoplasmas, which will significantly help our growers to produce high-quality pome fruit.

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Entomovectoring technology to combat pest insects and diseases in the flowers of small fruit crops

Organic berry and fruit production suffers severely from the lack of knowledge about biological products to control certain pest insects and diseases, despite the rising demand for these products. In addition, non-optimal pollination gives rise to the problem of a decreased yield. In Flanders, the main small fruit crops are strawberries. Mainly in the organic production of strawberries, yields on open field breeding have had a major decline. Ghent University is participating in an European project, the BICOPOLL project (Biological Control & Pollination), in which a solution for these problems is sought. The six international partners are developing technology for the dispersion of biological control agents using pollinators as a vector.

Flying doctors

A promising solution for the problem of pollination and biological pest control can be found using "entomovectoring technology". This new technology uses pollinators ("entomo") to transport ("vector") biological control agents to the flowers of the crop. This is an intelligent approach since the usage of pollinators ensures the realisation of two objectives: biological crop protection as well as enhanced pollination of the crops. This protects the flowers against pests and enhances the yield. The pollinators used for this application are called "flying doctors".

At Ghent University, Professor Smagghe and his team are working with bumblebees from the species *Bombus terrestris*. Using this vector, they consider the compatibility between the vector and the biological control agent. These are mostly microbial in nature, such as fungal spores from *Metarhizium anisopliae, Gliocladium catenulatum* and *Beauveria bassiana*. They can be used in the combat against thrips and gray mould in flowers.

For the development of a well-established entomovectoring technology it is important to investigate if the vector itself does not encounter any negative influence from the active substance. Toxicity tests are undertaken with different microbial control agents. To assess potential risks of the product against the bumblebee, a new test design was developed to screen powder products for their toxicity using *Bombus terrestris* microcolonies.

Another important factor is the loss of product during the flight of the bumblebee. These losses are caused by turbulence created by the wings during the flight. After one minute of flight, a loss of product up to 90% can be seen. To counter this loss, further insight in the complex interaction between the bumblebee skin and the biological control agent has to be acquired. Indeed, this skin is a complex hairy matrix where the product

is attached to. To enhance the product loading on the bumblebee, a filling carrier substance can be added to the active component. Because of the specific surface characteristics, these carrier products serve as a link between the active ingredient and the skin through which a higher load can be established.

A third important factor within this technology is the dispenser design. The dispenser loads the pollinator with the microbial control agent before leaving the nest. An optimal loading from the start is essential for the ultimate success of the control agent dispersal. Development of new and improved dispenser designs is also a main concern within this research.

The future takes flight

Once optimised this technology will have major economic and ecological advantages. Ecologically, there will be a lower environmental impact as a more efficient usage of the product is established. It is only used where needed, at the core of the plant in the flower. Not only do we have a reduction of the product used, the product used has a biological nature, which ensures total organic protection of the crop. Economically, the crops become more profitable because there is a higher yield thanks to an enhanced pollination and pests and diseases are combatted directly in the flower.

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The use of predatory mites for the control of spider mites in raspberries

Raspberries are extremely vulnerable for infestation by the two-spotted spider mite, Tetranychus urticae*. Due to a more favorable microclimate, problems are even more pronounced in protected production. Some cultivars, like Sugana, are clearly more sensitive.*

The content of leaf parenchyma cells is sucked out by the spider mites, which can be observed as grouped white-yellowish dots at the upper side of the leaf (although the spider mites are mainly present on the lower side of the leaf). Later, the infestation and symptoms spread over the whole leaf and the whole plant, leaving a mottled and dull appearance. As a consequence, photosynthetic activity drops, leading to inferior fruit quality and flower bud formation and the arrest of plant growth.

Call in the mite-eaters

Biological control can be done by the release of mite-eating ladybirds (*Stethorus punctillum*), gall midges (*Feltiella acarisuga*) and/or predatory mites, amongst which several species predate on spider mites. Organic as well as conventional production show great interest in the use of these predators, because resistance formation against new acaricides is appearing so fast and, once established, the presence of natural enemies is more reliable than chemical control.

In the current research only predatory mites were used, although certainly the gall midge *F. acarisuga* has a benefit in spider mite control as long as the introduction is early enough to give this predator the time to establish and build up its population. The predatory mites *Amblyseius andersoni, A. fallacis, Neoseiulus californicus* and *Phytoseiulus persimilis* were introduced in the crop by distributing small volumes at 0.5 – 1 m distance on the raspberry leaves. In bigger trials, small culture bags were hung in the crop. In the latter case the predators were introduced in once at levels of 40-80 mites/m. When predators were distributed in a scattered way, this happened three times with a 1-2 week interval at levels of 10-40 mites/m. Numbers of spider mites and predators were counted at regular intervals and the prey/predator ratio, important to estimate the success of the release, was calculated.

Predatory mites an effective strategy

The use of the predatory mites *A. andersoni, A. fallacies, N. californicus* and *P. persimilis* was effective against spider mites in raspberries. If spider mites were present, predatory mites could be observed in the neighborhood of these mites at 1 or 2 weeks after the first introduction. When the biological control was successful, predatory mites were spotted on 25% of the raspberry leaves (youngest leaves excluded). If predatory mites were present at these levels, no damage on plants was observed as long as the prey/predator ratio remained below 30.

P. persimilis does not establish in the absence of spider mites and its population reduces in dry circumstances. In such a situation, it is recommended to increase the humidity by nebulisation or spraying water on the soil. If only one species of predatory mites was introduced, the biological control sometimes failed, resulting in spider mite damage. Therefore, future research will always start with either *A. fallacies, A. andersoni* or *N. californicus,* amended with *P. persimilis* when the population of spider mites develops faster than the population of predatory mites.

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Biological control of fruit rot fungi of strawberry using epiphytic yeasts

Epiphytic yeasts are present on all plants, including strawberry. These yeasts grow on the surface of plants, but are not parasitic. Epiphytic yeasts are thought to provide a natural barrier on plant surfaces against infection by some plant pathogenic fungi. Epiphytic yeasts have been proposed as a promising biological control agent. Yeasts are suitable for biocontrol, as they generally do not produce allergenic spores, mycotoxins, or antibiotics, in contrast with some fungal or bacterial antagonists. Moreover, yeasts are known to efficiently colonise the epiphytic environment, which could antagonise the introduction and development of plant pathogens.

Epiphytic yeasts on strawberry?

Strawberry is one of the most widely grown small fruit crops in the world. Fungal diseases of strawberry, mainly caused by the fruit rot pathogens *Colletotrichum acutatum* and *Botrytis cinerea*, are responsible for severe economic losses. Epiphytic yeasts have potential for the biological control of these fruit rot pathogens, but before these epiphytic yeasts can be fully tested for exploitation as protective and biological control organisms, their behaviour under current plant growth conditions must be studied.

Research

To study the presence of epiphytic yeasts on the different strawberry plant parts, experiments were conducted at ILVO in collaboration with Pcfruit from 2009 through 2011. Examination of the dynamics of the yeast population on strawberry revealed differences in diversity and density depending on (i) the growing systems, (ii) strawberry tissue type and (iii) the sampling times. The effect of the growing system was demonstrated with different yeast species on greenhouse- and field-grown strawberry leaves. Higher numbers of yeasts were found on unripe fruit than on other strawberry tissues and the diversity of the yeasts on ripe fruit samples was most distantly related from the other strawberry tissues. Remarkably, both the greenhouse and field experiment showed that the main epiphytic yeast species associated with strawberry are resistant to standard applications of commonly used fungicides against fruit rot. This work could lead to an integrated use of epiphytic yeasts and fungicides.

Epiphytic yeast as biological control agents?

In a next phase of our research, we will investigate the potential role of epiphytic yeast as biological control agents against *Botrytis cinerea* and *Colletotrichum acutatum* in more detail. For example, based on our results mentioned above, the role of unripe fruit as a suitable target for protection with an artificial, uniform yeast coating will be investigated.

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Management of fungal diseases by application of UV-c and hot water treatments

Fungicide application is the most commonly-used technique in integrated farming to manage fungal diseases in fruit growing. However, such applications can have a negative impact on the environment. In addition, environmental and consumer groups are pressuring supermarkets to reduce residues on fruits. The competition between retailers is an issue based on residue levels which are much stronger then the legally MRL (Maximum Residue Limit) possibly combined with a maximum number of active ingredients present on the fruit. The challenge will now be how to manage pest and diseases in the post-blossom period until harvest with a minimum input of chemical products. Research concerning alternative control techniques is therefore an important topic. As organic growers are not allowed to use chemical products, this research can also be relevant to them. At Pcfruit npo, research concerning the efficacy of hot water or UV-c treatment for fungal diseases on fruits was performed.

UV-c as alternative technique to control powdery mildew on strawberries

The first trials were performed with artificial inoculation under controlled conditions. Different UV-c doses and also a variation in timing of the UV-c applications were tested. The best results (>90% efficacy) were obtained when plants were treated with 30mJ UV-c each day. However, the application of lower dose rates of UV-c light or applications in a 2 to 3 day interval had also a good efficacy (70 till 90%) for powdery mildew. Overall application off UV-c at a lower dose rate on a regular basis performed better than applications off UV-c at a high dose rate with longer treatment intervals. In the next step, a field trial on Elsanta strawberry plants was performed. The plants were treated with 15 or 38mJ of UV-c light three times a week during 2 months. The efficacy of these treatments was also very high (>90%).

Hot water treatments to control Neofabraea storage rot on apples

Research performed on Pcfruit npo showed that hot water treatments at 50°C during 2 minutes had a very good effect on storage diseases. Compared to untreated apples, hot water treatment reduced the amount of apples with Neofabraea rot by 50%. Additional applications by dipping in a solution with biological control organisms had even a better effect and reduced the percentage of rotted fruit by 60%.

The potential of physical methods to control fungal diseases in fruit growing

The trials described here are promising. The results show that alternative control techniques as UV-c or hot water treatment have potential to be used in practice for the control of fungal diseases in the near future. However, further research is needed to implement these techniques in the current management strategies.

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Postharvest treatments: applications with yeast in cold storage to control storage diseases

For the control of storage diseases, farmers can use a variety of strategies. The standard strategy for storage diseases is the use of specific fungicides, like Bellis and/or Switch, which are applied during the last five to six weeks prior to the harvest period. Besides those pre-harvest treatments, postharvest treatments can also be performed. The two application techniques that are registered in Belgium are dip treatments with Philabuster or thermonebulisation in cold storage rooms with Xedathane A. To *fulfill the extra legal requirements concerning the residues on the fruits, longer preharvest intervals need to be incorporated and no alternation in the use of different fungicide groups is included in the treatment schedule any more. Viable alternatives therefore need to be investigated. These alternatives might also be promising for organic growers.*

Benefits of post-harvest treatments with yeasts

Management of storage diseases with biological control organisms (BCOs) is a safer and environmentally friendly alternative which has potential for both organic and integrated farming. Furthermore, this type of strategy fits the objectives of the European guideline concerning the sustainable use of plant protection products. Various yeasts have already been selected for the control of storage diseases. Their mode of action is based on a competition for food and space. Pre-harvest as well as post-harvest treatments are performed with BCOs all over the world, but research trials pointed out that post-harvest treatments are more efficient than treatments in the orchard. Until now, only a pre-harvest treatment with one specific BCO (BoniProtect) is registered for pome fruit in Belgium. Conventional applications like dipping or shower treatment have some disadvantages like high investment or operational costs, cross contamination and the removal of the drainage water.

Application of yeasts in cold storage rooms to control storage diseases

Recently, research concerning the application of fungicides in cold storage rooms by thermonebulisation was performed. One disadvantage of this application technique was the non-homogeneous distribution of the product in the cold storage room. Some residue levels were therefore above the legal standards, which might have strong restrictions towards the retail or export industry. Based on these findings and the limitations for using this technique in practice, the idea arose to use this technique in combination with BCOs. The aim of a next research project is the application of yeasts through a spray or nebulisation technique in the cold storage rooms. The specific formulation type of the product and the development/optimisation of an appropriate technique for an efficient application and correct deposition of the product are the challenges of this project.

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Soil cover materials in the organic cultivation of raspberries

"Weeds" are plants that are growing where they are not wanted. Weed control in the organic cultivation of woody berries is an important point of attention. Possible solutions are: manual weeding, mechanical control, thermal control or covering.

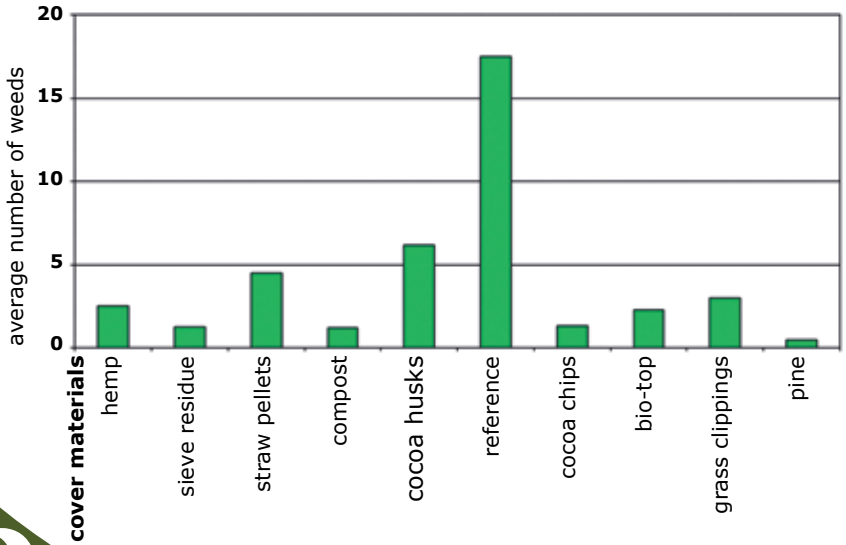
Testing different natural soil cover materials

Ten different cover materials of natural origin were tested for their weed suppressive properties in raspberries. We tested the following cover materials: cocoa husks, hemp, bark, cocoa chips, green compost, potato cork, straw pellets, grass clippings and sieve residue. These materials were tested during the first year for their sustainability, effectiveness against weeds and consequences for the plant.

The experiment was established in autumn raspberries. The parcel contains four rows, of which two with the Sugana breed, one row of Kweli and one row of Imara. In each row we set up the same ten objects.

Intermediate evaluation after one year

During one growing season, weed counts were performed on regular basis. The weed suppressing functioning of the cover materials is presented in the graph below.



