Research 2013 - 2014

Organic Food and Farming in Flanders

NOBL
Netwerk Onderzoek Biologische Landbouw & voeding

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Content
Organic Food and Farming in Flanders: Research 2013-2014

Dear reader,

Publishing an overview of research for organic food and farming in Flanders is becoming a tradition. We now present our third edition, with a growing number of contributions. People have been working hard on research and knowledge exchange for the development of the organic sector in the past years!

2014 was a milestone year for NOBL (the Network for Organic Food and Farming Research). Together with its partners in the Flemish Organic Research and Knowledge network, CCBT (Coordination Centre for Applied research and Extension for Organic Production) and *Biobedrijfsnetwerken* (Organic Farmers' Networks), NOBL published the first joint 'Research strategy for organic food and farming Flanders 2013-2017'. This research strategy describes thematically which research efforts can contribute to the further development of the organic agriculture as an agro-ecological production model and to the further development of the principles of organic farming systems.

Ensuring that research results reach those who need them remains a challenge. We try to achieve this by actively involve farmers and other chain actors in the planning and implementation of research but also through broad dissemination of the results in ready-to-use and comprehensible language available via our websites (www.nobl.be, www.ccbt.be), newsletters (the NOBL-*berichten*, the *Biopraktijk*), and short leaflets (the *Biokennisberichten,* www.bioKennis.org).

To everyone who has contributed to this overview, thank you! To all taking this publication in hand, enjoy your reading!

Lieve De Cock, Coordinator of NOBL

Organic agriculture in Flanders

Organic agriculture in Flanders

In 2012 the total area of organicall-cultivated land reached the milestone of 10 million hectares or 5.7% of the total agricultural area in the 28 European Member States. In Flanders, the growth continues slowly but steadily. Annual growth in number of organic farms has averaged 6.5% over the last 5 years. In 2013, there was 45% more organic area than in 2008.

A closer look

The organic sector welcomed 20 new organic farm units in 2013. Half of this growth is located in the province of West Flanders. As of 2013, 319 certified organic farms (a 7% increase) manage a total area of 5.065 hectares (+2,5%). Forty-one producers were certified for direct sales and 50 organic farmers process their primary products on-farm.

Land in conversion totals 771 hectares of the organic areas: this is a 70% decrease compared to 2012. Half of the total organic area in Flanders concerns pastures and nature-value farmland. The decrease of the area in conversion can mainly be attributed to the latter category. Cover crops make up 17% of the organic area, arable cultures 15%, potatoes, vegetables and herbs 10% and fruit is cultivated on the last 8%.

Farms that are fully converted account for 67% of organically cultivated land. The other 32% belongs to farms that converted their farm in different phases or are in conversion. Strikingly, less than 10% of the organic farms account for almost 50% of the whole Flemish organic area. A quarter of the organic farms manage 1.5% of the total organic area.

Government expenses

Government expenses for the organic sector are estimated at 3.57 million euro in 2013. This is a 3% decrease compared to 2012. Of the expenses, 38% go to the farmers as investment support, premiums, conversion planning and compensation of control charges. One-quarter of the expenses goes to research and development, which is the same share as the previous year. Another 21% of the expenses are used for chain and market development, and the last 16% goes to the promotion and advertisement of organic products and the education of organic farmers. On top of these specific expenses, 966,000 euro of direct payments were provided to 117 organic farmers.

The organic market

The total expenses for organic products (food and non-food) in Belgium, as measured by the GfK Panelservices Benelux for VLAM, amounted to 403 million euros. This is an increase of 8%. The organic products hold a 1.6% market share in the total expenses of households. A great majority (88%) of the Belgian households bought at least one organic product during the last year.

The prices of organic fresh products in Belgium are on average one-third higher in comparison with conventional products. This price difference has remained stable over the years. The products with the highest price premium are organic eggs, which are two-and-a-half times more expensive than non-organic eggs. Organic meat substitutes are the cheapest: the organic and non-organic products cost nearly the same.

Supermarkets remain the most important distribution channel for the commercialisation of organic products, accounting for 44.1% of the sales. Specialised retailers and hard discount stores record a significant increase in their market shares: up to 13.5% and 2.7% of the total sales of organic products.

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Research organisation

Government of Flanders supports research for organic agriculture

The Strategic Action Plan for Organic Agriculture 2013-2017 has been running for almost two years. This plan, which reflects the policy for organic agriculture, is developed and carried out in partnership with the Government of Flanders, Algemeen Boerensyndicaat, Boerenbond, BioForum Vlaanderen, Comeos Vlaanderen, Fevia Vlaanderen *and VLAM.*

With an eye on qualitative and quantitative growth of the organic industry, balanced market development and the optimal development of the exemplary role of the organic production within sustainability, it is important that the organic producers can rely on knowledge and information in order to further optimise their farm management.Knowledge development and a continuous access to it are crucial. This knowledge is provided by the Flemish organic research and knowledge network (FORK network: NOBL, CCBT, and Organic Farmers networks) as well as international cooperation (Core Organic ERAnet, EIP-focus groups).

A selection of 2013 and 2014 activities

In 2013 and 2014 as in previous years, the Government of Flanders has continued to support the activities of the CCBT, the NOBL and the Organic Farmers networks. More information can be found on their websites: www.ccbt.be, www.nobl.be and www.bioforumvlaanderen.be/.

In 2013 the Monitoring and Study Division of the Department of Agriculture and Fisheries published the report 'Organic as teacher for and student of conventional agriculture: order learning of farmers and researchers'. Making agriculture more sustainable requires (system) innovations. That report explains how starting from the theoretical framework about order learning can strengthen the pioneering role that organic agriculture plays in making agriculture more sustainable.

In this period Flanders and the Netherlands started to collaborate to disseminate knowledge to organic producers through the project '*BioKennisberichten*', co-financed by the Government of Flanders. This collaboration resulted in a joint website, www.BioKennis.org, a one-stop site for all knowledge and information from Dutch and Flemish research for the organic industry.

Besides supporting research projects happening in Flanders, the Government of Flanders continues to stimulate research activities in a European context. The project 'Developing a framework for evaluating new strategies on organic farms' (research funds from 2012) delivered its first midterm report. The

projects submitted during a 2014 call for research projects will be evaluated in fall of 2014. Topics on crop and animal production could be submitted.

In the meantime three projects with Flemish partners (Bicopoll (UGent), Tilman-org (ILVO) en HealthyHens (ILVO)), funded within the European ERAnet consortium of research funders CORE Organic II ERAnet, finished their research at the end of 2014. The project "Cobra" (Organic crop breeding, Inagro & HoGent), financed within the second call of CORE Organic II, continues its research till February 2016. Within the recent research call of the CORE Organic Plus consortium, the project 'Soilveg' (Inagro, UGent, ILVO) was selected for funding. This project builds on results of the previous Tilman-org project (non-inversion soil tillage).

What the future will bring…

The new Minister of Agriculture, Joke Schauvliege, wishes to create opportunities for a whole range of farms: specialised farms as well as multifunctional farms with agri-tourism and short chain initiatives, urban agriculture initiatives, organic farms, care farms and each new form of broadening of activities and/or diversification. The further realisation of the strategic action plan for organic agriculture 2013-2017 is explicitly mentioned in the political coalition agreements within the Government of Flanders 2014-2019. Specifically in the field of agricultural research more attention will be given to agro-ecological innovation. This fits nicely the intentions of the Research strategy for organic food and farming in Flanders of the FORK network!

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Organic farmers' networks
(Biobedrijfsnetwerken)

In the organic farmers' networks (Biobedrijfsnetwerken), organic farmers meet regularly to exchange experiential knowledge. Much of the knowledge is not only the result of research in laboratories or research stations. Knowledge is often a result of individual farmers' research on their own farm experiences. Sharing this experience – getting experience of other farms, but also bring in experiences of one's own farm – is the driver behind these Biobedrijfsnetwerken.

Functioning of the networks

Most of the organic farmers' networks started in 2009 on initiative of *Bioforum, Landwijzer* and the Louis Bolk Institute in the Netherlands. The research centres and agricultural advisors involved in each industry are invited to participate in the meetings of the networks. 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 quickly on track 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 Research and 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 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.

Since 2009 new networks for dairy farming, goat farming, livestock farming, poultry farming, small fruit production, arable farming and outdoor vegetable production were added to the *Vakgroep Fruit*, a network of organic fruit producers that has been active for years.

Frequently the networks collaborate 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, the farmers also share their experiences in specific thematic groups (e.g. in the vegetable sector: short-chain, large scale 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*" (consultancy project for conversion to organic farming). 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* wish to share this experience with all those who want to work with farmers' groups in research, including conventional agriculture.

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CCBT vzw - Coordination of applied research 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 and berries
- 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.

One of the cornerstones of CCBT is to involve farmers in determining their research needs. Together with the farmers' networks and the research stations, research needs are defined and translated into projects. Since 2010, 46 short-term projects have already been set up.

CCBT 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 itself has a budget to finance projects, funded by 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.

CCBT in the Flemish organic research and knowledge network (FORK 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 research on organic farming. Our important tasks are to provide advice to the Government of Flanders and update 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. Since 2013 the FORK network has created a structural cooperation with the Netherlands to provide knowledge for organic farming for the entire Dutch speaking area: www.biokennis.org.