Cocoa husks are the least effective against weeds. However, this material helped the young shoots to grow better. Bark functions the best against weeds, but the growing of young shoots is much slower. For grass clippings we can see a full digestion of the added material, with a full development of the shoots. Last, we see that certain materials – grass and cocoa husks – are desired by animals. Cocoa chips are subject to the influence of wind and rain. Straw pellets in their current commercial form are not allowed in organic cultivation. Grass clippings also have to come from an organic plot.

Some cover materials have a future

Currently many cover materials seem to be useful for the suppression of weeds. During the second year the differences will become more clear. It is therefore important to evaluate the experiment over a longer period of time. By 2016 we will have insight in five years of covering. Only then it will be possible to make final conclusions.

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Towards sustainable and productive EU organic glasshouse horticulture

Organic greenhouse horticulture (OGH) (i.e. the production in greenhouses or polytunnels) in the EU should improve its sustainability, production and productivity. Emissions of nutrients and the ecological footprint should be reduced. Production and productivity are too low to meet society's demands.

Aim of the project

This COST Action coordinates, strengthens and focuses the activities of the partners. It improves the communication, offers a common agenda, more and better knowledge for less money, sharing new techniques, an improved dissemination to OGH, basis for further collaboration in joint research proposals and support in the development of EU standards for OGH.

Scientific challenges

The scientific challenges are to design sustainable irrigation and fertilisation strategies, to reveal the mechanisms of resilience, robustness and suppressiveness for the management of pests and diseases, to integrate crop management, energy saving, renewable energy sources and new techniques and combinations with other activities and business to achieve climate-neutral production.

Robust planting material

The two main topics of this working group are:

- To design a common format across Europe for cultivar tests and other trials so the results will be comparable;
- Non-chemical methods of seed treatment approved by EU standards for organic cultivation.

Soil fertility, suppressiveness and water management

Soil fertility is a an important topic in OGH. Several subjects will be treated within this working group: crop rotations, cover crops, green manuring, compost application, mineralisation rates, dynamic nutrient balance, collection and treatment of greenhouse effluents, etc.

Plant Health

Management of diseases depends on a thorough knowledge of the three major components of a disease: susceptible host plant, virulent pathogen, and favourable environment. Pest control is mainly based on frequent releases of insectary-reared natural predators, also called "augmentative biological control".

Energy saving and climate neutral production

OGH systems in north-central Europe use even more energy than conventional glasshouse production in the same region. This is explained by the need to control climate more strictly than in conventional glasshouse horticulture for disease prevention purposes. Energy is a very high fraction of production costs (some 20%), even more so in organic glasshouse production, where the small size of the farm usually does not make cogeneration economical.

Sustainability and Standards

Specific measurement tools for this sector need to be developed for the assessment of the ecological, social and economic sustainability of OGH systems. There are some aspects of horticulture such as field vegetable production and orchards where research networking is recommended for the evaluation of the sustainability of horticultural production systems including organic, conventional, and integrated apple orchards.

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Biological control of the invasive leafminer *Tuta absoluta* in tomato cultivation in Flanders

Tomato cultivation in Flanders has recently been threatened by a new pest. The tomato leafminer Tuta absoluta*, which originated in South America, is a pest whose larvae make mines in the leaves of tomato plant. This leads to less photosynthesis and by consequence to a lower tomato production. The larvae can even penetrate the tomato fruits themselves, making them unsuitable for consumption and sale.* T. absoluta *has already shown in South America and Southern Europe to be a devastating pest causing up to 80–100% yield losses in tomato, so Flemish organic and conventional tomato producers are rightly concerned about this new threat.*

Pest control strategy

Chemical control must be limited to avoid development of pesticide resistance and potential negative side effects on beneficial insects currently used in tomato cultivation, and also to stay in line with the EU regulation on sustainable agriculture. Therefore, the aim of this project is to develop a sustainable, biologically based management strategy against *T. absoluta* that is applicable in tomato cultivation in Flanders.

Use of natural enemies

The project consortium (the Research Station for Vegetable Production of Sint-Katelijne-Waver, the Laboratory of Agrozoology of Ghent University, Research Centre Hoogstraten and ILVO) is looking to answer two questions:
1) Which natural enemies of this moth can be commercially deployed? and
2) What is the overwintering capacity of this invasive leaf miner?
This last question needs to be answered in order to adapt the control strategy of the pest to its population dynamics.

The bug *Macrolophus pygmaeus* is the main natural enemy against *T. absoluta* currently used in northern European glasshouses. Unfortunately, this predatory bug is not able to control the moth at the beginning of the production season or when a heavy infestation occurs. A profound study of the population dynamics of *T. absoluta* and the predatory mirid *M. pygmaeus* will give insight into the control capacity of this bug. The goals is to increase the efficiency of *M. pygmaeus*. In addition, the project will try to identify new potential biological control agents. Because biological control agents should be applied within the currently used cultivation practices and in an integrated pest management context, the direct effect of chemical pesticides on *T. absoluta* and the selected natural enemies will be studied.

Knowledge sharing on the local and international level

The aim of this project is to offer a package of sustainable control measures for *T. absoluta* compatible with and complementary to the currently used management strategies in tomato cultivation. As this is a practice oriented project that actively involves producers' organisations, we make great efforts to share our knowledge with the target group and stakeholders through all the classical communication channels. Given the widespread distribution of this pest, the researchers maintain close contact with international research projects having experience in research on biological control measures to *T. absoluta.*

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Potential of forage legumes on the cattle farm

Grass/clover is an essential fodder crop for every organic cattle farm. Conventional farmers are not aware of the potential of these grass/legume combinations. Lucerne/grass is almost not cultivated despite the very high dry matter yield and protein production per ha.

Focus on yield capacity of high quality forage and on the residual nitrate at the end of the growing season

In low mineral N conditions in the soil, clover and lucerne will fixate high levels of N which is also available for the grass. This results in a high dry matter production, a high crude protein content and a good nutritive value. These effects need to be quantified and compared to grass, fertilised with an authorised N level. The ratios of clover (or lucerne), grasses and herbs are determined in every cut. It is very important to measure the residual nitrate in the soil on grass and grass/legumes to detect if the legumes increase the risk of N leaching or not.

Forage production with grass/clover: looking for favourable combinations

ILVO has a great deal of experience with

- Pure stands and mixtures of ryegrasses with red and white clover or lucerne fertilised with a range of N-levels (0, 105 en 265 kg $N_{available}$ ha^{-1}).
- The influence of white clover in the sward, fertilised with slurry and chemical N (200-330 kg $N_{available}$ ha^{-1})

A new experiment started in 2011: a comparison of grass species mixtures, suitable for cutting conditions (perennial ryegrass, tall fescue, Festulolium) in a pure stand or mixed with red and white clover and fertilised with organic fertilisers (equivalent of 100 kg $N_{available}$ ha^{-1}). Yield, grass/clover ratio and nutritive value including protein content will be determined in every cut. In the soil residual nitrate will be measured.

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Triticale with forage pea or winter field beans for protein-rich feed

Since the organic feed legislation has been tightened, the interest of livestock farmers in growing their own concentrates has increased. In the search for a local, cheap protein source, the cultivation of legumes generates a renewed interest. The combination of protein and cereal crops gains a fixed place in the crop rotation on organic dairy farms. It is an easy and harvest secure crop combining a good feed value with an acceptable yield.

Mixed cropping: a combination of benefits

In mixed cropping (peas-cereal; beans-cereal; etc.) the benefits of the two crops are combined. The peas or the field beans enable nitrogen fixation and a high raw protein level. The cereal supports the peas or the field beans and suppress the weeds at the beginning of the cultivation. The yield of the mixed cropping is usually higher than the yield of the separate individual components. The downsides of mixed cropping are the potential differences in ripening of the different crops, which can cause problems for harvest planning. There is also a difference in competitiveness, therefore, the proportion of the crops in the mixture at harvest might vary from year to year. The general rule states that the cultivation demands of peas/field beans should be taken into account the most, because they are more demanding.

Mixed crops tested

Inagro is testing different combinations with different sowing densities for several years. In a 2011 experiment, two breeds of triticale were combined with forage pea (Assas), winter hardy dry pea (James) and winter field beans (Nordica and Diva). The triticale breeds were Grandval which is generally considered as the reference and Aprim which has a more open way of growing.

Forage peas and winter field beans confirm in 2012

During the growing season it became clear that a dense crop is needed for good weed suppression. A sufficient sowing density of the grain component is necessary both in a pure cultivation and in mixed cropping. Disadvantageous influences of a more vigorous grain crop (Grandval with respect to Aprim) were not expressed. A solid triticale crop as supporting crop is important, however.

Winter hardy dry peas are insufficiently competitive to make their yield potential in mixed cropping with grain. This low reliability was also apparent in the past several years.

Although the yields are lower than the previous years, the forage peas confirm their added value in mixed cropping. A similar to higher yield was realised with a higher proportion of proteins (peas) as an added value. To prevent alloying, the seed density cannot be higher than 25 z/m².

The winter field beans plotted behind, probably because of frost. Their share in the yield was lower than the previous years and the beans were not ripe at the threshing. This problem was not present in the previous years. Silage as moist grain is desirable in this case. For an acceptable cultivation, security, and weed suppression, a sowing density for the triticale of 200 z/m² (which corresponds to 100 kg/ha) is needed in combination with field beans at 30 z/m². For field beans, attention is needed for the thousand grain weight at the determination of the sowing density.

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No-tillage in organic agriculture in Flanders

Several organic farmers and vegetable growers have already been applying no-tillage on their farm for many years, while others plan to start. They hope this practice will improve the soil life and obtain a better soil stability. With the CCBT project 'No tillage in organic agriculture in Flanders', the Department for Organic Crop Production of Inagro offers a forum for knowledge exchange on no-tillage. During farm visits to ten farms in Flanders we asked farm managers how they manage no-tillage and what their experiences are with it. This gave us a starting point to visualise possible improvements and stumbling blocks and to search for a targeted answer.

Watching the neighbors

In this project, Inagro organised two farm visits. A first farm visit targeted large scale arable and vegetable growers. To do so, we visited two Dutch pilot farms. Central in this visit was a well equiped mechanisation, a targeted use of green manures and the use of controlled traffic farming.

A second visit targeted small-scale vegetable growing. Small scale farms are characterised by rather limited mechanisation. On more than half of these farms, the fields are not plowed, partly for practical reasons and partly out of conviction. Some plow to clear the land from weeds or to ease the establishing of clean beds. Often a rotary tiller is used for the deeper manipulations. Some aim with the no-tillage at improving the soil fertility quickly. It is in any case a quest for a balanced system, which the farm visits revealed is different for each farm. The soil type, history of the parcel and the attitude of the farmer seem to have a big influence.

Transnational experience exchange

The collected knowledge and experience from this CCBT project is brought in the European TILMAN-ORG project. The TILMAN-ORG project combines practice and research experiences with no-tillage and green manure from throughout Europe and will subsequently disseminate this to growers and advisors to help them optimise the organic cultivation method.

Data from an experiment with no-tillage performed since 2006 on the organic experimental farm of Inagro will also be made available in the TILMAN-ORG project. In this six-year experiment, plowing is compared to no-tillage in an organic vegetable crop rotation. This year, leek is cultivated in the experiment after an annual grass clover cultivation. In collaboration with ILVO the difference between early and late incorporation of green manure (in this case, grass/clover) is tested. Hereby, both the digestion of the green cover crop, the crop development of succeeding crop (leek), weed pressure and the nitrogen turnover in the soil are monitored.

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Replant problems with apple in organic fruit growing (existing orchard)

*The problems of replant diseases in apple are increasing dramatically. Where the earlier plantings were made on fresh soil, most of the new plantings are second or even third generation. Especially when the soil is heavily infested with nematodes (*Pratylenchus penetrans *among others) and to a lesser extent fungi, this can greatly affect tree growth. This often results in a weak growth, insufficient production, small fruit size and poor quality (e.g. colouring).*

Another important point wich receives not enough attention in current practice is the soil structure. The only opportunity to thoroughly change soil structure is just before planting. In existing orchards it is not possible to incorporate organic material and/or soil conditioners to improve soil structure and moisture balance.

The major problem of poor soil health is that the symptoms only become visible when the trees are already been planted. Because apple is a perennial crop, this problem is difficult to solve. Organic fruit growers are further constrained by the small range of products available.

Possible solutions

Several possible solutions have been proposed:

- Mycorrhiza strains. These cultures, which live in symbiosis with the root system of the trees, can improve the uptake of water and nutrients.
- Seaweed lime preparations would improve the soil structure, which would improve the trees' rooting.
- Other commercial soil conditioners. All of these products claim better rooting and a better uptake of the essential nutrients.

The experience within fruit growing with these new products is currently insufficient. Moreover, these are often very expensive treatments. By means of a comparative trial at a parcel of an organic fruit grower we want to get a better understanding of the influence of these products, so that we can better advise organic fruit growers.


Tree volume of 8 year old Topaz (23 June 2010)

First results

After two years we see that the Mycorrhizae have a limited effect on the growth. Only the trees which had already a moderate growth rate at the start of the trial are stimulated. On trees which hardly grow there is little effect. As a result, there is little difference in production and fruit size. Also in the uptake of various nutrients no effect of Mycorrhizae is found.

Until now the soil conditioners have had more influence on the vigour. After two years this has not yet been translated into a better fruit size, although the leaf/fruit ratio has been improved. The question remains if this will eventually also give an improved fruit size and a better mineral composition of the fruit. The 2012 measurements will shed light on this.

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Funding: CCBT project (Government of Flanders, Department of Agriculture and Fisheries)

Replant with Kanzi

New varieties often have a weaker growth compared to the standard varieties. Moreover, very often new apple orchards are second or even third generation. In some of these parcels a large population of nematodes has occurred over the years. This can cause growth problems in young trees.

In the past it was possible to use chemical soil disinfection before planting, so that the trees got a perfect start. Nowadays, it is only possible to use chemical soil disinfection in situations with a very heavy infection and after a soil analysis. However, in organic fruit growing there is no good biological soil disinfection available to reduce parasitic nematodes and plant pathogenic fungi. In this trial we look for the best preparation for a new planting. A distinction is made between chemical soil disinfection, green manures and fertilisers (soil conditioners).

Possible solutions

Currently, several possible solutions are presented.

- Chemical soil disinfection (= control)
- Green manures
- Fertilisers (soil conditioners)

Not all green manures are useful for reducing parasitic nematodes. Italian ryegrass and Phacelia are an ideal host for nematodes. With these plants, the number of parasitic nematodes will only grow, which will increase the problem of soil sickness. *Tagetes patula* (Marigold) is a very good soil disinfectant. The sowing, however, is not practical and is also expensive. We therefore are searching for an alternatives such as black fallow, yellow mustard, cabbage waste.