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

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

NOBL, the network on organic food and farming research, is anchored in the Flemish Organic Research and Knowledge Network (FORK network). NOBL was established with the aim of reflecting on how a more favourable research climate for organic food and farming could be created in Flanders. In the meantime the network has become a general platform to exchange information, ideas and experiences. It supports activities to promote research and knowledge creation and exchange in Flanders. The network brings together researchers, policymakers, farmers' organisations and representatives of other knowledge and research networks. Currently representatives from 17 organisations come together regularly, and the network is still growing. The Institute for Agricultural and Fisheries Research (ILVO) coordinates NOBL.

NOBL in action!

NOBL has many tasks and activities: besides organising regular meetings where members of the network visit each other to meet and learn about each other's work, the network is flexible enough to respond to the partners' current needs. Researchers and actors from the organic industry come together to find answers to current questions, formulate advice on priority research topics and explore new opportunities for funding new research projects. International cooperation and knowledge exchange is also stimulated via active participation in international working groups and networks (such as TPOrganics, COREOrganic ERA-NET, Organic E-prints, biokennis.org, etc.) and publicising NOBL as the contact point for organic food and farming research in Flanders.

NOBL no longer works alone; it has now joined with the CCBT (the Coordination Centre for Applied research and Extension for Organic Agriculture) and *Biobedrijfsnetwerken* (Organic Farmers' networks) to become the Flemish Organic Research and Knowledge Network (FORK network). 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 supports CCBT in the Flemish-Dutch cooperation for the

creation of one central online portal for knowledge about organic food and farming research in the Dutch-speaking language area: www.bioKennis.org. But NOBL and the *Biobedrijfsnetwerken* collaborate too. The farmers can count on the members of NOBL for finding answers to their needs and problems, and farmers in the *Biobedrijfsnetwerken* participate in research projects.

The cooperation between NOBL, CCBT and *Biobedrijfsnetwerken* resulted in the publication of the 'Research strategy for organic food and farming in Flanders 2013-2017'.

NOBL ahead!

NOBL keeps looking for new opportunities to improve knowledge development and exchange for the organic sector in Flanders. NOBL's doors are always open to new members wishing to reflect and collaborate on organic food and farming research projects.

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The Flemish Organic Research and Knowledge network: Bridging research and practice

Since 2012 the networks Biobedrijfsnetwerken (Organic Farmers' networks), CCBT (Coordination centre for applied research and extension for organic agriculture) and NOBL (Network for Organic food and farming Research) forms the Flemish Organic Research and Knowledge network (FORK-network). Drivers of the network are participatory research and knowledge exchange and dissemination of knowledge tailored to farmers.

Three networks, one mission

The three networks together with their partners make up the foundation of a research and knowledge network for organic food and farming in Flanders. In addition to their specific tasks, which are oriented towards various target groups (farmers, researchers, policy makers), these knowledge networks stress the importance of a coherent knowledge policy for the organic agriculture in Flanders. They tend to maximize the benefits of cooperation through the combination of complementary activities, multidisciplinary competencies and the avoidance of duplicate efforts.

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

Strength in unity

Continuous alignment between the networks allows the networks to bring different actors within the knowledge and research landscape in Flanders closer together and to create a closer collaboration between the actors. The tasks of the networks are aligned and complement each other as much as possible so that each network can work in an efficient way. So the questions and problems in the Biobedrijfsnetwerken for example, are put on the research agenda of researchers and policy makers by CCBT and NOBL. CCBT and NOBL look for funding and expertise to develop research projects. The in research created knowledge returns to the farmers via the different information channels of CCBT, NOBL and *Biobedrijfsnetwerken*.

This cooperation resulted in 2014 in the publication of the 'Research strategy for organic food and farming Flanders 2013-2017'. Based on its vision on sustainable and organic food production and consumption two general objectives are described:

- strengthening organic farming as a model of agro-ecological farming
- gaining expertise on the strengths of organic farming: soil fertility, biodiversity, environment, animal welfare, health,…

The FORK-network is willing to support research that is demand driven and implemented via a co-creative process. Different disciplines and expertise work together. Farmers and other chain actor are actively involved in the planning and the implementation of research.

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The Research strategy for organic food and farming Flanders

new

In 2014, the Flemish Organic Research and Knowledge network (NOBL, CCBT and Biobedrijfsnetwerken) (FORK work) published a first joint research strategy. Based on a vision on sustainable and organic food production and consumption the 'Research Strategy for Organic Food and Farming Flanders 2013-2017'describes thematically where research efforts can contribute to a further development of the organic agriculture as an agro-ecological production model and to the further sustainability of agriculture and society.

Vision

Over the years, a number of key relations within food production and between food production and consumption have been lost. Primary production often shows little connection with the natural environment of the ecosystem. And many modern consumers have no relationship with the origin of their food. To restore these relations, an integrative approach is needed which focuses on the total system. It is important to involve the entire supply chain in this process.

Organic agriculture opts for the development and implementation of autonomous, self-regulatory systems which operate on the basis of agro-ecological principles and are capable of preserving the proper balance in natural processes with a minimum of input. Organic agriculture limits itself to the use of natural inputs, which makes it possible to study the self-regulation of the internal (eco)system.

When looking for answers, sustainability in all its meanings and at all levels has to be considered. In addition to ecological and social sustainability, researchers should also keep economic viability, productivity, legal certainty and a long term development vision in mind.

Research areas

The research strategy describes three research areas which are highly interconnected:

- Robust organic production systems

Attention is given to optimising soil fertility, increasing biodiversity and implementing the best environmental practices and strong standard in the field of animal welfare. Innovative strategies and technological developments are essential in the further development and optimisation of the organic production systems.




- Flexible organic chain systems

To achieve stable market development, products should be available with a price/quality ratio that meets consumers' expectations and a price that covers the costs of the whole chain.

Optimisation, coordination, and cooperation based on the characteristics of the organic chain are necessary. Profitability, limiting risks and good competitiveness are central in the quest for economic sustainability. Economic sustainability cannot be separated from the social and ecological sustainability of the organic sector, however.

- High quality food

The organic consumer expects 'whole' food, where no vitamins, minerals or other elements need to be added. Processing of organic products is more than working with organic ingredients alone. It requires its own, flexible approach that must still largely be developed.

Research approach

Co-creative research where different disciplines and experts work together is focal in the development of research projects. Farmers and other chain actors are actively involved in the planning and the implementation of research. The FORK-network is willing to this facilitate the co-creative research process.

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Organic agriculture as teacher for and student of conventional agriculture

new

Not only (system) innovations are needed to make agricultural practices more sustainable. Farmers and other stakeholders must also have the capacity and willingness to learn. A recent study claims that organic and conventional farmers are able to learn from each other's practices. This learning may encourage sustainable innovations within both practices. In reality however, several obstacles hinder this process, which leads to either difficulties in accomplishing the results or a total lack of results.

Order learning

The theoretical framework on orders of learning is applied to explore these learning processes. This framework points out that every order has its own focus and depth of lessons learned, and that higher orders of learning are more difficult to reach. There are 3 orders of learning with specific characteristics:

- First-order learning focuses on efficiency improvements and verifies whether things are done right.
- Second-order learning focuses on improving effectiveness and checks whether the right things are done.
- Third-order learning focuses on (i) improving the functioning of the current knowledge system, (ii) the way we learn and (iii) what we consider as knowledge.

Opportunities to learn

Theoretically, there is an important distinction between the views of organic farming as a whole system versus organic farming as a shop of sustainable technologies. Techniques can rather easily be chosen and incorporated within one's production if they improve efficiency. These first-order lessons are relevant for organic and conventional agriculture. This information will be picked up more effectively if multiple information and communication channels convey the same message. Dissemination of the available knowledge (both Flemish and international) is facilitated if made available in a user-friendly language.

The switch from conventional to organic farming is an example of second order learning: known methods are abandoned and new, more sustainable paths are explored. The learning process does not stop with the decision to convert. To enhance interest in the switch towards organic farming, it is important to present organic farming in a positive manner to conventional

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farmers, advisors and suppliers. The last two groups will only change their conventional advice if they are also convinced of the added value of organic farming for their own business. For this reason, in knowledge activities themes relevant to both groups must be presented. Both groups can then gain new insights, but only if an adequate translation into practices is foreseen. Finally, conventional and organic researchers must develop common knowledge.

Third-order learning (better functioning of the knowledge system)

The current knowledge system makes it difficult for researchers to transcend their learning capacity limitations. Among researchers, the perception predominates that there are few opportunities for organic agriculture research due to a lack of scientific and social recognition. Formal structures, but also a receptive environment, culture and adjusted (knowledge) skills play an important role in developing, sharing and exchanging knowledge. The government, user committees, funding institutions and other stakeholders have an important role to play in boosting the number of active, formal knowledge sharing moments between the organic and conventional farming system.

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Agro-ecology - a new perspective on agriculture

Agro-ecology is not a new system, but rather a new concept. To find a way out of the current threatening lock-ins, all agricultural systems can be studied on the basis of agro-ecological principles and insights. In the first instance they lean on the ecological relationships between the natural resources that are used in agriculture.

Agro-ecology has three facets: transdisciplinary knowledge (from scientists), interdisciplinary agricultural practices (from farmers) and social movements (from society). The integration of these three facets has resulted in a common action mode that contests the dominant agricultural and food regime that is based on the intensive use of external inputs and develops alternatives.

Basic principles

The basic principles of agro-ecology include: (i) to recycle a maximum amount of biomass, (ii) to optimise the availability of nutrients and to restore equilibrium in the nutrient cycle, (iii) to preserve good growing conditions for the plants through the management of soil organic matter and to improved soil life, (iv) to minimise losses of the benefits of sunlight, water and soil, (v) to stimulate genetic diversity of crops and races in time and in space and (vi) to strengthen benign interactions and biological synergies. These principles can be translated further in a series of goals.

Intensify the South, detoxify the North

Agroecology appears as an important concept, certainly in the Southern hemisphere, to make optimal use of the possibilities for "ecological intensification" at an acceptable price. For capital intensive agricultural systems, solutions seem more complex. There is a general and large need for system research.

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Potential in Europe?

In the European Common Agricultural Policy (CAP) for the 2015-2020 period, there is already some maneuvering room to improve and support the economic and ecological performance of farms. However, the market orientation of the legislation and regulations is standing in the way of further application, and this, despite some research conclusions that this orientation has already reached its limits in terms of both ecological and economical robustness. It is expected that the application of a number of agro-ecological principles will more strongly present in the CAP after 2020.

France is currently taking the lead in agro-ecology, with strong initiatives through government projects as well as through research. In Belgium, there is a striking difference between agriculture in the southern region of Wallonia and the northern region of Flanders. Agriculture in Wallonia is more oriented towards crop cultivation, which is much closer to the agro-ecological principles. Flemish agriculture is economically stronger more intensive, more detached from the soil and more vulnerable for possible lock-ins or deadlocks.

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Robust organic production systems – arable crop and vegetable production

soil and soil management

crop protection

cultivation techniques and systems

varieties and breeding

technology

Soil management and soil quality in organic cropping systems: a matter of combination, observation and quantification

Soil management is decisive for soil quality. In turn, soil quality affects crop development and consequently crop yield and product quality. Soil management concerns soil tillage, fertilisation and rotation, including the use of green manures. The desired soil quality is attained by the right combination of cultivation measures. But which combination is best? And how can we tell when the desired soil quality is obtained? ILVO is looking for answers via different national and international projects.

Non-inversion soil tillage, green manure and compost

The TILMAN-ORG project (FP7 ERA-NET-CORE Organic II, 2011-14) aimed to combine non-inversion soil tillage and the use of green manures in order to improve sustainability of organic cropping systems, i.e. a high nutrient use efficiency, effective weed control, high biodiversity and increased carbon sequestration. ILVO was responsible for investigating nutrient dynamics and CO_2 emissions (soil respiration). For that purpose, a multi-year field experiment was set up on a certified organic field sown two years in advance with grass-clover as green manure. In the first phase of the experiment, the effects were investigated of the time and method of destroying the grass-clover sward on the nitrogen availability in the soil and the yield of the subsequent leek crop under a regime of mouldboard ploughing versus non-inversion soil tillage (Actisol®). Early destruction (March) of the grass-clover resulted in best nitrogen availability. Late destruction (May) after repeated mulching resulted in the highest marketable yield. Late destruction after harvesting a full-grown grass-clover cut resulted in the lowest residual mineral nitrogen content. Neither nitrogen availability nor crop yield was affected by tillage type.
Second, the fertilisation value of grass-clover as a 'cut-and-carry'-fertiliser (ensiled product) was tested under a regime of inversion versus non-inversion soil tillage.

Celeriac (celery root) crop yield linearly increased with dose (zero, ca 10 and 20 tonnes grass-clover silage per hectare). Non-inversion tillage negatively affected yield due to compaction in the arable layer caused by the leek harvest in autumn. As a third factor, farm compost application was tested what resulted in a higher yield due to the input of phosphorous and potassium. At Inagro a parallel and similar field experiment was conducted for demonstration.

Destruction of green manures

In the SoilVeg-project (FP7 ERA-NET-CORE Organic PLUS, 2015-17),

researchers will investigate the introduction and management of green manures. The roller-crimper technology will be tested as a termination strategy. With this technique, the green manure is pushed downward on the soil in its generative growing phase and bruised, after which direct drilling or planting happens in the vegetal mulch. The impact of the use of this technique on the development of the main crop, nutrient dynamics, soil quality, greenhouse gas emissions, weeds, pest and disease control and fuel consumption will be investigated in vegetable organic cropping system.

Search for a soil quality indicator

In the current CCBT project "Effects of soil management and fertilization on the soil microbiology. Search for a simple indicator for soil quality" different microbial detection methods (Rusch-test, phospholipids composition of the cell walls) and the molecular technique DGGE are evaluated as indicator for the general soil quality. This is done based on soil samples of treatments in (multiyear) field trials with soil management under certified organic growing circumstances held by different experimental stations (PCFruit, PCG, Inagro en PPK). Biological parameters as well as a number of chemical soil parameters will be determined.

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More info: www.ilvo.vlaanderen.be, www.tilman-org.net

Is soil microbiology a good indicator of soil quality?

new

Microbial activity plays an important role in many soil functions. Bacteria and fungi degrade organic matter and ensure the release and/or bonding of nutrients. In addition, a healthy and active microbial soil life improves soil structure and plays a role in the resilience of the soil.

Different objectives

Within this CCBT project, the partners Inagro, PCG, PPK, PCFruit, Organic Farmers' networks and ILVO examine together whether the Rusch test can serve as a good indicator of soil quality and whether this simple test can provide interesting information to the grower regarding his cultivation practice. In addition, we want to gain insight into the relations between soil management and soil microbiology in various sectors within the Flemish organic farming sector.

The exchange between more fundamental research (ILVO) and more practical research (applied research stations) is also an important aspect of the project: what do these microbiological tests teach us about soil quality and soil management of organic soils?

In search of a simple indicator of soil quality

The first part of the project consists of determining the soil microbiology on different organic fields across Flanders. Existing fertilisation experiments as well as currently-farmed fields will be examined. This allows us to explore the state of the soil under practical conditions with land that has been managed in the same way for several years. Three methods will be used to measure the soil biology.

The first of the three is the Rusch test, a relatively inexpensive and simple test developed by German doctor and scientist Hans Peter Rusch, which has seen little application as yet. This test includes a microscopic counting of the number of bacteria present in a soil extract in two ways. For the first technique, the soil extract is untreated and for the second technique, sugars are added to mimic the release of exudates in the soil by the roots. This results in the activation of the rod-shaped bacteria which are useful for plant growth. The greater the difference between the two techniques,

the better the soil quality in biological terms. The other two more complex techniques (PLFA and DGGE) will be compared to the results from the Rusch test to determine whether they all lead to similar conclusions.

The chosen fields/plots will be monitored for two years. During the first year, in addition to analysing the soil microbiology, a number of chemical indicators of soil quality will be measured. This may be partly explanatory for the observed differences in soil microbiology (TOC, HWC, pH KCl, Ntot). The second part consists of knowledge exchange on the possibilities to determine the soil microbiology by the different methods as well as on the possible relationships between the microbial life in the soil and the soil management in practice, as derived from the analyses.

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More info: www.biopraktijk.be, www.CCBT.be/projecten

Non-inversion tillage, compost and biochar applications as soil improving practices

Sustainable soil management should optimise soil condition in order to improve soil workability, reduce pressure from weeds, disease and pests, increase nutrient use efficiency, optimise the air-to-water ratio, and sustain crop yield and quality.

ILVO investigates how sustainable soil management can be accomplished, with a focus on (non-inversion) tillage and organic matter management. ILVO investigates the effect of these practices on nutrient dynamics, physical and biological soil quality, weed and disease pressure and crop yield. The research on soil improving practices such as non-inversion tillage and biochar and compost applications is based on long-term field experiments (BOPACT, BIOCHAR).

Results for compost and non-inversion tillage

In 2010, ILVO established the BOPACT field trial in Merelbeke. The name BOPACT refers to 'impact of compost and crop husbandry (tillage/fertilisation) on soil and pathogens'. The trial combines three factors, i.e. non-inversion tillage vs. mouldboard ploughing, cattle slurry vs. pig slurry and farm compost (2 tonnes C/ha.year) vs. no compost. The crop rotation consists of silage maize, potato, summer barley and leek. Cover crops are grown during autumn and winter.

In the first 4-year rotation, we could already detect effects of the treatments on soil quality. Non-inversion tillage caused a redistribution of organic carbon in the soil. The concentration of organic carbon in the top layer increased microbial biomass and soil aggregate stability, which makes the soil more resistant to erosion. After two compost applications, the organic carbon content and microbial biomass were already higher in the compost treatments compared to the non-compost treatments. We have not yet found a clear effect on the plant parasitic nematode *Pratylenchus penetrans*. The occurrence of the nematode was strongly dependent on the crop grown. The proliferation of the inoculated bacterial disease *Dickeya solani* was lower in the pig slurry plots compared with the cattle slurry plots, what could be explained by the higher N content of the potato tubers or the higher application of calcium with the cattle slurry. We could not detect clear effects of the treatments on crop yield and nutrient uptake yet.