It is very important that the trees should get a good start in the planting year. Several fertilisers (soil conditioners) that may improve the growth of young trees are being promoted by different companies.

Growing Tagetes patula (Marigold) in the year before planting

Vivisol best

After four growth years, the trees where Vivisol was incorporated into the soil before planting had a similar increase in trunk circumference as the trees in the disinfected objects. The stronger vigour has also ensured that the tree volume in the first growth years was larger than in the control. With the other soil conditioners the effect on the growth was smaller. In contrast, the green manures had little to no impact on the growth.

The production figures show that so far the best result was achieved by the object with Vivisol. After 3 production years the yield was 39% higher compared to the control. With the other soil conditioners the yield was only 10 to 20% higher.

In this trial especially the result of the green manures (biological soil disinfection) was disappointing. After three production years, the trees with *Tagetes patula* (Marigold) as pre-cropping even had a lower production than the control trees. Thanks to the good results in 2011, yellow mustard and cabbage waste gave a surplus of ± 10% after three production years. When the soil was kept fallow during one year by suppressing the weed (black fallow), the total yield was ± 15% higher than in the control object.

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Funding: Government of Flanders and fruit growers (2007-2009)
EFRO (40%), Province Limburg (40%) and own resources (20%) (2010-2011)

Development of 'Earwig Management Tool': software for organising orchard management with respect to beneficial earwig populations

Earwigs are general predators with a broad range of pest insects on their menu. As natural enemies they play an important role in the natural suppression of pest insects in pome fruit growing. In the past, earwigs were sometimes considered as pest insects because they can foul bunches of fruits in which they hide. Sometimes earwigs feed on fruits, but closer investigations showed that this occurs only in fruits that are already damaged (for instance by hail). The beneficial impact on several pest insects largely compensates the small contamination damage which might occur.

Help! Why don't I have earwigs in my orchard?

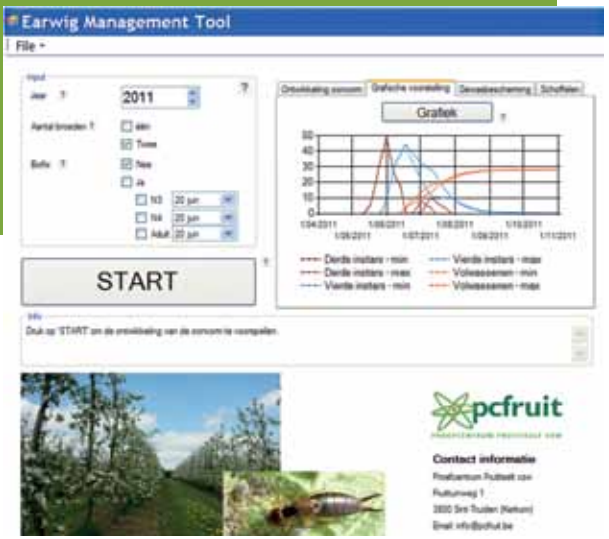
Large numbers of earwigs are found in certain orchards, but they can be totally absent in other orchards. An explanation lies in the life cycle of earwigs and the impact of orchard management on this life cycle. Earwigs do have a univoltine life cycle, and therefore every detrimental intervention harms the population for the rest of the year and has consequences for the population size the following years.

How can we maintain stable earwig populations in orchards?

In order to improve the size and stability of earwig populations in orchards, we first had to acquire profound insights in the population dynamics of this insect. A model was developed which enabled us to predict the development of earwigs throughout the growing season based on temperature data. Second, we had to find out which orchard management actions are harmful for earwigs at crucial moments in their development cycle. Finally, the obtained knowledge had to be translated into useful advice for growing practices regarding adapted orchard management with respect to optimal development of earwigs.

'Earwig Management tool': your PC is a brother-in-arms of the earwig

The Earwig Management software tool is an integration of the day degree model for earwigs with orchard management recommendations. The program has a user friendly graphical interface, easy-to-use options, and one-click features. The software can be downloaded and installed on any personal computer with a Windows operating system. While running the program, a connection to the internet is required for updating the



temperature data in order to generate accurate predictions of the actual earwig phenology. In addition, a database with known side effects of soil tillage and spraying applications on the different life stages of earwigs is integrated in the system. The output gives the current status of the earwig population and management recommendations for activities critical for their survival. Hence, by consultation of this user-friendly software, fruit growers can predict the earwig development in the field at any time, and organise the timing of orchard management actions accounting for the presence of (vulnerable) life stages of the earwig life cycle. Doing so, negative effects of specific orchard management actions, such as badly timed spray applications and soil tillage, can be avoided.

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Mating disruption systems in pome fruit, grape and red berry growing

Caterpillars can cause great damage in fruit growing. In pome fruit growing the larvae of codling moth are a notorious pest, but also larvae of several leafrollers can cause severe losses. In grape growing, the European grapevine moth, Lobesia botrana*, and the vine moth,* Eupoecilia ambiguella*, are infamous pests. In berry growing, the currant clearwing moth,* Synanthedon tipuliformis*, can cause severe damage because of their habit of boring and feeding into the cane of the plants.*

Some available chemical crop protection agents are very effective against caterpillars. However, nowadays, the usage of chemical crop protection in fruit growing can have an impact on the environment (pollution of surface waters) as well as the economic value of the harvested fruit (residue concerns). Hence, there is a need for a general implementation of alternative crop protection strategies with a lower impact on the environment. However, changing from trusted chemical crop protection to alternative strategies is not that evident, since growers may lack know-how and they fear production losses.

A confusing cloud of love

The mating disruption technique is not only useful in pome fruit cultivation; it is also a useful alternative crop protection strategy in grape growing and berry growing. The mating disruption technique involves a massive introduction of female pheromone in the crop, and as a result the male moths cannot localise the females anymore. This results in no mating, and thus no harmful caterpillars. In other countries the mating disruption technique of *Lobesia botrana*, *Eupoecilia ambiguella* and *Synanthedon tipuliformis* has already been applied in large uninterrupted fruit growing areas. For Belgium, however, there is no registration of mating disruption technique for grape and berry growing. Therefore pcfruit vzw initiated some trials.

Does mating disruption technique also work in glasshouses?

In order to effectively confuse the male moths, the mating disruption in field-grown fruit crops have to be applied on a large scale (at minimum 1 ha of uninterrupted orchard). However, table-grape growing has much smaller production areas. The grapevines are grown in glasshouses, which physically limits the moths' flight area. Our aim is to find out if mating disruption might also work in these grape growing conditions.

Encouraging first results

The first trial results indicate that mating disruption (with occasional additional correction sprayings) provides good control efficacies in table grape growing glasshouses. The best results were obtained with larger application areas (bigger glasshouses), as is the case for mating disruption of open-air orchards. In glasshouses with higher cam and less ventilation, the mating disruption was more effective, because in these conditions there is less variation in the pheromone concentration in the air.

Also *Synanthedon tipuliformis* turned out to be effectively confused by pheromones in a first outside mating disruption field trial. Further research has yet to reveal whether damage of caterpillars has consequently decreased.

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Hoeing in "Conference" orchards

Chemical weed control is subject to increasing pressure. More herbicides are disappearing from the market, for example. This leads to the need to search for alternatives to keep the black strip weed-free. We started a demo trial in 2010 with mechanical weed control. In this trial, two hoeing machines were compared with chemical weed control. Findings can also be of interest for weed control in organic orchards.

Trial design

The trial was conducted on orchard growing Conference pears, planted in the spring of 2007. The following objects were established:

- Chemical weed control (=reference)
- Chemical weed control + mechanical weed control (Pellenc Tournesol)
- Mechanical weed control with Pellenc Tournesol (rotating knives)
- Mechanical weed control with Belhomme Reflex (Flat hoe)

The impact of hoeing was investigated on the yield, the fruit quality and the mineral composition.

Results

The production for the hoed trees was highest in 2010, with a slightly smaller fruit size. In 2011 however, the production was higher for the trees with chemical weed control. Despite similar to lighter hanging, the fruit size after hoeing was smaller again, regardless of the machine used. After two years of production, the number of kilograms harvested for the hoed trees was at the same level as for the chemical weed control equivalents, but the average fruit size was 15 grams lower.

Pellenc Tournesol

Belhomme Reflex (flat hoe)

From the fruit analysis at harvest, the Belhomme – hoeing machine seemed to lead to a lower K content in the fruits. This may indicate that more roots were damaged with this machine. For both machines a lower N content and a higher iron content was determined. The differences in fruit composition did not cause big differences in fruit quality at harvest. But the fruits of the hoed rows were on average a little softer and had a higher sugar content.

Every year in autumn, the girth of the trees were measured for the different objects. The yearly increase is a measure for the vigour. From these results, hoeing does not seem to have a negative impact on the vigour of the trees.

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The effect of mechanical thinning in apple orchards

In recent years, many chemicals, including thinning agents, have disappeared from the market. The thinning effect of the products currently available is often not sufficient. Even when they are combined, there is still much hand-thinning to be done.

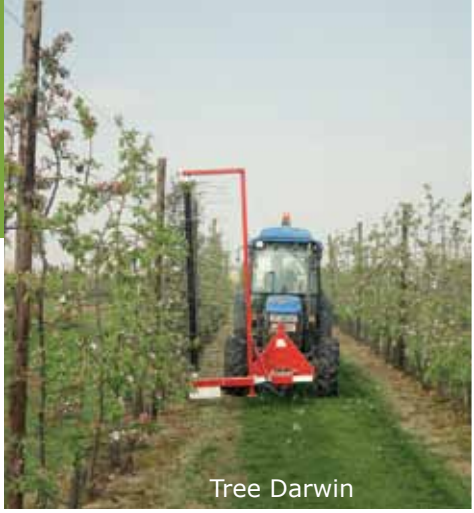
In organic fruit growing the situation is even worse, because no chemical thinning agents are allowed. Only sulphur is available (and in neighbouring countries also lime sulphur) to perform a non-manual thinning during flowering time. In practice, however, the thinning effect is often disappointing, requiring a great deal of hand-thinning.

Trials

To determine whether mechanical thinning can be a good alternative for chemical thinning, several trials on different varieties have been performed at the *Proeftuin pit- en steenfruit* since 2008. Besides the comparison of different machines (Tree Darwin, Machine Uni-Bonn and BMV) we also examined the influence of the timing of application, the rotor speed, the driving speed and the number of laces on yield, fruit size, fruit quality and flower bud formation for the following year.

Tree Darwin best so far

At this moment the results with the Tree Darwin are more positive in comparison with the Bonn machine. Preference is given to the Tree Darwin in terms of thinning and leaf damage. The BMV-machine was taken in test in 2012 for the first time and cannot yet be judged. It is remarkable that there is already a substantial difference in thinning effect by rising the rotor speed from 200, over 220 to 240 rotations/minute. The intensity of thinning can be regulated in this way.


Tree Darwin


Machine Uni-Bonn

Mechanical thinning must be done during flowering, between the beginning of flowering and full bloom. The flowers must be separated from each other. If mechanical thinning is done too early, whole clusters will be removed. When it is performed too late, leaves are damaged too much, which is negative for the further development of the fruit and for the flower bud formation for the following year.

A major disadvantage of mechanical thinning is the early timing of application, namely between beginning of flowering and full bloom. At that time one has no idea yet of the fruit set. Moreover, there is still a (big) risk for spring night frost.

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Research on the potential of organic planting material of strawberries

The organic strawberry grower has little or no access to organic planting material. Asking for exemption to use conventional plants is still possible, but evolutions in our neighboring countries indicate that this solution is temporary. For late cultivations, for which there is only six weeks between the planting and the first harvest, the risk exists that residues of the conventionally cultivated plants can be found inside the fruits. Such 'accidents' must be avoided. These findings originated the start of prolonged research.

Five years of research lead to promising results

The first organic cooled plants came on the market in 2007. They were cultivated by a Dutch conventional propagation company. Everything proceeded according to the specifications of organic agriculture and they collaborated with an organic grower who propagated the strawberries on a SKAL-certified parcel. The first experiments were performed at the PPK 'Pamel'. The organic plants were located next to similar conventional plants. The results were deplorable. Besides a lot of problems with weeds, the dropout rate was too high and the production was disappointing. The cause of the lower production could be found in the much too long field period and the competition with the uncontrollable weeds on the breeding parcel. At the PPK 'Pamel', other breeding experiments were installed. After four years of research we get 25 to 35% more yields with organically propagated plants.

The use of compost turned out to be a miracle solution

Mother plants of strawberries need a field period from April till August. The stolons grow during June and July. Starting with this knowledge at PPK 'Pamel' we looked for a breeding system able to cope with the problems. Mother plants (EE – plants) are grown in a cultivation greenhouse until field planting. In this phase, we regularly remove the flowers. To ensure the planting in April, we already pull the strawberry beds in October. The beds are covered with a black foil. The space between the beds is 3.8 meter. This gives the stolons enough space to develop. The ground between the beds is covered with root canvas.

The pre-pulled plants are brought outside from March on to harden. Fourteen days later they are planted on the breeding parcel. At the appearance of the first colons, we place five centimeters of compost on the root canvas. In dry periods we water in the morning to keep the compost wet and to enable the plants to engrain. The compost suppresses powdery mildew (*Spaerotheca macularis*) and black spot disease (*Colletotrichum acutatum*) on the breeding field, amongst others. Furthermore, the plants make more fine hair roots. Therefore, the total root surface is much bigger than for conventional plants. The regrowth is better, resulting in a better developed plant, with a higher yield as a consequence.

From research to practice

On April 1, 2013 the CCBT project 'organic planting material for strawberries' started, with the aim of providing organic planting material from the end of 2013 to the organic strawberry grower. This project will turn research results into practical application.

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Development of research on herbs at PCG: niche or promising diversification?

Diversification on farms deserves attention. When forces are combined the cultivation of herbs is improved, more specialised and better commercialised. The cultivation of herbs is gaining increasing importance, because this, together with innovative processing, could offer a new source of income for the agriculture industry.

Gathering knowledge

The technical knowledge about cultivating herbs is quite limited. Scientific literature applicable on Flemish soils and climate is very rare. Nevertheless, PCG is collecting the existing knowledge and in this way expanding the existing knowledge of vegetable growing with the knowledge of kitchen and medicinal herbs.

Establishment of field trials

Initially demonstration trials were established at the practical research station. In this way we could create affinity with this branch of the culture of several herbs. Subsequently, herbs became a true concept at the practical research station: variety tests and cultivation technical experiments of diverse crops have already been established. Examples of breeds/varieties trials are: parsley, dill, coriander, nasturtiums, chives, sorrel, arugula and basil. Growers determine the test subject of the next season; even the experiment plan is completed as much as possible by them. At this time, breed and variety trials are predominant in organic cultivation, but potted herb cultivation is included. The biggest obstacle for the cultivation of herbs in pots on (mobile) gutters or tables, is fertilisation. Different kinds of fluid organic manure are investigated in the cultivation of rosemary and thyme.

Link with the sector - experiments and tests on location, tours and farm visits

The different breeds/varieties involved in the tests on the PCG are also implemented on numerous farms. In this way, the farmer can immediately experience what breed or variety is the best in his environmental situation (e. g. other soil, location, etc.). All knowledge generated by the practical research station is public knowledge and is communicated thoroughly to the sector. During farm visits organised by the practical research station, growers can learn from each other.

Sale

As the herb market of both kitchen and medicinal herbs is quite limited, it is important to link production and sale. There is potential for growers, but the appropriate outlet has to be found. Also the processing of the herbs can create numerous alternative outlet channels.

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What happens to a tunnel in the summer?

Using a tunnel for spring and autumn cultivations is probably economically the most profitable choice when saling to long chain market. Tunnel use can be approached differently on certain farms, depending on the company's interpretation, the labour availability, and the market sale. Regardless of the technique chosen, using a tunnel during summer can also be recommended.

Classical setup: spring and autumn cultivation

Most of the farms, especially those delivering to the long chain (auction, wholesale, etc.), choose for a spring and autumn cultivation in their tunnel. In this way, they have an earlier and/or a later harvest when these crops are not available for open field cultivation. Mechanization is much easier outdoors compared to tunnel cultivation, but the prices are most of the times better. During summer and a limited period during winter, the tunnel is empty. It is nevertheless important to pay attention to the tunnel in this period, to prevent increasing weed pressure and/or desertification. Different techniques can be applied, depending on the operations of the farm. The options are:

- Poultry:
  Depending on the kind of poultry kept in the tunnel, the tunnel is kept clean to a greater or lesser extent. A chicken, for example, is less inclined to clear the grass compared to a maned goose. But maned geese cause more moss formation.
- False seedbed:
  After the weeds germinate, the farmer remove them. This can be repeated several times during the summer.
- Covering the soil with anti-root cloth:
  The weeds present, or at least the light germinators, die from lack of light.
- Covering the soil with anti-root cloth, but open it regularly:
  In this way, different rounds of germinating weeds can be cleaned up.
- Sowing green manure:
  Both phacelia and Japanese oats are possibilities. Phacelia is a little bit slower to cover, whereby some openings still exist for some weeds. Timely mowing phacelia is of primordial importance. The flower can be present, but seed forming should not take place. Japanese oats are a rapidly-growing ground cover. With this green manure, the problem of seed forming is not or less present.

The potential difference in organic matter content, nitrogen content, etc. after repeated treatment is also being investigated. Regardless of the treatment, it is important to irrigate on a regular basis to stimulate the soil life.

Summer cultivation

Certain farms, especially those selling directly to the consumer (short chain), choose for a summer cultivation in the tunnel. This is recommended when a sales channel is available to valorise the crop. Possible crops are fruit vegetables, including different types of tomatoes. This cultivation of fruit vegetables can potentially be preceded by a short early cultivation, such as spinach. The labour spent in such a cultivation again depends on the sales. In the tomato cultivation for example, the plants can be topped when they are grown to the top of the tunnel. The farmer can choose to not lower the plants, especially when the tomatoes are sold through a long chain. Letting the plants down requires extra work and the quality can possibly be lower due to tomatoes laying on the ground. When the tomatoes are sold on-farm, however, it may be worth prolonging the cultivation and lowering the plants.

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Field experiments in organic agriculture at the PIBO Campus

PIBO Campus vzw is the applied research institute connected to the Provincial Institute for Biotechnical Education in Tongeren. The institute includes an organic agriculture department. Some parcels are made available for a six-year crop rotation. The cultivation technique for the organic cultivation is now being refined. Every year different varieties are tested for each crop in the rotation.

Field trial research and dissemination

Students help to maintain the experimental fields during their practical courses. They measure the parcels and adjust the tillage, sowing and hoeing machines. They monitor the trials during the whole season under the guidance of a lecturer, a teacher and a cultivation supervisor. They perform regular observations of emergence, growth, insects, diseases, yield, quality and the financial efficiency per hectare.

During the annual field visit, farmers, students and other interested parties can evaluate the different varieties, the plant protection products, the fertilisation systems and the cultivation techniques in the various crops. A brochure with current data is provided every year.

The results of the field trials are also presented during a winter meeting. In these meetings, the farmers obtain a brochure with explanations of cultivation techniques used in the trials. By bundling the test results, we aim to give a schematic reference to the farmers, advisors and educational institutes. The field trials are a link between scientific research, and the practitioners and all those interested in organic agriculture.

Our cultivations

For many years we have been working with a six-year crop rotation. For the second year in row, cabbage is no longer grown; we have successfully substituted it with grain corn.

Grass/clover

We have opted for one organic variety. The most important factor is obtaining a good yield. The goal is to harvest four complete cuts per year.

Triticale
A triticale variety trial is performed in collaboration with the Department for Organic Crop Production of Inagro in Beitem. The goal is to look for suitable varieties for organic production. The harvest goes to an organic poultry farmer. The triticale is milled to feed the chickens.

Chicory
In addition, one variety of chicory is sown. The focus is this year on weed control. The harrow is used, with the goal of lowering the need for hours of manual weeding work. The hoeing machine is equipped with weeding fingers.

Potatoes
This variety trial is also established in collaboration with Inagro. Several breeds are taken into account and evaluated for resistance against *Phytophtora infestans*, growth and yield. In the variety trials, we look for breeds appropriate for potato crisps.

Grain corn
We are currently researching the different varieties of grain corn available on the market. The varieties are sown at two different times. For each variety, the emergence, soil covering, growth, disease pressure, and yield are stated. This is the first organic grain corn experiment in Belgium.

Field beans
For field beans, we are testing different cultivations in undersowing. Simultaneous with the field bean cultivation, we sow the following crops: wheat, peas and vetch. The densities are also manipulated in the undersowing. The harvest goes to an organic livestock farmer, mills the field beans for his dairy cattle.

Some side projects include monitoring the *b.akkerbrood* project and the cultivation of hemp and cameline.

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Attention to disease susceptibility in the admission of new varieties to the national catalogue

Before new varieties of agricultural crops can be commercialised, they must be examined for the value for cultivation and use (VCU). For this, the agronomic properties of new varieties are compared with those of currently listed, successful varieties. Only new varieties with sufficient VCU are proposed for inclusion in the Belgian variety catalogue. One of the important aspects during VCU trials is investigating the resistance or tolerance of new varieties for various diseases.

Experimental set-up

Each year, new varieties are sown in variety trials according to the VCU guidelines. The trials run over several years (2-4 depending on the crop) and at several locations (4-9) in different Belgian agricultural regions. The trials are carried out at conventional farms and are integrated into the normal crop rotations. Each trial consists of 3 or 4 repetitions, randomising all varieties. Crops for which variety trials were established in recent years include maize, winter cereals, grasses, flax, and chicory.

Disease susceptible versus disease tolerant/resistant

During the growing season no fungicides are applied. This allows to evaluate the intrinsic value of a new variety. Differences in disease susceptibility are carefully noted during the growing period. By doing so, data are available for several varieties of different crops and for several diseases:

- Rust in ryegrass
- Leaf spot in timothy
- *Rhizoctonia*, mildew, *Cercospora* and rust in fodder beet
- Mildew, *Sclerotinia* in red clover
- Mildew, leaf spot and rust in industrial chicory
- *Pythium*, mildew, *Fusarium* and *Verticillium* in flax
- *Fusarium* stalk rot, smut, *Helminthosporium* leaf spot, *Rhizoctonia* root rot in maize
- Leaf rust, mildew, leaf spots, net blotch in winter barley
- Leaf spot, mildew, yellow rust, brown rust and *Fusarium* head blight of winter wheat

At the final evaluation of a variety, new varieties with high disease tolerance/ resistance are more likely to succeed for the VCU trials. This results into the inclusion of several varieties which guarantee a high production level without fungicide treatments to the Belgian catalogue.

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Disease resistance is a priority when selecting varieties for organic agriculture

*Currently, no powerful fungicides are available or authorised for organic vegetable growing. Therefore, varieties with good disease tolerance are decisive for a qualitative and operationally safe yield. Good resistance against disease is also gaining importance in conventional agriculture. The increased attention for breeding is a positive evolution. The different cultivation conditions and different weighing of crop characteristics causes the order of crops in organic vegetable growing to differ from the order in conventional cultivations. Therefore, Inagro establishes multiple variety experiments under organic cultivation conditions. In 2010 and 2011 experiments were established with potatoes (*Phytopthora infestans*), leek (*Puccinia alii*) and celery (*Septoria apiicola*) amongst others. In Brussels sprouts, a complex of leaf diseases determining yield stability. We have been able to demonstrate a significant variety effect.*

The case of autumn leeks

Good disease resistance is especially important for leeks. In autumn, rust (*Puccinia allii*) and purple spot disease (*Alternaria porri*) are the largest threats. In winter, paper blight (*Phytophtora porri*) is the main evildoer. The effect of the various diseases varies according to the cultivation period. Degradation leads directly to more work to clean the leeks (=higher labour costs) and causes quality losses and yield losses.

The table illustrates the results of the variety experiment of late autumn 2011.

Because of its good disease resistance and quality, Antiope is currently the reference for organic autumn leeks. Except for the actual degree of the attack, the place of the attack is also important. Walton, for example is quite heavily damaged by rust, but especially on the older leaves and on the leaf tops. After cleaning, a great deal of usable product remains. For Miracle, the damage by rust is located more in the leaf axil, which makes it impossible to clean.

cultivar	seed company	damage by												overall view						
		rust							purple spot											
Antiope-F1	S&G	7.4	a						8.0	a					8.0	a					
Belton-F1	Nunhems	5.9		b	c				7.6	a	b				5.6					e	f
G321 ks-mg-02	Bingenheimer Saatgut AG	4.0						f	6.5				d	e	5.3						f
Levis-F1	S&G	4.6					e	f	6.1					e	4.0						f
Miracle-F1	Vitalis Biologische Zaden	6.4	a	b					7.0		b	c	d		5.8				d	e	f
Natan-F1	Nickerson-Zwaan	5.8		b	c	d			7.8	a					6.8		b	c			
Poulton-F1	Nunhems	5.4		b	c	d	e		6.8			c	d	e	6.6			c	d		
Surfer-F1	Bejo	6.0		b	c				7.4	a	b	c			6.4			c	d	e	
Vitaton-F1	Nunhems	5.3			c	d	e		6.5				d	e	7.8	a	b				
Walton-F1	Nunhems	4.9				d	e	f	6.8			c	d	e	7.3	a	b	c			
Average		**5.6**							**7.0**						**6.4**						
V.C. (%)		5.4							6.0						5.2						
p-value		<0.01**							<0.01**						<0.01**						
scale	1=	a lot							a lot						very bad						
	9=	none							none						very good						

*significant (0.05>p>0.01); ** very significant (p<0.01)

values within one column followed by the same letter are not significant different (Duncan, p=0.05)

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Genetic diversity in vegetable crops in action

Seed is an indispensable factor of production in agriculture and horticulture. In the organic sector, the range of organically propagated cultivars is still limited. Creative and resourceful growers had developed activities of seed propagation and selection on the farm, growers then selected varieties which perform well on their farm. Local varieties are living heritage. In addition, they are genetically very diverse. To prevent the demise of these sources of biodiversity in Flanders, a demonstration project about on-farm production of seeds was conducted.

Collaboration

The National Research Station for Chicory Witloof, Inagro (Department for Organic Crop Production), the Institute for Agricultural and Fisheries Research (ILVO), Ghent University, the Study Group for Seed Growers and the Brussels Study Group for Soil Cultured Chicory strive for conservation of genetic diversity in vegetables such as celery, cauliflower, chicory and leek.

The activities of the partners were mainly aimed at the professional sector, with a focus on four crops, namely leek, cauliflower, celery and chicory witloof. The maintenance of the local landraces was a central objective of the project. The first aim was to focus attention on the generation of growers with local old varieties and to give them more recognition for their years of (selection) work. The project partners worked together with demonstration farms to promote the local old varieties and to bring the knowledge of on-farm seed production to a new generation of growers interested in this matter.

Activities

Demonstration platforms

On the demonstration farms in the regions around Kampenhout, Schriek, Roeselare and Melle, demonstration platforms were designed to demonstrate the propagation of local varieties and the various stages in the seed production and seed storage. The added value of the collaboration with demonstration farms is that the managers testify of the knowledge for on-farm seed production based on their own professional experience and field practice.
Some of the trials are:

- Biodiversity in the local varieties of early and late cauliflower from Mechelen;
- Biodiversity in the local varieties of leek (production);
- Biodiversity in the local varieties of leek (disease tolerance);
- Differences in herbicide tolerance and disease tolerance of the local varieties of chicory witloof;
- Biodiversity in the local varieties of hollow pipe celery.

Practical field visits were organised on-site at the research and information centres and the demonstration farms. The researcher-instructor and the manager always elaborated on the theoretical background that was demonstrated.

Website

The website *www.zelfzadentelen.be* was developed during the duration of the project and provides a significant dose of technical and practical information for (future) seed growers about how to get started. The "*minibib*" section consists of the information about the title, preformer and location of publications. The website has links to other websites about on-farm seed production. The *Seed Growers' Study Group* continues to maintain the website.

Seed calibration

ILVO and the National Research Station for Chicory Witloof offer seed cleaning and calibration activities to the growers.

Marketing opportunities

During the final seminar on marketing, case studies were presented to the visitors. The five proposed cases each testified the commitment and creativity of the manager who had created a market segment and an economic success story. The diversity of the local varieties is indeed well placed to respond to new (niche) markets, such as regional markets, farm shops, community-supported agriculture food boxes, etc.

Where do we go from here?

Some growers have long seen on-farm seed production as a logical step for the company to provide organic seeds. This has not always been a success. Local varieties thrive in the environment where they are selected. A lot of effort is needed to develop a cultivar with good quality, high yield and a long shelflife. Moreover, with several crops on the farm an adapted seed multiplication plan is needed for species that cross over. The participating institutes in this project will further support were possible the main initiatives of the on-farm seed producers of local old varieties.

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Funding: Government of Flanders and the European Union

Resistant and/or less susceptible apple varieties

Within the Practical research station for Fruit Growing npo - unit experimental garden for pome and stone fruit - all new apple varieties are tested for their susceptibility to scab, powdery mildew, nectria canker and storage diseases. To this end, four trees per variety are planted in a separate parcel, which is not sprayed against powdery mildew, nectria canker and storage diseases. Sprayings against scab are only done when there are very heavy infections. In this way we get an idea about the susceptibility of the new varieties and their potential for organic fruit growing.