Results for biochar

Since 2009, ILVO has been investigating the effect of biochar on soil quality, crop yield and disease pressure. Biochar is a stable, carbon-rich product of pyrolysis (heating without oxygen) of biomass residues. On the short-term, we have found some effects of the tested biochars, e.g. acceleration of the nitrogen cycle, nitrogen adsorption and pH increase. In 2011, ILVO established a field trial with biochar (BIOCHAR trial). However, little effect on soil and crop growth could be observed after 1-2 years. An exception is the longer term carbon sequestration, what is positive for climate change mitigation. In addition to two pure biochar additions, we applied a compost and co-composted biochar at the end of 2013. For the co-composted biochar, biochar was added at the beginning of the composting process. The field trial will be continued in the coming years to investigate the longer term effects. Note that only a few biochars have been tested. Biochar characteristics are variable depending on the feedstock and pyrolysis conditions.

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More info: www.ilvo.vlaanderen.be, www.fertiplus.eu, www.catch-c.eu

Good practices for sustainable soil management: performance and applicability

Through crop choice and rotation, tillage practices, and fertilisation, farmers can increase soil quality and therefore optimise crop yield and quality. What is the precise effect of 'good soil management practices' on diverse soil quality indicators and on crop yield? To what extent are these practices compatible with farm management? ILVO has tried to answer these questions by investigating long-term field experiments at the European level and by organising a farm survey in Flanders.

Compost and non-inversion tillage: results of the EU FP7 Catch-C project

The Catch-C project has investigated the impact of diverse soil management practices on crop productivity, soil quality (chemical, physical and biological), carbon sequestration and greenhouse gas emissions through results of a large number of existing long term field experiments performed throughout Europe. Compost applications and non-inversion tillage were two of the well-studied practices. The results show that both compost and non-inversion tillage can improve soil quality. They both contribute to carbon sequestration, increase chemical soil fertility and stimulate soil life. However, compared to ploughing and mineral fertilisation (reference practices), non-inversion tillage and compost applications lead to an average yield decrease. This average yield decrease is relatively limited for non-inversion tillage (-3%) and is especially short term (< 5 years) for compost. Given that research in Flanders has previously shown that yield decreases by non-inversion tillage can be caused by soil compaction that is not sufficiently lifted, it is sometimes advised to apply the non-inversion tillage at ploughing depth or to plough once in a while.

Compatibility of compost and non-inversion tillage with Flemish farm types

Despite the Catch-C project results which show that compost and non-inversion tillage can improve soil quality, the adoption rate of both practices is limited in Flanders. Based on interviews and large scale questionnaires in three regions in Flanders, ILVO has assessed the drivers and barriers, as perceived by farmers, to applying a variety of soil improving practices. This survey was performed for the dairy farmers in the Campine region (+ part of the Sand region), arable farmers in the loam belt and mixed farmers (vegetables-pigs) in the area of Roeselare.

The results of the farm survey show that barriers can have an economical, biophysical, legislative, human or social nature. These barriers vary between regions and farm types. By analysing differences in perceptions between adopters and non-adopters, we could gain insight into some potential misconceptions and we could search for control factors that seem to be less of a problem for adopters. These insights can help policymakers and extension services to stimulate farmers to adopt sustainable management practices on their own farm. Barriers experienced both by adopters and non-adopters can be the subject of further research. This farm survey was also conducted in 7 other European countries. We are comparing the results to get a better view on the adoption rate and most important drivers and barriers to apply certain practices at the European level.

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Limiting nutrient losses and improving product quality during storage of cattle manure by composting and ensiling

In the context of the Manure Decree and the Natura 2000 implementation ("PAS" - focus on reducing nitrogen emissions), ILVO is investigating whether the storage and processing of solid cattle manure could be optimised to reduce nutrient losses and obtain high-quality fertiliser. Are composting and ensiling appropriate techniques? The possibilities of composting and ensling are investigated in the lab as well as in the field.

Experiments in lab and field

ILVO is investigating whether composting and ensiling can optimise the storage and quality of cattle farmyard manure and the solid fraction of cattle slurry. The study includes several aspects: (1) nutrient losses to soil and air during storage, composting and ensiling, (2) differences in quality of the end products (non-treated cattle farmyard manure, composts, ensilage products), (3) effects of adding residual flows and additives on the composting process and the quality of the end products. These tests were conducted at field scale, with a simultaneous lab experiment using ensiling buckets and similar treatments. This provided a comparison of ensiling treatments at lab and field scale.

Preliminary results

Preliminary results indicate that organic matter degradation occurs when manure is composted or left untreated, but that the degradation process differs. Only minor differences in quality between the composted and non-treated farmyard manure could be observed, however. This could be due to either the straw-richness of the farmyard manure or the relatively small dimensions of the windrows, where the outer zone was relatively large compared to the total volume. A larger pile of non-treated cattle farmyard manure would increase the chance for undesirable effects and could negatively affect the quality. This could indicate that the storage of cattle farmyard manure rich in straw kept in relatively small piles is a smaller problem than often supposed.

Also the ensilage products have the potential to be used as a soil improver or fertiliser, as the material is rich in organic matter and nutrients are

expected to be easily available. In contrast to the composting process, ensiling resulted in only little organic matter degradation, indicating that organic matter decay will continue after the ensilage product is applied to the soil. This could have both positive (increased soil microbial activity) and potentially undesirable (increased emissions after application) effects.
Detailed results of this experiment will be available soon (Viaene et al., in preparation). The second part of this study, a set of incubation and pot experiments, is designed to reveal the effect of the various end products of the composting/ensiling process on soil and crop growth.

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More info: Viaene, J., Nelissen, V., Reubens, B., Vandecasteele, B., Willekens, K., in voorbereiding. "*Rapport Optimanure: Optimaliseren van de opslag en bewerking van vaste rundermest via compostering of inkuilen. "Beschikbaar via www.ilvo.be*

Waste as a soil improver: use of biochar in composting and during compost application

ILVO research within the FP7-FERTIPLUS project focuses on how soil quality can be improved by the application of biochar and compost, with the goal of reaching optimal crop growth, reduced nutrient losses and a higher soil and plant pathogen/disease suppression.

Convert waste to compost and biochar

The FERTIPLUS project assists the EU in the design and implementation of innovative strategies and technologies for recycling waste into compost and biochar for use in agriculture. Bio-waste has a great potential for conversion into bio-energy or as an alternative to chemical fertilisers. The core theme of FERTIPLUS is to ensure that good quality bio-wastes are returned to the soil in such a way that their nutrients are safely recycled, contributing to soil quality improvement and reducing the use of chemicals in agriculture.

Application of biochar during composting and in the field

The aim of the research on biochar at ILVO is to gain insight into the effects of biochar or compost blended with biochar as a soil amendment for temperate regions. Within FERTIPLUS, ILVO will determine the influence of biochar addition on the composting process and compost storage, and will evaluate innovations for creating added-value products. Furthermore, ILVO will set up and execute lab scale experiments and bioassays with different biochars, composts and biochar-blended composts and will continue existing field scale experiments with composts and biochar. The results of these bioassays, laboratory and field trials will allow for evaluation of nutrient dynamics, enhanced soil health and evaluation of overall soil biodiversity.

Blending biochar (10% on a dry matter basis) to the feedstock mixtures before the onset of composting process resulted in an enhanced rate of organic matter decomposition and more regular development of the composting process. By blending biochar in mature compost (at the end of the composting process) the readily available P in the tested composts

was reduced. By reducing the readily available P in the compost, biochar addition can help in reducing possible P leaching losses short after compost application. Mixing a low dose of biochar with a high C/P in a compost high in P resulted in a product with a higher C/P ratio, a higher organic matter content and a lower readily available P concentration than the pure compost. Biochar, compost and biochar-blended compost are further tested in the lab and in the field for agricultural and environmental aspects, i.e., crop yield, carbon sequestration in the soil, soil health and potential soil and plant pathogen/disease suppression, and reduction of the nutrient losses by leaching. A field trial with the pure biochar, the biochar-blended compost and the pure compost will be further monitored in coming years. One of the key deliverables of the project is a series of guidelines for the different materials produced in relation to the best application practices for an effective and safe use of the end products (biochar, compost and biochar-blended compost).

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GeNeSys: Valorising agricultural byproducts by composting

new

The GeNeSyS project (Use of By-Products as System Innovation) is the first Coordinated Action within ILVO's research strategy entitled ILVO2020. The aim of GeNeSyS is to perform transdisciplinary research in an innovative way to optimise the valorisation of byproducts from the agricultural and fisheries industries. In one of the four cases, ILVO is investigating the possibilities of composting agricultural byproducts. Compost application can contribute to a better soil quality and more fertile soils. These fertile soils, which are at the base of biomass production, are a prerequisite for food production and other future bio-economy activities. Moreover, nutrient and material cycles are closed locally when byproducts are valorised on the farm.

Bottlenecks

The first phase of the research project was to generate ideas about different hindering factors and identify opportunities for composting and compost application in Flemish agriculture and horticulture. To identify those hindering factors and opportunities, approximately 70 stakeholders from diverse stakeholder groups such as farmers, supply chain members, technologists, scientists and policymakers were interviewed. The information gleaned from these interviews helped to refine the research questions and approach. The relevant stakeholders are also involved in subsequent participatory research steps to help ensure that the identified problems are tackled from diverse scientific disciplines. Also practical knowledge is integrated to identify, formulate and develop solutions for the multidimensional challenges.