Search for resistant and/or less susceptible apple varieties

Since 2009, interesting new apple varieties for organic fruit growing are also planted in a separate parcel with an organic spraying scheme. Currently, 27 new apple varieties are planted in this parcel. Here we focus on the influence of copper and sulphur sprays on the quality of the skin.

In the parcel with an organic spraying scheme the black strip under the trees is kept free of weeds by alternative weeding using rotating cutters and, when necessary, by mowing with a mower with a swinging arm. Against scab and powdery mildew, only copper and sulphur are used. We also use organic fertilisers.

In the planting year predatory mites are introduced into the orchard and the codling moth and leaf rollers are controlled by mating disruption (and if necessary, with virus preparations).

If promising varieties are found in the first screening, we plant more trees to find solutions for the specific problems of the new variety (especially concerning cultivation techniques). At this time, we have one variety in the second screening, namely Sweetango®, a bicolour summer variety.

Results

In 2009 the first promising new resistant apple varieties were planted in an organic parcel. The trees are still too young to be able to decide whether any of these varieties are suitable for organic fruit growing.

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Early cultivation of strawberries on soil

The Belgian strawberry market is dominated by the Dutch variety Elsanta. *It is possible to guarantee a continuous supply 10 months a year because this variety is used in a diversity of crop systems. The high productivity, the fresh red fruit color and the enjoyable taste are the most important plant/fruit characteristics of this variety. Nevertheless the disadvantages of this variety became also visible during the years. The plant produces fruits with a lower fruit classification under certain circumstances. These fruits are more sensitive for pressure and transport damage and after storage, fruits became pale. The biggest disadvantage of* Elsanta *regarding diseases is the susceptibility for* Verticillium*. The practical research station started an intensive search for a new variety with characteristics that can compete with these of* Elsanta*.* Elsanta, Darselect, Clery *and the new varieties* Flair *and* Elegance *were tested in the 2011 and 2012 variety trial at the practical research station for small fruits in Tongeren (pah).*

Plant and fruit specifications

Flair (Goossens Flevoplant) is a new, long-stalked variety with an early yield and good flavour, but the coloring of the fruits is a weak point. *Elegance* (East Malling) is a mid-season strawberry variety with a high production potential, a good fruit classification and an excellent fruit quality. Extra attention should be paid to control powdery mildew in these plants. *Elegance* (1,288 kg/pl) and *Elsanta* (1,211 kg/pl) seemed to be the most productive early varieties while *Darselect* (76%), *Flair* (74%) and *Elegance* (74%) delivered the best fruit classification. *Elegance* seems to be the perfect variety to compete with the standard variety *Elsanta.* A disadvantage is the middle harvest period of the early full soil *Elegance* variety, which corresponds with the harvest of the strawberry season cropping. The variety *Flair* is a better early full soil strawberry crop compared to *Elegance* but it is characterised by lower production compared to *Elsanta* and a high picking frequency.

Growing specifications

The difference between an early and a late planting, tested in 2011, was not explicitly due to the exceptional early spring. The *Elsanta* trial of 2012 shows a reduction of almost 50% between an early (16/08; 980 g/pl class I fruits) and a late (06/09; 500 g/pl class I fruits) planting. The optimal

Elegance: a valuable new variety

plant density did not change between the early and the late planting date; *Elsanta* 4 pl/m², *Flair* 4 pl/m² and *Elegance* 5 pl/m². The spring 2011 results show the enormous influence of weather conditions on these crops. Besides a well-founded decision in planting date, plant density, extra covering with agryl and working with tunnels, always keep in mind that everything should be adjusted according to the weather conditions.

The new June-bearing strawberry *Elegance*: What can you expect?

During the variety trial of 2009, the British variety *Elegance* (East Malling - Meiosis) attracted some attention. Meiosis describes this variety as very productive with a good fruit classification and attractive, shiny uniform conical shaped orange-red fruits. Other advantages of this variety should be the good quality and colour of the fruits after storage, the low rain and *Verticillium* sensitivity and the long harvest period. Variety trials at pah during the past four years (2009-2012) confirm these plant/fruit characteristics. The limited sensitivity of the *Elegance* plant for powdery mildew is not an unconquerable disadvantage. Time will prove if this variety will become a standard variety in the Belgian strawberry selection.

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Research on crops grown under protected conditions at PCG

Since 2001 PCG is performing numerous research on organic crops in glasshouses or plastic tunnels. This practice oriented research encompasses many breed and rootstock experiments, but the research package also includes demonstration research. The experiment schedule is set annually by a technical subcommittee for organic agriculture in which organic growers are present.

Trials

Weed control in tunnels was an important research topic in demonstration experiments during the last two years. Several preparatory techniques are possible, including using maned geese or chicken during the fallow period, false seedbed, sowing of green manure and the covering the soil with anti root cloth, etc.
The table below gives an overview of the research done on crops grown in glasshouses or tunnels performed in 2011.

Crop	**Most suitable breed / rootstock**
Bussel root (spring)	Damco (Nunhems) Mokum (Bejo)
Chinese cabbage (spring)	Manoko (Bejo)
Pepper block - white	Blondy (S&G)
Pepper sweet point - yellow	E492950 (Vitalis)
Pepper sweet point - red	Palermo (Rijk Zwaan) E493461 (Vitalis)

In the spring of 2012, a variety trial for spinach and green celery was laid down in tunnels. In autumn we will investigate which variety of parsley and lettuce is the most suitable. Many fruit vegetable experiments are done in heated greenhouses. Several varieties of *Coeur de boeuf* and small types of tomatoes are compared with each other. Besides, different breeds of sweet point pepper, red and orange block peppers and pepper rootstocks are investigated in randomised experiments.

Experiments with gardeners

If possible, growers are actively involved in the research. Similar varieties and rootstocks as these used in the experiments in the research center are delivered to gardeners so they can contribute additionally from their own experiences.
Through these experiments extra repetitions are created, which enables us to investigate extra questions as whether the soil influences the crop results.

Demonstration experiments

Variety and rootstock experiments count for an important part of the research in organic protected cultivation. In this way, growers are able to make the most optimal choices in the ordering of their seedlings. Several parameters are taken into account: quality, yield, storage life, flavor, brix value, disease resistance, etc.

The cover materials used for advancing the cultivation in tunnels, eg. for the cultivation of bundle carrots, is also tested in the practical research station. The character, type and amount of fertiliser is a test subject in heated greenhouses. The goal is of course to match the fertiliser as much as possible to the needs of the plant

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Improving red clover as a fodder crop

On-farm forage production is an important aspect of sustainable agriculture and red clover plays an important role in this. Red clover is used worldwide in the temperate climates for silage, grazing and as organic nitrogen fertiliser because of its good spring vigour, relatively fast growth, capacity for nitrogen fixation, and high nutritional value. In mixtures of fodder crops, the high content of protein and unsaturated fatty acids of red clover have a positive influence on milk and meat quality. Moreover, red clover increases the yield of grass-clover mixtures through symbiotic nitrogen fixation.

The major problems of currently available red clover cultivars are their low persistence (after 2 to 3 years most red clover plants have disappeared from mixtures with grass species) and their low seed yield. ILVO is currently studying the factors that control plant architecture and disease resistance in this species, as two aspects that can contribute to a higher persistence and better (seed) yielding plants.

The use of natural diversity existing in red clover to improve persistence

We are using a collection of cultivars, old landraces and wild populations that represent the worldwide morphological and genetic diversity present in red clover (diversity trial). In this collection, architectural features such as branching pattern, flowering time, re-growth capacity after mowing, leaf size, plant height, growth habit (creeping or erect) and susceptibility to diseases such as mildew, clover rot and rust are studied. Six interesting genotypes with diverging branching patterns have been selected for detailed research. Thorough morphological, physiological and molecular analyses are combined to understand the mechanism of branching in red clover. Among these six genotypes, the correlation between branching and agronomically relevant traits such as seed yield, re-growth, persistence and competition ability are evaluated in meadow conditions. This knowledge will allow us to identify ideotypes for future breeding selections.

From higher persistence to improved and cheaper cultivars

Reliable selection of disease resistant plants is difficult in naturally infected fields. Therefore, an artificial infection protocol was optimised to inoculate young red clover plants with clover rot (*Sclerotinia trifoliorum*). Using this protocol, resistant plants can be selected at an early stage in resistance breeding programme at ILVO. The most resistant plants from the diversity trial are used directly for resistance breeding. Recently a project was initiated to study the influence of factors other than branching pattern on seed yield. First, the relation between flower tube length and seed yield is investigated in diploid and tetraploid cultivars. Subsequently, the influence of nectar production and pollen viability on seed yield will be investigated in tetraploids.

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6189

Animal Production

Feed

Animal welfare and health

Production systems

Towards a more efficient mineral utilisation in the feed of organic dairy cattle

Previous research has revealed mineral deficiencies among organic dairy cattle in Flanders. The aim of the current project is to determine where in the cycle soil-feed-cow-faeces mineral uptake and availability is low. Of particular interest is the relation between feed characteristics and mineral bio-availability in the digestive tract, which may ultimately lead to a more efficient use of mineral supplementation.

The preliminary results presented here reveal the relative contribution of feeds, supplements and drinking water to mineral supply and their relation to mineral status of cattle on these farms.

Ten Flemish organic dairy farms were sampled for feed and water; on each farm, blood was collected from five lactating cows. Based on feed and water mineral analyses, estimation of water uptake and information on mineral supplementation, total mineral supply was calculated for early lactation and evaluated according to requirements.

Mineral supply in feed is not always sufficient

Rations in organic dairy farms typically contained much less corn silage than in conventional farms. The main component of the rations was grass/clover which proved to be much richer in minerals than corn. Nevertheless, mineral supplements were needed especially to provide adequate amounts of trace elements such as selenium, zinc, copper and iodine.

The contribution of water to mineral supply was negligible. On average, rations had concentrations of macro minerals above requirements except for sodium during summer. Especially during summer, supply of potassium was high. Individual results of farms show inadequate supply of calcium, sodium and sulfur and on some farms excessive amounts of sodium and sulfur.

Excessive dietary concentrations of iron as well as elevated molybdenium on some farms require attention, given their antagonistic effect on copper, for instance. High potassium concentrations lower the absorption of magnesium. Mean supply of selenium was marginal while also low amounts of zinc, copper, and iodine were registered on individual farms.

Relationship between minerals in feed and animal status

Mineral analysis of blood plasma showed deficiencies of magnesium, copper, manganese and selenium. The animal status was compared with the feed characteristics.

Multivariate regression analysis was used to find formulae to predict mineral bio-availability through dietary nutrient composition. For some minerals, their status in the animals could be predicted on the basis of dietary nutrient composition (other than the level of the respective mineral), suggesting a tool for improving mineral bio-availability beyond supplementation only.
In vitro fermentation trials will be set up to further investigate relations between feed characteristics and mineral bio-availability.

Preliminary conclusions

Although all farms used mineral supplements in their rations, mineral deficiencies were demonstrated through feed and blood analysis, suggesting insufficient supplementation or possible overestimation of mineral bioavailability. The impact of water on mineral supply was negligible.

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HealthyHens: "Promoting good health and welfare in European organic laying hens"

Laying hens on organic farms in Flanders, Belgium

The Institute for Agricultural and Fisheries Research (ILVO) participates as Flemish partner in the European CORE Organic II project "HealthyHens". The general objective of HealthyHens is to identify management strategies that lead to good health and a good welfare in European organic laying hens.

An epidemiological approach will be used to identify the most important risk factors that influence health, welfare, mortality and production results of organic laying hens. With knowledge about the risk factors, recommendations and effective prevention and treatment strategies will be developed to optimise management of the organic laying hens. Another objective is to decrease the environmental impact by reduction of point pollution near the barn and in the free-range area.

The main deliverables of this project are scientifically based recommendations on efficient management of health and welfare of organic laying hens and their environmental impact in different European countries. This knowledge will be transferred to farmers and advisors. Moreover, each individual participant gets insight on how they situate themselves in comparison with other Flemish farms and other farms in Europe. Farmers and advisors can apply the developed measurement methods and protocols and use these for their own objectives, such as evaluation of their own farm or as a tool for visits by monitoring bodies.

International identical implementation of the project

HealthyHens is conducted in an international research consortium of eight countries (DE, DK, IT, UK, NL, AT, SE, BE), where in each country the observational study is carried out in an identical manner on farms with organic laying hens (in total at least 109 farms spread over 8 countries). The project is focused on the following four topics:
1) endo-and ectoparasites,
2) use, design and management of the free-range,
3) feather pecking and cannibalism,
4) other health and welfare problems, such as bone- fractures and -deformations and foot problems.

ILVO contributes as Belgian (Flemish) partner to the development and training of the methodologies to collect data in a standardised way. Researchers from ILVO will conduct measurements and evaluations on

at least eight farms with organic laying hens in Flanders. At the start, all international partners have collectively drawn up a list of criteria that the farms must meet and protocols are developed which are applicable in each country. All researchers follow training meetings to ensure the protocols are applied in a uniform manner. Poultry farmers are personally contacted to request their participation in the project.

Communication to the sector

In order to communicate properly with the organic laying hen sector, the organic and poultry associations NOBL, BioForum, CCBT and the Provincial Centre for Applied Poultry Research gave their support to the project.

ILVO will disseminate the research results in scientific publications, and publish popular publications (written in Dutch) in media addressed to the main interest groups in Flanders (through e.g. CCBT-newsletter, Poultry magazine). Communication to the sector will also take place through reports, presentations, congresses and workshops. All publications resulting from this project are also available through the Organic Eprints Portal. More information can be found at www.ilvo.vlaanderen.be.

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Shade as protection against heat stress for cattle on pasture

In temperate regions, most cattle - especially in the bio-industry – are kept on pasture for at least part of the year and thus are exposed to potentially aversive weather. Research in more extreme climates has shown that cold and heat stress may have negative consequences for animal welfare and productivity. However, it is unclear whether in a temperate climate, like in Belgium, adverse weather conditions in are common and extreme enough to cause problems for cattle and which type of protection is best suited. ILVO – in cooperation with the Universities of Ghent and Leuven - explore this in the PASTRESS project.

Shade as protection against heat stress (HS)

Tree shade is a fairly inexpensive and yet very effective protection against solar radiation and thus heat. One can also create shade by means of shade cloths. Various climatic indices are available to quantify the combined effect of temperature, humidity, wind speed and solar radiation, and thus the need for shelter. By relating such indices to various indicators of HS, we enquire about the need for shade for dairy and beef cattle on pasture.

During the pasture period of 2011, a herd of dairy cows (Holstein) and a herd of beef cattle (Belgian Blue, BB) were divided into a group with and a group without access to a shaded area planted with young willows, in between which shade cloth was hung. In moderate to warm weather conditions we followed up on shadow use, respiratory rate (RR) and other visual signs of HS (e.g. salivation) and the effects of various climatic indices and of shade were investigated. In dairy cattle, we also examined whether the body temperature, milk production and quality, and the production of stress hormones (cortisol) were affected by the climatic indices and access to shade. Additionally, we evaluated the microclimate under and out of shade, on several hot days spread across the summer.

The negative effects of (mild) HS

The limited use of shade observed in the summer of 2011 suggests that the climatic conditions under study caused no extreme HS. Yet we saw visual signs of HS and shade use increase as the value of the climatic indices increased, in both dairy and beef cattle. We also demonstrated that the observed conditions resulted in a higher breakdown of body reserves of fat

and protein, increased production of stress hormones (cortisol) and higher body temperature in dairy cattle. There was no consistent, strong effect on daily milk yield. As the value of the climatic indices increased, milk lactose and protein content decreased slightly and urea content increased slightly, although sampling days for the last three parameters did not cover the possible extremes in a Belgian summer.

The effect of shade on microclimate and on the animals

Shade especially reduced the Black Globe Temperature (combined effect of air temperature and solar radiation), but also the air temperature in itself. We also observed a beneficial effect of shade on the 'Panting Score' (measure of visual signs of HS, like panting and salivation) and the RR of BB suckler cows. In their suckling calves and dairy cows 'Panting Score' - but not RR – was lower in the shade. In addition, shade reduced evening body temperatures of dairy cows.

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Funding: Federal Public Service of Health, Food Chain Safety and Environment

Coccidiosis in goat kids: effect on growth and subsequent milk production

Coccidiosis is one of the most important diseases of young stock on goat and cattle farms. Almost all dairy goat farms are more or less affected, in some cases with serious economic damage.

*Coccidia (*Eimeria *spp.) are single-celled parasites that are taken up from the environment. Once in the body, they penetrate the intestinal cells and multiply there. In this process the intestinal cells are damaged; this can cause acute symptoms such as bloody diarrhea and emaciation.*

However, an infection can also be present without acute symptoms (subclinical coccidiosis). Because of the intestinal damage, nutrients may be less efficiently absorbed and growth delay occurs. Economic consequences in the longer term are caused by lower productivity due to reduced growth.

Better growth with herbal feed supplement

Health care in organic animal production is based on prevention of disease. This can be achieved through well-considered pasture and stable management and supporting natural resistance. Phytotherapeutic supplements can help to keep infections at a tolerable level or to boost natural resistance.

In an earlier project on phytotherapy, an herbal feed supplement normally used to support resistance to intestinal worms seemed to be active against coccidiosis. In a subsequent trial the feed supplement was tested on goat kids during three months to see if it had an impact on infection with coccidia.

Growth of the goat kids was significantly better in the group that received the herbs than the growth of those in the control group. After three months the mean weight difference was 4 kg. The mean daily weight gain in the herbs group was 26% higher in comparison with the control group.

Influence of growth advantage on subsequent production

Heavier, well-developed young stock are expected to be pregnant earlier, produce more milk during the first lactation and have a longer lifespan.

Currently a follow-up project is monitoring whether the growth advantage of the animals in the treated group is also effectively translated into a better performance in the first lactation.

Six months after the end of the herb experiment the goat kids were reweighed. The goats from the herb group were on average still 5 kg heavier than the goats in the control group. The goats are currently being followed during their first lactation. Body weight is monitored and every six weeks the milk production is measured.

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Funding and partners:
CCBT project 'Aanpak van coccidiose, bij geitenlammeren en kalveren' Hooibeekhoeve in cooperation with Wim Govaerts & Co cvba
CCBT project 'Opvolging coccidioseproject: impact van de groeivoorsprong van geitenlammeren op de latere productie' executed by Wim Govaerts & Co cvba, Government of Flanders, Department of Agriculture and Fisheries

Organic poultry: Countering infections of *E. coli* and *E. rhusiopathiae*

E. coli *is the most common bacterium in poultry.* E. coli *attacks if the immunity of the animal is weakened by disease (IB), stress (pecking) or by bad management. In laying hens,* E. coli *can cause an infection of the peritoneum, the oviduct or the ovary. In broilers, the infections are mostly of the air-sacs, lungs and joints.*

E. rhusiopathiae *appears more often in alternative production (aviary, free range and organic production). In poultry it can weaken the hens, cause diarrhea, reduce the egg production and cause sudden death. This pathogen can cause large economic losses.*

Looking for alternatives

The aim of this project was an exploratory literature review about the potential of alternative products to counter infections caused by *E. coli* and *E. rhusiopathiae* in organic poultry. The target group were producers in organic laying hens and broilers.

This review enumerates different alternatives to supplement for *E. coli* infections. For infections of *E. rhusiopathiae*, few, if any alternatives are found in literature. This disease must be counteracted through optimal management. Before supplementing a product, it is advised to ask the appropriate authorities if the product is allowed for use. Supplementing vitamin A and E can have a positive effect on the protection of older broilers. Herbs, plants and their extracts can also be used. The characteristics of garlic are widely known and examined. Garlic has an antibacterial, antiviral and anti-oxidative activity. Also thyme and origanum are promising herbs because of the antimicrobial activity of the active components thymol and carvacrol in the essential oils of these herbs. Also the properties of cinnamon and mint are frequently mentioned in literature. Commercial products are often a blend of these alternatives.

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Boars or barrows: Alternatives for surgical castration without anaesthesia

A ban on surgical castration without anaesthesia is discussed throughout the European Union. At the end of 2010, a declaration came from Brussels in which several main actors in the pig meat chain agreed on a plan to voluntarily end the surgical castration of pigs in the EU by January 1st, 2018. As a first step, since January 1st 2012, surgical castration of pigs, if carried out, should be performed with prolonged analgesia and/or anaesthesia.

Different alternatives have been developed, but information about the feasibility on farm was lacking. Therefore, this research aimed to evaluate on farm each of the alternatives: castration without anaesthesia as a control treatment, castration with analgesia surgical castration with CO_2 anaesthesia, immunocastration (also called vaccination against boar taint) and production of entire male pigs. When evaluating alternatives for surgical castration, not only practicability and economical feasibility, but also the effect on animal welfare, final meat quality and the prevalence of boar taint is important. Besides these factors, legislation, market acceptance and risk for boar taint occurrence should be taken into account.

Feasibility in practice

This research has revealed several stumbling blocks, opportunities and challenges. Castration with analgesia or CO_2-anaesthesia carries extra costs: 0.22 and 0.07 €/male pig respectively. One of the hurdles to producing entire male pigs or immunocastrates is to find an agreement with the slaughterhouse to accept these type of animals without a price reduction. Market potential is increasing, but is still limited. The lack of an objective, online boar taint detection method is probably the main limiting factor to shift towards the production of entire male pigs. Profit can increase when producing entire male pigs or immunocastrates, but results will depend on the level of improvement made for performances (feed conversion ratio) and carcass results (higher meat percentage, but lower dressing percentage), possible costs of the boar taint detection method when producing entire male pigs and the cost of the vaccine when producing immunocastrates (3.29 €/male pig). Surgical castration eases pig management by preventing the development of male sex characteristics and hence reduces aggressiveness and sexual behaviour. Farmers' experience with producing entire male pigs was limited at the start of this project. Observations of behaviour at the end of the fattening period confirmed earlier findings about increased sexual and aggressive behaviour of entire male pigs compared to barrows and

immunocastrates, but also indicated that skin lesions and leg problems due to this behaviour were light rather than severe. Three percent of the entire male pigs were identified as having strong boar taint. Percentages varied between farms from 0 up to 14% for entire male pigs, while boar taint was absent in barrows and immunocastrates.

Opportunity or threat?

A shift towards entire male pigs or immunocastrates can be challenging, but also brings opportunities for the pig producers if the necessary information and support is provided. However, market potential of entire male pigs and immunocastrates is still limited.

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Optimisation and innovation of organic and low input dairying through European collaboration

During the past year, researchers of ILVO visited approximately ten organic dairy farms (cows and goats) in Flanders and the Netherlands in order to observe the sustainability of each farm. These visits were organised in the context of the European project SOLID (Sustainable Organic and Low Input Dairying). SOLID aims to improve the technical performance and the economic competitiveness of organic and low input dairy systems in Europe, while maximising their potential to deliver environmental goods and enhance biodiversity.

SOLID visits

Compared to other European countries, the farm visits revealed high scores for animal welfare and soil quality, unlike system diversity and biodiversity, which were the topics that have received less attention in the past years on these farms. These first results will be used in a participatory process in which farmers will be involved through several workshops. One of the first aims of this participatory approach is to identify the research needs in the organic and low input dairy sector. The research priorities will be thoroughly investigated in the several partner countries and the research findings will be reported to the collaborating farms by means of a farmer handbook.

SOLID involves stakeholders

The project starts from a coordinated participatory approach, in which all stakeholders (organic and low input farmers, farmer organisations, advisers and processors) from ten countries will be involved from the beginning. Farmers will be involved to define the research needs, and innovative ideas will be tested on commercial farms. Meanwhile, research institutes will investigate topics such as the development of decision support models and possibilities of adopted feed and breeds.

SOLID partners

A total of 25 institutions and organisations (research organisations, farmer cooperatives, consumer organisations, advisory bodies, and private enterprises) in ten countries are included in the project for a period of five years starting in April 2011. The project is coordinated by the Institute of Biological, Environmental and Rural Sciences at Aberystwyth University, UK. The partners in Flanders are the Institute for Agricultural and Fisheries Research - Social Sciences Unit (ILVO), Wim Govaerts & co and Ghent University- Department of Agricultural Economy.

SOLID results

The results of both the research institutes and farms will help farmers choose the breeds and feeding strategies to maintain productivity and improve animal health and welfare, while meeting the market requirement for high quality milk. Project results and outcomes can be consulted on the project website (www.solidairy.eu).

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Funding: EU-7th framework
More info: www.solidairy.eu

The potential added value of a well designed outdoor run

Chickens should use their outdoor run optimally. The image of the farm and farmer depends on a nice open air area featuring well-feathered and active hens. As the hens use the run properly, the litter and manure will be spread in the outdoor run, avoiding the manure to concentrate around the building. The design of the run determines mostly if the hens use it or not. To be sure, chickens started out as forest animals and feel the safest under or round the cover of trees and bushes. To design a good outdoor run, the advice is to create lines or strips of trees and bushes.

Can an outdoor run offer an added value?

It would be interesting for the organic farmer if he/she could create an extra value out of the investment and design of the outdoor run. One opportunity is to implement a mixed agricultural system, such as the combination of poultry and the production of short rotation coppice (SRC).

Mixed agricultural systems can deliver ecological, technical and socio-economic advantages. The interaction between planting of SRC and poultry can offer an ecological advantage. By combining hens and SRC in an outdoor run, the hens can naturally counter infestations, insects and weeds.

A good design with bushes and trees can provide the farmer also a zootechnical advantage. Trees can give cover and can serve as wind shields. They can provide a stabilising effect on the climate en thus reduce stress due to extreme cold or heat.

The socio-economic advantage can be the diversification of the farmer's income by combining different kinds of agricultural production such as the production of SRC. Because of the growing demand for biomass, the production of SRC can create an economical added value for the farmer.

Goal

The outcome of this project is a literature review. In this review we will summarise the opportunities and possible stumbling blocks concerning the measures implemented by the farmer to enforce the added value of the outdoor run. The target group is organic poultry farmers. This project can outline the possibilities, advantages and disadvantages of a well-considered outdoor run design. This is for a very specific sector, namely organic egg and broiler production.

The project included a workshop organised by the farmers' network "Organic Poultry". The location was the farm of one of the producers from the network. Monique Bestman (Louis Bolk Institute) showed some inspiring cases and suggestions for a design of the outdoor run. Pieter Verdonckt (Inagro) looked at the legal and practical chances to implement SRC in the farmers' management.

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Organic poultry: responsible use of the open-air area

In organic poultry the animals must have permanent access to an open-air area, preferably pasture, when weather conditions and the condition of the outdoor run allow it, unless there are restrictions and obligations concerning the protection of the public health and the animal health (Raadsverordening 834/2007). The checklist of Raadsverordening 834/2007 mentions the use of the outdoor run as a criterion. The inspector must state if the chickens are locked up without access to a meadow in open air while the conditions (weather and state of the run) would allow it.

What's the problem?

The regulation "when weather conditions allow access to the outdoor run" is not specified in the legislation. At the farmers network "Organic Poultry" the farmers agreed that this regulation evokes a great deal of discussion among farmers and during audits by various authorities.

Chickens normally get daily access to the outdoor run on a certain time. Depending on the season and the weather conditions, this management scheme does not always correspond with the behavior of the chickens. An exploratory literature review is required to search for criteria to fill in this regulation more concretely for organic poultry.

In the literature review, we want to focus on different aspects concerning physiology and animal welfare. A criterion can be something like the temperature perceived by the animals (wind chill). This perceived temperature is the result of a combination of environmental conditions and animal factors. These factors influence the way the hens can dissipate heat. Specific animal factors for poultry are: age, the ratio between body volume and body surface, growth rate, body weight, egg production, feather condition and behavior. The wind speed, relative humidity, the ambient temperature and the temperature gradient between the animal and his surroundings are important environmental factors influencing the heat dissipation in poultry.

Literature review and interpretation of criteria

The aim of this study is a summary and interpretation of criteria found in literature, which could serve or help to concretise the meaning of a "responsible use of the outdoor run" in organic poultry. These criteria should describe the chickens' optimal experience of comfort concerning the outdoor run.

A workshop will be held at the end of the project to discuss the results of the literature review in detail, together with organic farmers, experts in animal physiology and experts in animal welfare.

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Herbs in grassland for a healthy livestock

Minerals and trace elements are needed for a good resistance, health, growth and production of dairy cattle. Cows fed with concentrates usually do not have shortages of minerals and trace elements. Only roughage often provides insufficient minerals. Because they give mainly roughage-rich diets, organic farms need to pay extra attention to the mineral supply. Organic farms with ruminants only have limited possibilities to administer extra minerals and trace elements to the diet, due to the regulations. They are therefore very dependent on the minerals and trace elements they can administer through roughage.