The first idea-generation phase indicated that compost is not commonly used in Flemish agriculture, although the majority of the farmers are aware of the positive effects of compost application on soil quality. This revealed that some obstacles that are hindering on-farm composting and the use of compost. Therefore ILVO is investigating some technical aspects such as composting 'difficult' feedstock materials such as wet crop residues and animal manure, i.e. feedstock that can lead to nutrient losses if not properly processed. In addition, the shortage in brown or carbon-rich materials and the search for alternative brown byproducts is investigated.

Looking for solutions

The first research phase also showed important policy, logistical and economic factors that hinder on-farm composting and compost application in agriculture. This is investigated in several case studies of different organisational forms of composting. The four cases are:

1) On-farm composting on a biodynamic mixed farm with supply of byproducts from the nature management sector (wood chips and clippings), mixed with farmyard manure and hay.
2) On-farm composting of wooden byproducts from pruning trees on a tree nursery, mixed with farmyard manure from a neighbouring farmer. The composting process is executed by a composting company on the farm premises.
3) Cooperation between different farms and nature conservation agencies to compost farmyard manure, crop resides and clippings.
4) Opportunities to export byproducts (e.g. leek residues) from the farm to a composting company, where agricultural-grade compost can be bought.

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Effect of farm compost application and crop rotation on soil quality and crop yields in Flanders

A high level of soil quality may become an important basis to optimise yield, nutrient use efficiency and disease-suppressiveness of the soil. The application of farm compost and crop rotation are two potential agricultural management practices for sustaining or improving soil quality.
Farm compost made from ingredients available on the farm (e.g. manure, straw, crop residues and surplus grass) may contribute to the buildup of organic matter in soil and may improve soil structure, soil life, soil fertility and eventually crop yields. Growing crops in rotation may reduce the use of external inputs through internal nutrient recycling and prevent the proliferation of diseases and pests.

Sustainable soil management research

ILVO investigated the effect of farm compost application and the use of crop rotations on soil quality and crop production. The research was conducted as part of a PhD study in cooperation with Ghent University (Department of Plant Production). Two long-term field experiments at Ghent University's experimental farms were intensively monitored for several years.

The farm compost trial (*boerderijcompostproef*) was initiated in 2004 and combines a crop rotation (potatoes, fodder beet, forage maize and Brussels sprouts) with an annual farm compost (FC) amendment. The crop rotation trial (*vruchtwisselingsproef*), started in 2005, compares several maize-based cropping systems at different N fertiliser levels. Both experiments are ongoing. In 2009 and 2010, a wide range of chemical, physical and biological soil properties were determined on both field trials.

Our results demonstrated that the repeated amendment (seven years) of FC improved soil fertility and structure and significantly increased the soil organic carbon content. Besides that, FC stimulated soil life (more earthworms and microbial biomass) and significantly reduced the amount of plant-parasitic nematodes (on average -30%). Crop yields also increased significantly after the fourth annual FC application. The positive effect of continual FC amendment on crop yields was attributed both to a slow release of nitrogen and to an increased soil organic carbon content. The specific trial setup prevented us from fully separating the nitrogen and the carbon effect in the soil.

Results from the crop rotation trial revealed no significant effects on overall soil quality or crop yields that could be ascribed to the introduction of a grass-ley or an extended crop rotation that includes field pea and potato compared to a monoculture silage maize (+ Italian ryegrass as a cover crop) at a common N rate of 150 kg N ha-1. We suggest that the relatively short time period of this experiment (5 years) was not long enough to fully express the cropping effects on both crop production and soil properties.

From our results it can be concluded that after a period of 6-7 years, the repeated application of farm compost improved soil quality to a higher extent compared to introducing a grass-ley or an extended crop rotation.

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Manures and MAP4 throughout the Flemish organic sector

Organic farming relies on 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 since the latest version of the manure legislation (MAP4), phosphorus has become the limiting factor. Fertilisation strategies (type of fertiliser, volumes, time of application, among others) had to be adjusted. As a result, shifts occurred in the deposition of organic manure. In addition the organic legislation required that all organic manure should be deposited on organic fields.

Closing the organic nutrient cycle

The demonstration project "Organic fertilisers and MAP4 throughout the organic sector" addressed the most important sectors of the Flemish organic agriculture. It had 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 nutrient cycle for the entire Flemish organic farming sector.

The project offered support to the organic farmers for the implementation of MAP4 through demonstration of organic fertilisation strategies for different organic sectors, respecting the norms of MAP4, the organic farming legislation, good soil management and the organic matter content. Hereby, the optimization of the crop production was kept in mind, with special attention for the economic conditions.

New fertilisation strategies

Based on the results of the ADLO research project "Optimal use of organic manure from poultry and ruminants for a healthy organic crop", possible (new) fertilisation strategies were put into practice in various sectors during 2012 and 2013. All strategies took the abovementioned aspects into account.

The fertilisation trials on vegetables and potatoes showed that the conventional fertilisation recommendations are often too high for organic farming because they do not adequately reflect the impact of the multiannual accumulated soil fertility and the contribution of leguminous green manures, among others, to the nitrogen availability. An adapted set of recommendations seems necessary for optimal yield and minimal NO_3 residue. Furthermore, the impact and potential of manure, compost and ready-made fertilisers was investigated.

completed

Regarding the NO_3-residue in strawberry cultivations, soil management and cultivation practices seemed more important than the type of fertiliser. In a follow-up CCBT project, PPK will continue the search for optimal fertilisation strategies for berries. pcfruit will also continue to look for optimal fertilisation strategies for organic pears, in cooperation with the organic growers. The fertilisation of fruit crops based on poultry manure seemed difficult to sustain because of too much P and too little N.

The phosphate standard in MAP4 makes it difficult to deposit poultry manure in Flanders. The Poultry Research Farm examined measures that the organic poultry farmer can take to maximise the N/P ratio of the manure. Feasible solutions are found in the reduction of the N emissions in the stable and during manure storage. Fertilisation trials on clover showed that poultry manure provides opportunities for this crop.

All of these issues were widely discussed during organic farmers' networks, open field days and meetings of technical committees and groups. On February 19, 2014 the project partners BioForum, CCBT and Inagro organised the conference 'Organic, soil and fertilisation' in cooperation with ILVO.

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Location: Various locations throughout Flanders
Financiering: ADLO, Department of Agriculture and Fisheries, Government of Flanders (2012 - 2013)
More info: www.biopraktijk.be, www.CCBT.be/projecten

Which green manure to plant, when?

When striving to maintain a balanced phosphorus supply, animal manure is not sufficient for the nitrogen requirement of vegetable crops. Leguminous green manure crops can help to bridge this gap. Depending on the sowing time and the growing period, different leguminous plants are best. The CCBT project 'Leguminoos – grandioos!' *explored some opportunities for legumes as green manure.*

Sowing in wheat stubble or after early vegetables, end of August

At the end of August, leguminous plants (common vetch, Egyptian, red or crimson clover) were sown either alone or in combination with bristle oat (*Avena Strigosa*). By mixing the leguminous plants with bristle oat, the benefits of both components are combined: bristle oats provided good weed suppression, while the leguminous plants ensured nitrogen delivery for the successive crop. Except for the plot with pure Egyptian clover, a good weed suppression was achieved in autumn as well as in spring. The subsequent nitrogen delivery in the successive vegetable crop stayed below expectations, however. A possible reason for this is that the released nitrogen was partly absorbed by the bristle oat. Winter-hardy leguminous green manures (red clover or crimson clover) regrow in spring and fix some additional nitrogen which benefits the successive crop to a limited extent.

Sowing in autumn after late vegetables

After a late-harvested vegetable, winter-hardy leguminous green manures such as winter vetch, forage peas and winter field beans can be sown. Field beans leave too much space and let weeds develop. Forage peas and winter vetch offer good potential if they can develop into a full crop during spring. Two months after incorporation of these green manures into the soil, a surplus of 70 kg NO_3-/ha was measured in the tillage layer in comparison to winter rye as a green manure.

completed

Regrowth of crimson clover in spring between straw of frozen bristle oat - 18/06/'13

Sowing in spring before late vegetables

In the case of planting vegetables in late spring or in summer, there is time to sow a leguminous green manure. Egyptian clover, common vetch and summer field bean were compared to phacelia (*Phacelia tanacetifolia*, not leguminous) and left fallow. Weed suppression and damage caused by herbivores were points for attention in all leguminous crops. Field beans and common vetch showed a significantly higher nitrogen delivery in the soil four weeks after planting of the successive vegetable crop.

Conclusion

This project revealed several potential options to implement leguminous green manures. Further research, however, is needed to optimise these opportunities.

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Nitrogen dynamics in relation to soil condition

To which extent and in which time span will soil management measures contribute to the improvement of soil condition? How decisive is soil condition for crop and environmental quality? Which impact do soil condition and soil management have on nitrogen dynamics in the soil and on nitrogen utilisation of the applied fertiliser? A survey of 30 farmers' horticultural fields took place and a multiyear field trial was performed to answer these questions.