Herbs in grassland in Flemish conditions

Recent research, carried out by both Inagro and foreign research institutes, mainly focused on the possible shortages of minerals and trace elements in an organic diet and on the availability of minerals and trace elements in herbs. In most of the model diets on organic farms with producing ruminants, shortages in minerals and trace elements appear. Inclusion of grassland herbs, including chicory, narrow plantain, yarrow and dandelion in the grassland can allow a better coverage of the mineral requirements. If the diets are balanced for minerals and trace elements through the cultivation of these herbs, we only see some constraints for high productive cattle or fast growing cattle, that can be solved (inexpensively) with a smaller dose of copper and the addition of salt. In the CCBT project 'Cultivation techniques for healthy cattle' we investigate how herbs can be sown on an organic dairy farm. For this purpose, the ecology and cultivation technique of herbs with a animal health improving effect is visualized and tested against the Flemish cultivation circumstances. In addition, the cultivation's technical feasibility, the zoological needs and the economic framework in which Flemish dairy and goat milk producers operate are taken into account.

Preliminary results

In this experiment different varieties of dandelion, chicory, narrow plantain, yarrow, burnet and small chore are tested. Further, different fertilisation regimes were tested in combination with grazing or mowing management. The herbs were sowed with a strip cutter in an existing grass clover meadow in autumn. The sowing was difficult because the sowing machine was blocked regularly and some rows were not sowed entirely. Another parcel was entirely resown by the farmer in autumn with a grass/clover/herb

mixture. From the first results we conclude that the competitive strength of the existing grass clover after overseeding is high. Small plantain and chicory and to a lesser extent yarrow were powerful enough to compete with the existing grass/clover mixture. Small burnet and caraway appeared only occasionally, mainly in the unfertilised zone. In the re-sowed parcel, the herbs were able to compete better with the grass/clover and also the small plantain and caraway occur more. A multiannual monitoring is needed to visualise the influence of the pasture management on the persistence of the herbs.

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Socio-Economics, Market and Chain issues for the organic sector

Impact of the European agricultural policy reform on organic farming in Flanders

Ex-ante evaluation of the legal proposals from the European Commission

The European Common Agricultural Policy (CAP) is currently under reform. From 2014 on, the various components of this policy will change, including direct payments and rural development policy. This study builds upon the legal proposals of the European Commission to estimate the potential impact of the CAP reform on organic farming in Flanders. To begin, the analysis examines the amount of pillar I and pillar II support that go to the organic farmers under the current CAP.

For the current CAP, the year 2013 is considered as reference scenario. This means that an estimate of the support pillar I and pillar II support in 2013 is calculated based on the data from 2010/2011. In Flanders, there are 240 farmers who are certified for organic production and submitted a single application in 2011. In the report, we only study the organic farmers who are farming at least half of their land under organic production. This totals 209 farmers. Only 46% of the organic farmers will get Pillar I support in 2013. At that time, there will be more organic farmers with Pillar II support, especially for agri-environmental measures and/or the payment nature (86%). Of these, the "organic hectare aid" measure is the most important.

According to the legal proposals of the European Commission for direct support under the new CAP, only farmers who had entitlements in 2011 or farmers who grew in 2011 only fruit, vegetables, potatoes and/or wine will be eligible for new entitlements from 2014 on. This is the case for the total eligible area. As a consequence, the number of potential beneficiaries increases, but is still limited to 117 or 56% of the organic farmers. The total area with entitlements will increase significantly, from 1,982 ha to 3,085 ha, because the entire eligible area will be charged and not just the entitlements that the organic farmers own at the time. Today, 92 organic farmers (44%) do not receive pillar I support and will not be eligible from 2013 on. The average area cultivated by theses organic farmers is 7 hectares. Many of them focus on horticulture, but also have a limited area of arable and fodder crops.

The impact of the redistribution of direct payments was investigated for two scenarios: one scenario with an unchanged budget and a second scenario with a budget decrease of 8%. In both cases, the suckler cow premium is not decoupled. Because of redistribution effect, in both scenarios the

organic sector receives more direct support in comparison with the reference scenario of 2013. There is about 393,698 euro (49%) extra support in the first support and 302,113 euro (37%) extra in the second one. Also the average amount is higher and amounts to 10,206 euro per producer in the first scenario. In this situation, there are many more winners than losers. In the second scenario (with a budget decrease), in comparison with scenario 1 and 2, there are two additional losers and two fewer winners. For the scenario with budget reduction, 21 losers have an average loss of 5,030 euro per producer. The 96 winners have an average gain of 4,247 euro per producer. But the profits and losses vary greatly between producers. A small minority has a large loss or a large profit. In the scenario with budget reduction (scenario 2), the group of the 25% biggest losers is characterised by larger companies with more cattle, and with more and more valuable entitlements. Within the group of the 25% biggest winners, half of the farmers hold many sheeps and/or goats. They also have more cattle and a larger area. At least three-quarters of this land is dedicated to forage crops. In addition, a group of farmers focuses on horticulture; they do not keep animals.

In the proposals for rural development policy by the European Agricultural Fund for Rural Development, the "organic hectare aid" remains a possibility. The difference is that it will no longer be an agri-environmental measure but rather a separate measure. The proposes maximum amounts of aid are the same as the current maximums. It is, however, uncertain if a payment above the established maximum ceiling will be possible, as in the current Flemish Rural Development Programme. In justified cases, such a higher support level could be approved by the European Commission. It is therefore still not clear whether organic farmers will receive the same or lower levels of the "organic hectare aid".

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Inventory of key indicators for organic dairy and beef cattle

Organic farmers with dairy cattle, beef cattle and dairy goats were consulted concerning research needs. During these meetings, they were asked about subjects where organic management differed from the conventional management. These differences are mainly related to health care, young stock rearing, feeding strategy and breeding.

In this project, indicators that relate to management and health and are relevant for ruminants in an organic farm are listed. A list of key indicators will be selected based on the priorities set by the farmers.

The specificity of organic management

In terms of health care, a preventive approach through natural resistance to infections is important. Breed differences may play a role. Organic livestock farmers are convinced that the use of antibiotics must be reduced. Indicators can quantify the current use of antibiotics. These results can be used to set goals for future use of antibiotics. They can also reveal potentially profitable strategies that can be further investigated.

The quality of young stock rearing can have a major impact on the subsequent production. Elements that play a role are diseases, parasites, mineral supply, feed quality, time of insemination, amoung others, etc. Organic farmers are experimenting with alternative approaches such as keeping calves with the cow, family herds, and others. A tool to assess the impact of these approaches would be useful.

The feed management on organic farms differs in many ways with the conventional farms: different forage crops, the limited availability of organic by-products, a different approach to health care, etc. Appropriate indicators can provide a picture of how the different breeds and crosses perform on the Flemish organic farms.

Specifically for organic beef farming, profitability is an important concern. For example, organic farmers are often asked to manage grasslands in nature reserves. This type of low-input production can be interesting

because costs can be kept low, but only if beef cattle of sufficient quality can be produced. For beef cattle, it is also important that in addition to indicators for growth and health, indicators are found that can be used for a model for cost price calculation.

Setting targets

By selecting key indicators and collecting the data, it should become possible to:

- get a clear picture of common problems and set targets for the future in order to solve them;
- identify research topics that can help to reach the targets;
- in the long term, use the evolution of the indicators to monitor progress.

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Business figures for the organic sector: a general sector approach

Very few business figures are available for Flemish organic agriculture and horticulture. The aim of this project is to collect some figures. Business figures have been collected from a number of organic farms since 2005. Averages and spreads have been calculated. These figures have also been compared with the averages found in conventional farms. We have always accounted for the type and size of the farm.

Due to the limited number of farms producing organically, one single farm can have a great influence on the overall results while processing these figures. Therefore comparing the organic farms with the conventional farms was often difficult and risky. Nevertheless, sufficient figures have been collected in order to draw some general conclusions.

General conclusions

1. More than 50% of the organic farms participating in the project were more profitable than their conventional colleagues.
2. For many organic farmers, working according to the organic production method was a strategic choice because they are not willing to follow the trend of upscaling within their sector. They were searching for higher profitability by changing their cultivation method. Many companies have realised this goal.
3. Over the years, organic dairy farms can count on a higher milk price, with an extra variance between 6 and 9€ per 100 litres more than the conventional farms. The fluctuations are often due to temporary market instabilities. The organic dairy farms often rank among the best compared with their conventional colleagues in their category. The costs of organic milk production are higher. The milk production per ha is much lower.
4. The organic vegetable sector is divided: some farmers still wish to expand the size of their farm, while others wish to maintain the current situation. Some farmers are afraid that the prices could come under pressure if the cultivation surface expands. On the other hand, an increased supply on the markets also offers chances for the market. Much depends on the level of the market potential.
   The organic fruit sector is also expanding. The new producers are welcomed into the group with open arms, as the organic fruit producers are convinced that the demand is greater than the supply in Flanders.

5. As the hours performed cannot be estimated correctly, it is difficult to calculate the earned income. Neither conventional nor organic farmers found it important to correctly register the hours worked. But it is common knowledge that organic farms are more labour intensive. Large differences in labour can arise when investing in the right material for weed control. The work force also changes when comparing conventional and organic production. Certain labour peaks flatten out, but others are sharpened.
6. Despite the large differences among organic farms, these figures appear to indicate that it is possible to earn a good income from organic farming. Nonetheless, just as with conventional farms, profitability depends highly on management.

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Organic and low-input dairy farming: false friends?

The European 'SOLID' (Sustainable Organic and Low Input Dairying) project aims to identify innovative measures that should enable organic dairy farmers to innovate in a competitive way. Organic farming is studied along with low-input agriculture, because neither fits with the current innovative measures that mainly focus on the modern-day intensive production systems. The question is, "to what extent do low-input and organic farms truly match, or is their affinity mainly due to their large differences with the mainstream of modern-day dairy farms? Are they false friends?" Insights into aspects of similarity and difference are important, however: if there are sufficient similarities between organic and low input farms, identifying competitive strategies may be important for both low input and organic farms.

What is low input, and are organic farms by definition low input?

The definition of a low input farm in the SOLID project is based on the sum of the cost of purchased feed, fertilisers, crop protection products and energy divided by the number of livestock units at the farm. This number (from here on denoted as SOLID.LSU) is then compared with a reference value. Based on European FADN accounting data of 2007/2008, for each individual EU member state a reference value for this SOLID.LSU has been determined. This reference value corresponds to the maximum value of SOLID.LSU of the 25% farms with the lowest SOLID.LSU. This reference value for Belgium is 408 €/LSU. The member states with the highest SOLID.LSU are Denmark (1035 €/LSU) and Malta (1052 €/LSU), while the member state with the lowest SOLID.LSU is Romania (305 €/LSU). In organic farming, input prices are generally higher than in conventional agriculture, the SOLID.LSU reference value is less suitable to position the organic farms within the group of low-input farms. Rather than quantify the inputs used, it is more interesting to focus on the ratio of different inputs used and compare these with the output produced on the farm. This is called input efficiency.

How can we assess the competitiveness of innovative measures?

Input efficiency simply means that when fewer inputs are needed to produce one litre of milk, the more efficient the production will be. In SOLID, measuring input efficiency has been considered as a suitable method to evaluate the competitiveness of farms and to identify competitive innovative measures. Measuring input efficiency of organic and low-input farms is based on three types of efficiency numbers. The first is the purely technical efficiency, based on the size of the total input-package of physical inputs relative to a product unit, namely milk. Here it is expected that the organic and low-input agriculture will not differ that much. The second, the allocative efficiency, uses price information and focuses on the reciprocal substitution of inputs. Because of higher input prices, organic farms will presumably use fewer external inputs and rely on strategies based on higher land use for forage production. Finally, price efficiency will indicate possibilities for additional improvements in competitiveness. The price advantage of organic products will presumably be vital in improving competitiveness.

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Funding: EU-7th framework
More info: http://www.solidairy.eu

Which factors determine the sustainability of fruit farms in Flanders?

Which factors determine the sustainability of Flemish fruit farms in 2012? In order to answer this question, we relied strongly on stakeholder input to ensure a broad base for our study. We organised a workshop with researchers, extension agents, cooperation representatives, fruit growers and representatives from several societal groups. Together, we brainstormed about the question at hand, grouped the issues that were mentioned into themes, and asked them to set priorities. This first rough framework was refined by input from literature and production standards for fruit culture.

Sustainability framework

The sustainability framework contains following themes and subthemes, grouped into the three pillars of sustainability:

1. Environmental and ecological themes: crop protection (pressure mitigation and good practices), energy and water (efficiency and source), biodiversity, waste (prevention and recycling), nutrients and soil (diverging concerns for pome fruit and strawberries, erosion);
2. Economic themes: efficiency and productivity, profitability or farm income, fruit prices, stability, risk;
3. Social themes: external (landscape, social acceptance and image), internal (work management, collaboration, job satisfaction), entrepreneurship.

A separate framework for organic fruit culture?

Bioforum organised a similar workshop with organic fruit growers. The sustainability themes that emerged there were very similar to those derived from the first workshop, where no organic growers were present. The organic growers also thought that biodiversity, crop protection, production that addressed market demands, social acceptance and image and collaboration within the sector are important sustainability themes.

The main exception was soil quality. Whereas this was hardly mentioned in the first group, the organic fruit growers find it very important. They put forward that a living soil, containing a wide range of soil life, makes an important asset to a healthy perennial crop. Building up and maintaining soil organic matter content is therefore seen as an essential part of fertilisation.

Indicators

Next, to make the sustainability framework concrete, we determined indicators for each of the themes. The indicators are partly taken from

the instrumentarium developed by ILVO's Social Sciences Unit and partly from literature. When selecting them, we first only took the criteria for a scientifically sound sustainability assessment into account. Afterwards we checked whether the indicators could be calculated from the Flemish Farm Accountancy Data Network. If they were not, we proposed alternative indicators.

The proposed toolbox of indicators includes, among others, an indicator set for soil quality. Soil organic carbon content makes up half of this indicator set, in addition to indicators for chemical, physical and biological soil quality. Results from the toolbox of indicators are intended to serve as a starting point for discussions on sustainability in fruit grower groups ("Fruit cafés").

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Networks and innovation: Connection in the broader innovation landscape?

Agricultural and horticultural enterprises are faced with the innovation challenge of enhancing their competitiveness and meeting social challenges. In their quest for innovation, farmers' individual entrepreneurial qualities are often put to the test. External factors such as market prices, technology and legislation are essential when choosing and developing innovations. Innovation capacity is guided, broadened and strengthened by networks, but their function is underexposed in both research and practice. Networks can facilitate knowledge flow and co-construct decision frameworks. Therefore networks are central in influencing both individual innovation opportunities and external socio-economic conditions.