Effects of compost and non-inversion tillage in a multiyear field trial

In the multiyear field trial soil management (2009-2011), a variation in soil condition was created by (i) applying different doses of farm compost (0, 15 en 45 tonnes per ha per year) and (ii) practicing non-inversion tillage (Actisol) versus inversion tillage by mouldboard ploughing. The rotation consisted of broccoli - carrots - leek.

Significant differences between soil management regimes concerning organic matter and nutrient dynamics and soil biology were found in the short term. Differences in soil quality were most clear for the 0-10 cm soil layer. Differences in nitrogen dynamics were small enough that they did not call for a change in nitrogen fertilisation. In the third experimental year, no difference was found in the nitrogen utilisation by leek of a top mineral N dressing. Compost sustained the conservation of the organic matter stock. The nitrogen mineralisation potential in the 0-10 cm soil layer was higher in case of non-inversion tillage (incubation trial) which corresponded with the higher organic matter content in this layer. In case of non-inversion tillage, mineral nitrogen is located higher in the soil profile, by which it is easier to access by the crop's root system. This phenomenon was observed as well with regard to the distribution of potassium and magnesium in the soil profile. The effect of non-inversion tillage on crop yield was limited and year and/or crop dependent.

Nitrogen dynamics on farmers' fields 2009-2011

Leek was grown in 2009 on the fields under consideration. Nitrogen dynamics in the soil-plant system were assessed via extensive sampling and analysis of soil and crop and evaluated in relation to pre-crop, nitrogen fertilisation, planting date and soil quality.




In the first half of the growing season, the availability of mineral nitrogen in the soil profile was affected by the nitrogen fertilisation and the organic nitrogen content in the arable layer (indicator for potential to supply nitrogen). In the second half of the growing season, the utilisation of nitrogen supplied from soil and fertilisation was also related to the organic nitrogen content (indicator for soil quality). In the first half of the growing season, the soil was a source for plant available nitrogen whereas in the second half of the growing season, microbial immobilisation took place. The factors that may have affected the residual nitrogen (mineral nitrogen up to a depth of 90 cm) at the end of the growing season were investigated for a two-year period 2010-2011. Crop choice, fertilisation, organic matter content and crop rotation were considered.

Nitrogen fertilisation advice

The basis for advice on nitrogen fertilisation in vegetable cropping systems can be improved based on knowledge of the nitrogen dynamics. Crop nitrogen utilisation will improve and the risk of nitrogen losses will decrease when fertilisation is attuned to the crop's need and the amount of nitrogen that becomes available from the soil.

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Soil P availability and P leaching risk in long term compost and farmyard manure amended soils

Amendments of compost based on plant material and dairy farmyard manure help to increase the soil organic carbon levels, but also influence soil P availability and P leaching losses. This was observed in several long-term fertilisation field trials conducted by ILVO, Ghent University and INRA (France). The sampling took place in the context of an ILVO-KU Leuven doctoral research project.

Towards more soil organic matter and fewer P losses

Many agricultural soils in Flanders contain high amounts of phosphorus (P). These soil P amounts exceed the crop's needs and are an important source of phosphorus leaching losses. P fertilisation is currently restricted to address P leaching losses. However, these measurements also restrict amendments of organic fertilisers, applied as a source of organic material to increase the soil organic carbon level. The farmers' desire to increase or at least maintain the soil organic carbon levels must be balanced by a halt to increasing phosphorus leaching losses. This research question thus became 'What is the impact of different types of organic fertilisers on P leaching losses?'

Soil P availability and P leaching in relation to fertiliser type

Five long-term field trials were sampled to determine the soil organic carbon level, the soil P availability and the soil P stock (ammonium lactate extract, P-AL). The soil P availability was measured as P-$CaCl_2$ (0.01 M $CaCl_2$ extract) and HWP (hot water extract). Soils were also transferred to the lab to conduct leaching experiments as a proxy for P leaching losses from the tillage layer. We observed in fertiliser field trials from Ghent University (°2005, silt loam) and INRA (France)(°1998, silt loam) that dairy farmyard manure and composts based on plant material have a comparable potential to increase the soil organic carbon level in the long term. However, the long-term amendments of dairy farmyard manure also significantly increased the soil P availability and P leaching risks as compared to compost amendments at an equal rate and to non-amended soils. This was confirmed with a sorption experiment with radioactive labelled ortho-P. It is remarkable and unexpected that application of composts did not reduce the ortho-P sorption of the soil, compared to zero-P fertilised control soils. The underlying

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mechanisms are still not fully understood and need more attention in future research. In a data survey based on six long-term fertilisation field trials, it was observed that P leaching in soils with a high P status (high P-AL levels) were determined by the soil P availability.

Conclusion: farmyard manure or compost?

Based on the results of this project, we concluded that the type of organic fertiliser used has an important influence on the soil P availability and P leaching. Composts based on plant residues seem to be a better option to increase the soil organic carbon levels without increasing the risk of P losses in comparison to dairy farmyard manure in soils with a high P status. In soils with low P stocks (low P-AL levels), however, where too-low soil P availability can create problems, dairy farmyard manure seems to be a better option than composts.

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Fertilisation in organic vegetable cultivation in 2014

For vegetables with high nitrogen requirements or a long growing period, organic farmers often opt for manure as basic fertilisation. However, the norm for phosphorus in the Flemish fertilisation action plan (MAP 4) (max. 55 kg/ha for vegetables and potatoes) limits the amount of nitrogen that can be applied in the form of manure. Compost in combination with slurry or organic granular fertilisers may offer more possibilities. One new trend is the use of 'cut-and-carry fertilisers'. The aim is to cut crops such as grass-clover and alfalfa and use them as fertiliser on another field.

Since 2013, organic farmers are obliged to ask for 'nitrogen advice for vegetables' when planning to grow certain vegetable groups. Advice based on a soil sample during the growing season is also useful for additional fertilisation in both conventional and organic cropping systems.

Research on fertilisation in organic vegetables

Following the more restricted fertilisation norms under MAP 4, the Department for Organic Production at Inagro performed fertilisation trials in several organic crops (leek, cauliflower, potatoes and grass-clover). In these trials, the feasibility of the basic fertilisers (manure, slurry, compost or cut-and-carry fertiliser) as well as the need for additional fertilisation with organic granular fertilisers and their dosages was examined. This research was partly carried out in the context of the ADLO demonstration project 'Organic fertilisation and MAP 4 throughout organic production' and partly by own funds of the Department for Organic Production at Inagro.

KNS advice not readily applicable in organic crop production

Fertilisation trials in leek, potatoes and cauliflower in 2012 and 2013 showed that the conventional fertiliser advice is not readily applicable to organic conditions. The target values used by conventional recommendations seem to be too high for organic production. The recommended higher nitrogen application is more expensive, gives little or no yield surplus, and gives rise to a higher nitrate residue in the soil after the crop. Nevertheless, limited additional fertilisation based on an interim soil sample analysis is useful. Some experience in organic cultivation is needed, however, to interpret

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the values of this analysis. The actual development of the crop, the soil condition and the history of the field have to be taken in account, amongst others. Therefore Inagro is further developing recommendations adapted to organic conditions.

Cut-and-carry fertiliser looks promising

Depending on the quality of the cut-and-carry fertiliser used, different results were obtained in several trials. An old, fibrous cut of alfalfa had a negative effect as a fertiliser in potatoes in 2012. With a high-quality grass-clover silage in 2013, a yield surplus of 7 tonnes per hectare was achieved in comparison to a basic fertilisation with manure. In the first crop of cauliflower in 2014, the same nitrogen availability and crop yield was achieved with cut-and-carry fertiliser as with organic granular fertiliser with an identical nitrogen content. Further research is needed for the practical application of cut-and-carry fertilisers.

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Monitoring nitrate nitrogen in organic fruit orchards

Organic fruit growers are faced with fertilisation questions after passage of the 4th Flemish Manure Action Plan (MAP4) which includes stricter requirements regarding nitrate nitrogen in autumn and other issues. 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. Better understanding of this process is important to reduce the risk of penalties and restrictions of the Government of Flanders. The organic fruit growers also need to improve their view of the needs of the crop. The question is whether the organic fertilisers can ensure that the trees absorb enough of the nutrients they need.

Inhoudelijke omschrijving van de proef

In MAP4, both nitrogen and phosphorus fertilisation are under pressure. Organic fruit growers face two major constraints: knowledge of the nitrogen reserve (including residual nitrogen in autumn) and the restriction of the phosphorus fertilisation by 2015 required 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*" (a group of organic fruit growers) to follow the evolution of the nitrate nitrogen during the growing season. Per parcel, a comprehensive soil analysis was performed to determine the humus content and the content of nutrients at the start of this project. The fruit growers were asked to make detailed records of all cultivation measures such as mechanical weed control and spreading of organic manure, so that these data could be included in the interpretation of the results. Finally, by means of leaf and fruit analyses, the mineral composition was determined to compare the uptake of nitrogen with the values in the soil.

In addition, in spring 2012 a trial with different nitrogen levels in one of the parcels was established. In this trial also the fruit quality (firmness, sugar content, starch value and colouring) was determined at harvest and after storage.

Monitoring nitrate nitrogen in different organic fruit orchards

In 2012, one apple parcel exceeded the residual norm of 90 kg NO_3-N. Interestingly, this excess did not arise from fertilisation but rather from natural mineralisation; the C content of this parcel was very high. None of

completed

Toedienen van organische mest

the other parcels exceeded of the residual norm of 90 kg NO_3-N in the upper 90 cm. In 2013 no parcels exceeded the residual norm of 90 kg NO_3-N.

There was a large variation in fertilisation of the trial plots. Despite this variation, all parcels had good levels of minerals in the fruits. Caution is still needed regarding phosphorus and potassium levels in the soil. All forms of organic fertilisation still contain high levels of K and P. The continuous use of organic fertiliser can be a problem, especially for potassium during storage when the K/Ca ratio becomes too high.

Monitoring nitrate nitrogen in an organic fruit orchard with different nitrogen levels

Blood meal is a quick source of nitrogen. However, when the soil temperature in the period of the fertilisation remains too low, the tree only absorbs a limited amount. Raising the dose at that time has no sense. As established in the spring of 2013, a high nitrogen level may even be detrimental to the flower bud formation. N from soy is available later for the tree compared to blood meal. This allows the tree to absorb more nitrogen, as the root activity is higher later in the growing season. But the absorbed nitrogen is not always necessary for the fruits.

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Funding: CCBT-project 'Opvolging N-min in biologische fruitaanplantingen' (Department of Agriculture and Fisheries, Government of Flanders) (1/4/12 - 31/12/13)
More info: www.CCBT.be/projecten

Different types of fertilisers to be compared in an organic Conference pear orchard

new

Until now, little attention has been paid to fertilisation in organic fruit growing. This means that continuity of production and good storage quality are not always obtained. Until recently, organic fruit growers only worked with a fast-acting nitrogen such as blood meal or a slow release manure or slurry. Organic digestate is now also offered to the fruit growers, which besides N and P also contains high levels of K. Since pears do need some potassium, this product might be best suited to the needs of this crop. The question is whether this digestate will release sufficient nitrogen around the bloom for a good nitrogen content in the fruit.

Use of digestate as alternive source for N

For Conference pears, N and K are the most important nutrients. These elements, present in organic digestate, may make digestate a suitable fertiliser for pear growing. But there are a number of potential problems. The nitrogen of digestate is released slower compared to blood meal but just around bloom the pear trees need good nitrogen uptake. Will the nitrogen in the digestate become available in time? If not, more digestate could be applied, but this would give disproportionate amounts of potassium. Too much potassium can be a problem for the uptake of other nutrients such as Ca and Mg.

A high nitrogen gift in combination with hoeing, a classical weed control method used in organic fruit growing, can cause a peak of nitrogen in the soil. The question is whether this nitrogen will be absorbed or will leach into the groundwater. A comparison of two levels of digestate was therefore needed.

Use of soy meal

Soybean meal is used in organic vegetable growing (PCG - Kruishoutem), but it has not been tested in Conference pear growing. This product contains mostly nitrogen and would have a longer effect than blood meal. Soybean meal will thus also be tested in this project.


Taking of samples

Effect of hoeing

In order to get a better view of the release of the nitrogen of the different fertilisers, in particular as a result of hoeing, two soil samples (one before hoeing and one a few days after hoeing) will be taken in spring to determine the NO_3-N-content in the top layer of the soil up to 30 cm deep. In autumn, also the residual nitrogen to 90 cm deep shall be determined. At the same time we shall look at the fruit quality and the leaf quality.

In spring 2014 a comparative trial with 8 different objects was started in a parcel of an organic fruit grower (Yvan Verhemeldonck – Halen). The 8 objects that were chosen in autumn 2013 in agreement with the *Vakgroep Biologisch Fruitteelt*. The selection is based on the results of the CCBT project "Monitoring nitrate nitrogen in organic fruit orchards" and the ADLO-demo project "Manures and MAP4 throughout the Flemish organic sector."

Results

No results are available yet.

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More info: www.CCBT.be/projecten

Potential uses for mycorrhiza in apple orchards

new

The lack of uncultivated soils (where no fruit trees have ever been planted) is a significant problem in Flanders and worldwide. This can lead to replant disease, which is currently causing some problems for the growth of apple trees in Flanders.

Cause replant disease

Factors causing this disease can be either abiotic (soil structure, drought and cold stress, mineral content soil, pH, etc.) or biotic (a complex of nematodes and fungi). But research indicates that the major cause is a complex of nematodes and fungi. Besides the problems with replant disease, climate change will also have an important impact on fruit growing. Climate changes such as extreme weather conditions (prolonged drought periods and heat waves) are already occurring and can cause drought stress in apple trees and other problems. The frequency of such drought periods is expected to triple. Apple trees will need to be able to cope with these problems in the future.

Potential role of arbuscular mycorrhiza (AMF)?

Mycorrhizal fungi (in particular arbuscular mycorrhizal fungi (AMF)) may be useful to address these problems. AMF, which form a symbiosis with roots of about 80% of all plant species, are abundantly present in the soil of most ecosystems. AMF originate from the soil and can provide long-lasting solutions. The AMF-root symbiosis allows plants can take up more water and nutrients from the soil. Trees therefore can have a better growth and less fertiliser is thus needed to obtain the same growth. Furthermore, the extra uptake of water and nutrients trees leads to lower susceptibility to stresses, including drought stress. Furthermore, AMF ameliorate the soil structure by producing glomaline and expanding the root system.

AMFs in pome fruit

Various products with mycorrhiza are available on the market, but those mycorrhizal strains do not originate from apple orchards. In this project, the mycorrhizal populations in apple orchards are investigated. This research has shown that a high diversity of AMF is present in apple orchards. Different AMF from these orchards will be grown and multiplied to perform some field trials with a mix of AMF originated from apple orchards. The efficacy of those mixes towards apple replant disease and drought stress will be evaluated.

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Optimising fertilisation for organic berries

new

The organic sector of berries and other small fruit is a very diverse sector in full expansion. There is a wide range of crops and many different cultivation methods and fertilisation strategies. Organic commercial fertilisers, compost, waste materials or a combination of these are all possible fertilisers. The fertilisation of small fruit affects not only the production of the current year, but also the production of the following year. When fertilising, the grower may or may not follow a recommendation that is based on soil analysis. From interaction with practitioners, it seems that fertilisation recommendations are sometimes misinterpreted in the (organic) small fruit sector. In addition, information on specific fertilisation needs of (organic) berries is currently lacking.

Objectives of the project

The first objective of this project is to inform practitioners about correct application of fertilising advice, within the limits of the Flemish fertilisation legislation. The second objective is to refine the knowledge about fertilisation needs of (organic) berries:

- to gain a better understanding of the nutrient requirements of organic small fruit and the effect of fertilising strategies on yield and shoot development;
- to further explore the potential of leaf analysis and plant juice analysis;
- to gain a better understanding of the influence of tillage (e.g. mechanical weed control), sowing of a green manure and other techniques regarding nitrate residue in autumn.

On-farm fertilisation trial

In an on-farm fertilisation experiment, different fertilisation strategies are compared with regard to their effect on yield and crop development of primocane-fruiting. Harvest data, number of shoots, length of shoots, number of buds and total aboveground biomass are registered, so that relations between the applied fertilisation strategies and the production can be indicated. During this trial, the use of plant juice analysis is also explored, to see whether this tool can be useful to estimate and adjust the fertilisation of organic berries. Links between soil, leaf and plant juice analyses are investigated. The fertilisation trial consists of 5 objects in 4 repetitions. The fertilisation strategies are chosen in consultation with the project partners and the practitioners:

- object 1: zero fertilisation
- object 2: 50% NPK advice
- object 3: NPK 100% advice
- object 4: NPK 150% advice
- object 5: NPK 200% advice

Testing the effect of different management techniques on the nitrate residue

In a second field trial, the effect of sowing of green manure, mechanical weed control and possibly other techniques on the nitrate residue will be determined. To protect water quality, a low nitrate residue in autumn is important. The timing of weed control, sowing of green manures, etc. are activities that can have an influence, but sufficient insight into their effect is lacking. The effect of these techniques on the nitrate residue will be measured.

Study based on specific fertilisation strategies on farms

Short-term fertilisation experiments provide useful insights, but for a perennial crop like berries, the fertilisation history also plays a major role. A great deal of unexplored information about the effect of certain fertilisation strategies on the evolution of the organic matter and nutrient content of the soil can be found at the farms of the berry growers themselves. By means of a survey, the fertilisation history of a few farms will be linked with the current soil condition and performance. The aim is to reveal certain trends and thereby inform other growers about how their colleagues cope with fertilisation.

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More info: www.CCBT.be/projecten

Lowering the soil pH in organic growth of berries by using pine forest sod

new

Small fruit cultures require mildly acidic to very acidic soil. For blackberries and raspberries, the required pH is 5.8 to 6.5, for blueberries it is even lower: between pH 4.0 to 5.0. Contrary to the conventional growing systems, organic cultivation does not allow the use of acidifying fertilisers or the use of acidified water. This is one of the major problems for the profitability of organic small fruit production.