Farmers and networks

In this research project, Ghent University and ILVO address questions about the representation and participation of farmers in different types of networks such as industry federations, extension, farmer groups, practical research stations and policy networks. How do these different network forms come to terms with the changing needs of farmers? How do farmers perceive networks and their role within them? How do farmers and other network stakeholders create partnerships aimed at strengthening a base from which innovations arise?

What is innovation?

But what is meant by innovation? Is any renewal also innovative? Is each innovation an individual one? The first series of interviews and focus groups show no clear answer to this. Through the use of qualitative research methodology we would like to allow different interpretations of 'innovation' in order to maintain and map its inherent multiplicity. We therefore look at how farmers formulate specific needs and how their interaction with networks determines:

- obtaining knowledge
- making business decisions
- addressing societal challenges

One unique aspect of this research is that we do not start from a general approach whereby innovation is disconnected from the specific characteristics of each sector, but rather from a case-by-case analysis in which we consider different branches of agriculture and horticulture separately. Six sectors are investigated. ILVO is currently focusing intensively on organic farming and intensive pig farming. Each time, we consider highly case-specific dynamics. But we also investigate how each case informs the other. Finally, examples from abroad are analysed in function of their relevance for Flanders.

Networks for organic agriculture

As agricultural practice, organic farming shows a remarkable diversity in crop choice and combination, marketing structures and integration of agriculture and environment.
This multitude of possible innovation paths do not make it easy for organic farmers. Furthermore, the organic sector does not share a clear vision about what innovation really means. The question rises whether there is a need for coordination and how it can be met. At this moment individual innovators are searching contact with each other to achieve improvement via collaboration. Networks such as *Bio zoekt Boer* (Organic Seeks Farmer), *Biobedrijfsnetwerken* (Organic Farmers' Networks) and '*Bio zoekt Keten*' (Organic Seeks Chain) aim to improve knowledge flow and (infra) structures. In many respects, organic farming has revealed itself as pioneer in creating horizontal networks in comparison with the more conventional vertical approach. But also in this situation, questions remain about how resources can be best used to guide entrepreneurial decisions or how to create a better relationship with government and knowledge-transfer actors.

We want to determine which network-forms can play which role by querying farmers with different visions and innovative practices. On the basis of these findings we aim to develop an action plan. In this plan, we intend to contribute to the formation of a network that participants actively engage in.

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CA/N 120

Technology

Energy efficient heating with long term heat storage in organic protected horticulture

All growers, whether conventional or organic, have to cope with high energy costs. Growers are trying to control these costs by using new technologies. CHP, or simultaneous generation of electricity and heat, is one of the most efficient technologies to lower energy costs. However the application of CHP is not always possible for growers with a small surface or a great variety of crops, as is often the case in organic horticulture. Therefore PCG, which has been doing research in organic protected horticulture for many years, searched for a practical solution for (small) organic companies.

Semi-closed glasshouse in organic horticulture

Two years ago PCG invested in a new glasshouse with an energy efficient heating system that applies the concept of a semi-closed glasshouse. The set-up had to fit in an organic culture with a high energy saving potential of 50% and an increased production potential of 5%.

The system consists of an isolated greenhouse of 1250 m² (six compartments) with three gas absorption heat pumps with a total of 120 kW (COP of 130% to 170%). These have a maximal outlet temperature of 65°C and the CO_2 that is produced by combustion can be used in the greenhouses. Cold is also produced by the heat pumps which can be used for dehumidification. With the active dehumidification greenhouses can be closed more often, resulting in fewer heat and CO_2 losses. Organic growth has a higher humidity because it is done in full soil, therefore dehumidification is used to maintain a steady level of humidity.

Cold and heat are stored on short term in two water tanks of 45 m³. In the long term, heat can be stored in the ground using BTES (Borehole Thermal Energy Storage). This BTES field allows enough CO_2 production on sunny days and makes it possible to store the excess heat in the ground. In wintertime this heat can be used by the heat pump.

Measuring energy use

Since January 2012 measurements have been carried out to identify energy and CO_2 flows. Heat demand for organic peppers and tomatoes, both in greenhouses of 400 m², is being measured. A COP of 140% has been measured for the complete growing season. That results in a primary energy saving of 28.6%. The energy use of the organic peppers (planting date end of January) is 271 kWh/m². The organic tomatoes (planting date

mid of January) have an energy use of 319 kWh/m².

Prognosis of saving potential and further research

The prognosis to the end of November for peppers is 332 kWh/m² and for tomatoes is 380 kWh/m². If the COP of the heat pumps is included for the calculation of the gas consumption per m², the peppers arrive at a petrol use of 20.5 m³/m and the tomatoes arrive at 23 m³/m². When the results are compared to a reference situation of 36 m³ gas per m² for peppers and 40 m³ per m² for tomatoes, a saving of 35% is achieved for peppers and 41% for tomatoes. Further research will focus on extra energy saving using climate control and plant sensors. Also the BTES field and CO_2 flows will be examined.

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RTK-GPS: an added value on organic farms

In 2009, Inagro, together with an innovation group of organic farmers, explored the potential of RTK-GPS (Real Time Kinematic Global Positioning System) for organic practice in Flanders. The focus was on more effective mechanical weed control and maintenance of an optimal soil structure. In 2010, an RTK-GPS system was bought and implemented. Because of the mechanical weed control, also the machines needs to be steered by RTK-GPS. An intermediate frame was developed to be placed between the tractor and the machines. This allows for quickly switching the machines.

Prototype 'intermediate frame' ready for practice

An RTK-GPS steering entity on the machine has to correct potential deviations of the machines. On larger farms, this steering unit is often built onto the sowing machine and/or the hoeing machine. This means that either more steering units have to be purchased, or the units have to be constantly switched between machines. This seems impractical. A disk-controlled intermediate frame fitted with an RTK-GPS unit would solve this problem. This frame hangs on the lift of the tractor. The machines are linked onto the back of the frame. The frame is constructed to allow the operator to drive machines with a PTO shaft (e.g. a precision seed drill or a punching machine).

Mechanical weed control

RTK-GPS enables the operator to drive straight and to repeat this. In principle, hoeing can happen up to two cm from the crop row without needing to steer manually. Some problems prevented us from achieving this in 2010 and 2011. Nevertheless, we did succeed in adjusting the hoeing knives to be more narrow to the row and we already achieved three to four cm.

Driving straight, and having the tractor also driving straight while hoeing, at least lowers the need to adjust the hoeing machine. The GPS-unit on the tractor is a definite added value.

Seasonally controlled traffic farming

In previous years we have regularly encountered less productive rows in our cultivations. We attribute this to the superficial soil compaction in the track of the harrow, although we already drive on low pressure and

the conditions while harrowing were good, according to us. It is possible that such errors are more severely punished in organic farming than in conventional cultivation, because of the different fertilisation. By using the GPS, we want to keep a fixed path for all operations after plowing, to make sure all the plants are growing in uncompacted ground. This is called a 'seasonally controlled traffic farming'. In general, it is our impression that the crops on the experimental farm are more homogenous than former years. This was also substantiated in a couple of tests, for example in a test of a second cultivation of cauliflower. Two times four rows were planted after rotary harrowing according to the 'controlled traffic' concept and two times four rows were planted after rotary harrowing with a conventional tractor. To monitor the compaction of the soil, a trench was dug right through the rows. At the 'fixed path', it was possible to push the spade in the ground manually across the whole topsoil depth. The rooting in these rows was quite homogenous and already reached topsoil depth. In the conventional method this was not the case for the rows planted in the track of the tractor. The differences were largely leveled at harvesting and all cabbages were good. However, the tracks at the conventional method were a little smaller.

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Research on optimising the application of insect parasitic nematodes against the cabbage root fly

Since 2010 Inagro, ILVO and Ghent University are performing research on the optimisation of the application of entomopathogenic nematodes (EPN) against a number of pest insects in vegetables. The soil application against maggots of the cabbage root fly is investigated in cauliflower. An improved application technique offers perspectives for EPN as an alternative organic control method against cabbage root fly.

Semi-field experiments

During the winter and spring of 2011, four pot experiments with cauliflower plants were established in a glasshouse. A plant tray spraying was tested as a pre-plant application. After planting (in pots) two application methods were tested with EPN: (1) spraying with an adapted mobile spray boom and (2) a soil drench. Two extensions with a nozzle targeting the base of the plants are mounted at the left and right of the spray boom. There were also variations in the combinations of different application methods in the experiments. The applied dose was 180,000 or 370,000 EPN/plant for the plant tray treatment and soil drench treatment and 55 EPN/cm² for spraying.

The results of these semi-field experiments illustrated that drenching a solution of 180,000 or 370,000 EPN/plants led to a significant reduction of the damage caused by the cabbage root fly. A plant tray treatment with 180,000 EPN/plant had less effect. Spraying plants with 55 EPN/cm² had no or only limited effect on the damage caused by the cabbage root fly.

Results of the field experiments in 2011

In 2011 field experiments were conducted in cauliflower, broccoli and radish. In cauliflower the number of dead plants could be reduced significantly by both a plant tray treatment and a combination of two drench applications compared to the untreated control. Two drench applications reduced the number of dead plants the most. The applied dose per treatment was 180,000 EPN/plant. In this way the amount of applied EPN was two times higher compared to the plant tray treatment.

Results of the field experiments in 2012

In April and May 2012, Inagro established field experiments in cauliflower. Two of them were under organic cultivation conditions and one was under conventional cultivation. In these experiments the focus was on the frequency and the application time of the EPN treatments in comparison

with the applied EPN dose.

In these experiments, the plant tray treatments with 200,000 EPN/plant delivered the best results of all applications. A smaller dose and application by drenching showed to be less effective. The reference treatment with Spinosad still clearly delivered a better result. Further research will have to reveal whether the plant tray treatment can be optimised.

Conclusion

Entomopathogenic nematodes of *Stenernema feltiae* potentially offer an alternative control method to limit the damage caused by the cabbage root fly. They are safe for user and do not leave a harmful residue, but they are more delicate in use than chemical insecticides and are therefore less persistent. To achieve an relevant application for practice, a more thorough optimisation is needed. The research in 2011 and 2012 shows that both the application technique and dose are crucial to obtain a good control effect. This should be elaborated to realize the full potential of EPN for the control of the cabbage root fly.

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Food, Quality and Health

Do organically produced vegetables and fruit taste better?

One of the reasons why consumers buy organically cultivated vegetables and fruit is that they are convinced they will get superior taste. But is this really true? Taste research attempts to answer this question.

Taste research at the PCG

The Provincial Research Station for Organic Vegetable Cultivation in East Flanders (PCG), located in Kruishoutem, started taste research for vegetables and fruit in 1998.

For this taste research, a tasting room with a food preparation area was installed in the PCG according to international standards (ISO 8589). In this room with 14 booths, equipped with colour filters on the lighting to eliminate colour differences on the samples, the panel members taste and review the vegetables and fruit. The review happens according to accepted sensory practice and is done blind, i.e. the panel members do not know (for example) which breed or cultivation type the investigated products are.

The PCG uses various panels. The consumer panel includes about 200 people, men and women of varying ages, and is used to determine which fruits are deemed to be most tasty and which properties are found to be superior or inferior.

The panels focus not only on taste but also on mouth-feel, juiciness, texture, and visual aspects of the food. The panel members possess an optimal sense of taste and smell. They are trained to recognise and review the different sensory components of each vegetable or fruit. This panel quantifies appearance, taste, texture, aroma and smell of a particular fruit or vegetable by using their human senses but in a systematic way, as if they were machines. By linking the results of the lab investigations as well as the taste panel, we gain insight into the characteristics that most determine the appreciation of vegetables or fruit by consumers.

Which vegetables and fruit have been tested so far?

In the beginning of September 2010, a consumer test with 67 consumers was done on vine tomatoes of eight races of an organic cultivation. The consumers evaluated the appearance, tastiness, taste, sweetness and acidity, texture, juiciness and firmness, and toughness of the skin.

In the end of August 2011 we performed a consumer test with 65 consumers on various races of pepper from an organic cultivation: seven races were tasted and all 21 sweet point paprikas in various colours, even light-yellow to white and purple bell peppers and spicy peppers, were evaluated for appearance.

In June 2012, four races of '*Coeur de Boeuf*' tomatoes from different organic farms were evaluated by 150 people for tastiness, taste, sweetness and acidity, texture, juiciness and firmness, and toughness of the skin. Also in June 2012, 306 consumers, which were selected based on gender and age, tasted the fruits of five strawberry varieties from organic and/or conventional cultivations and evaluated them for appearance, smell, tastiness, taste and texture.

Through publications in professional magazines or the PCG newsletter, the growers were informed about the results. This gave the growers additional information when choosing varieties to grow.

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Time for innovation in organic food processing

What are the strengths and weaknesses, opportunities and threats (SWOT) of organic food processing in Flanders? This research question is currently been studied by the Institute for Agricultural and Fisheries Research (ILVO), in collaboration with BioForum Flanders and Flanders' Food to support the strategic goals of the sector through operational actions and innovations in the coming years (through 2020). The goal of this feasibility study is to identify the hurdles for entrepreneurs and to reveal the opportunities for growth and diversification. Processors of organic food must be better positioned and must aim for export markets. Optimisation of the production can be an important asset.

ILVO gladly takes on the role of open-minded "sponge" that absorbs all the info … and processes it

The first step is a detailed SWOT analysis based on company visits, several brainstorming sessions and a literature study. The SWOT analysis is a model that analyzes the internal strengths and weaknesses and the opportunities and threats of the environment. Once the strengths and weaknesses, opportunities and threats are identified, the SWOT analysis will direct in which areas the innovation should be focused in the scope of the strategic goals. The processors of organic food have the ambition to increase their market share of organic food products up to 5% by 2020. This model should enable processors to think in a more structured way about their growth and innovation for organic processed food.

Helping innovation to happen

The value of this study is that the SWOT analysis must make both the strategic objectives and the possibilities for innovation tangible. We descend to the level of the operational objectives and actual projects. We emphasise the identification of potential for innovation in the organic processed food industry. Besides product functionality, aspects such as sensory quality, shelf life, conformity with distribution requirements, etc. are also important for the intended innovation plan. The investigated innovation needs include product innovation, process innovation, marketing and logistics.

Trying to answer all food processing questions

During this study, ILVO tries to provide suitable advice to the organic food companies that have specific questions. At ILVO's Food Pilot processing plant, processor can get answers to many technological questions. In this pilot plant facility, any processor can test (new) products or processes in practice. The Food Pilot is a collaboration of ILVO, Flanders' Food and IWT. For more fundamental questions, ILVO, together with BioForum Flanders, tries to find solutions by working with the relevant (inter)national research groups or by responding to the appropriate calls for project proposals.

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