Possibilities for lowering soil pH

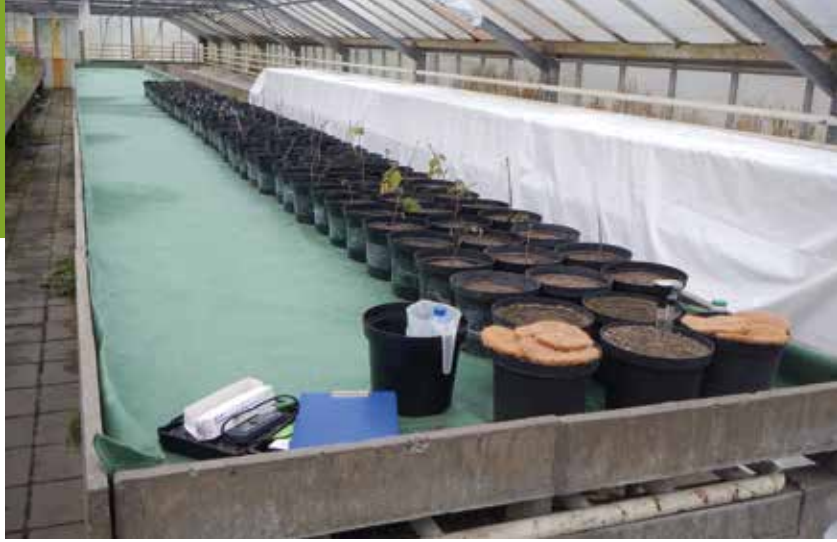
At the request of the sector, Research Centre Pamel started exploring the possibilities to obtain/maintain a sufficiently low pH in organic berry growing. An exploratory project, financed by CCBT in 2011, showed that the use of compost only had a limited impact on the pH, while the use of irrigation water had a larger impact. Trials were set up to determine to what extent the soil can be acidified by use of elementary sulfur and by-products based on Lactobacillus spp.

Does the use of pine forest sod offer a solution?

Heathland can be repaired by cutting swaths of sod and scraping off the top layer of the forest floor after chopping down the pine forest. After removing the rather acidic top layer (sod), the seeds of heathland-plants can germinate from the historic soil seed bank.The sod pieces contain the humus-rich soil layer of 5 to 10 cm together with the top layer of organic litter. In the Research Centre in Pamel, a master student of KU Leuven is studying the possibilities to use this pine forest sod to lower the soil pH in berry cultivation.

Characteristics and quality of sod

First, some characteristics of the sod will be determined, i.e. the initial pH. Through germination trials, possible weed pressure is mapped. Additional analyses will test for microbiological presence in the sod.



Trial in pots and trial in the field

In a greenhouse in Pamel, a trial has been set up in which pots are filled with soil mixed with sod (different concentrations, different treatments). The evolution of the pH in these pots will be measured, together with other parameters. In the second phase an on-farm field trial will be set up. The first results are available in spring 2015.

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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 better aligned with the crop needs?", "Does the crop react differently to another kind of fertilisation?"

Nature, types and varieties - plant versus animal fertilisation

The grower usually applies 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 fertilisers that vary in origin and cost.

Soil and leaf juice analysis

It is relatively easy to investigate the amount of nitrates in the soil using soil analysis. This, however, does not show the amount absorbed by the plant at that point, nor the needs of the plant. Leaf juice analysis using both rapid testing and profound analysis, helps to give an idea of what happens in the plant. With this technique we can better adjust fertilisation to the need of the crop. During rapid testing the nitrogen and potassium of the stems are measured. During the profound analysis, a whole series of elements of the leaf blade is measured. This analysis is carried out on the oldest vital and youngest adult leaf. By sampling two parts of the plant, an image of the sap flow is given. Using leaf juice together with soil analysis results, we can determine the moment of fertilisation. The fertilisation that is given at that moment is done according to soil analysis, where the nitrogen level is supplemented to the restricted amount of units for the relevant cultivation.

Multiannual trial setup

The trial setup (started in 2011) tests both animal and plant base fertilisation with blood meal, dried chicken manure pellets, soybean meal and malt sprouts. During the last 4 years of research different types of crops are used: cluster tomato, cucumber, red block peppers and prune

tomato. The demonstration experiments are set up in two compartments where animal manure is used in one compartment and plant manure in the other compartment. The border rows of the compartments only receive base fertilisation and no additional fertilisation. The border rows cannot be regarded as a valuable object, but they give an indication of how the crop proceeds without additional gift of an organic grain. During the trials, yield, fruit quality, crop stand and preservation and taste are included in the result processing.

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Controlling plant diseases and pests by using beneficial organisms

Biological control is the application or preservation of beneficial organisms (viruses, fungi, bacteria, yeasts, insects and mites) to control diseases and pests of crops. Below are some examples of biocontrol research at ILVO.

Viruses combatting with plant-pathogenic bacteria

Bacteriophages are tiny viruses that infect bacteria. They multiply in the bacterial cell that is eventually killed by the phages. The new phages are released and search for new victims. This cycle is repeated as long as bacteria are present. This research is conducted with phages against the plant-pathogenic bacteria *Pseudomonas syringae* pv. *porri* and *Xanthomonas campestris* pv. *campestris* that were isolated from infested leek and brassica fields. The efficacy of these phages was clearly demonstrated in the lab. The next step is to look for the right conditions to grow, formulate and apply them in practice. However, we need to take into account that resistance can occur against these phages, as they are very host specific. A phage cocktail may in this case be necessary to control all possible variants of the host bacterium. The development of phage therapy contributes to a sustainable vegetable production.

Bumblebees as vehicles for biocontrol organisms against fire blight

A recently-started IWT project will explore biological control of fire blight disease on apple and pear, which is caused by the plant pathogenic bacterium *Erwinia amylovora*. Several commercially available biocontrol organisms are tested for their mode of action and their ability to colonise apple and pear flowers. In addition, the prospect of using bumblebees as vehicles for delivering these micro-organisms into the flowers of apple and pear will be explored.

Predators eliminate harmful insects

Previous monitoring studies performed in various crops have illustrated that a large diversity of predators and parasites occur naturally in these environments. Due to their key role in the control of plant pests, it is important to inform and make growers aware of their importance, not only concerning the occurrence of the natural enemies but also concerning the culture technical measures and strategies that preserve or even stimulate these beneficial and naturally occurring insects. The hunter/predatory fly *Coenosia attenuata* has, together with the predator mite *Parasitus americanus*, often

Monitoring of beneficial insects

been observed in vegetables grown in greenhouses. In both tree nurseries and various arable crops, a high diversity of aboveground arthropods occurs. Ground beetles, not always visible, but prominently present, are commonly known as important predators, just as are staphylinid beetles, ladybirds and hoverflies. Parasitic wasps, responsible for parasitising aphids, are equally observed regularly. Knowledge about the identity and function of these insects is essential for the natural control of their plant pathogenic relatives.

Using the good guys to control the bad ones

The examples above illustrate opportunities for steering good organisms in the plant environment against problematic organisms. Bacteriophages are used against plant pathogenic bacteria and natural enemies are monitored to control plant parasitic insects and mites. Insects can be a vector for plant viruses, but natural pollinators can also be used as vehicles for delivering beneficial biocontrol organisms into flowers. Research to identify and study these interactions is therefore very important.

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More info: www.ilvo.vlaanderen.be/Cropprotection/

Non-chemical control of plant diseases and pests: a search for a "coalition" of measurements

The non-chemical control of diseases and pests involves much more than the use or maintenance of antagonists or natural enemies. ILVO also searches for other or supplementary measurements that can be used in organic agriculture, such as optimal soil management with focus on disease suppression, plant resistance and phytosanitary measurements. We present some project examples below.

Control of *Drosophila suzukii*

We investigate the application of practical and non-chemical control measures with the intention of preventing the development and expansion of *Drosophila suzukii* in (commercial) fruit orchards. Research into the attraction of volatile components of various fruit types and their associated micro-organisms should generate a basis for designing a more specific and effective "attract and kill" trap for this fruit fly. The construction of a compost container at farm level should support the treatment of affected plant material by combining two facets of sustainability, e.g. the environmental suppression of the pest insects during the composting process and the recycling of raw materials. Such a compost container will subsequently contribute to the control of this fruit fly.

Soil management to increase disease resistance

Our goal is to conduct soil management in order to increase the natural resistance of plant and soil. Examples of such soil management strategies are the use of compost, biochar, green manures and reduced tillage to control plant parasitic nematodes (e.g., *Globodera* sp. on potato and *Meloidogyne chitwoodi* on carrot and bean) and plant pathogenic fungi (e.g., *Rhizoctonia solani* of lettuce and *Botrytis cinerea* of strawberry). To investigate the underlying mechanisms of disease suppression, we measure physicochemical and microbial soil parameters and we search for correlation with disease suppression.

Resistance against fungal diseases and development of warning systems

Bioassays are being developed in several plant-pathogen systems to test for the presence of disease resistance. We first determine the level of diversity within the pathogen population as it is best to have active resistance against all pathotypes present. As a part of disease warning systems, we develop methods to detect the pathogen in planting material, air, soil and water. In addition, increasing our knowledge of the introduction, spread and survival of pathogens as well as the climate conditions that are important for infection are helpful for developing warning systems. Examples of plant-pathogen systems in which this research was conducted are chrysanthemum white

Detection of pathogenic fungi spores in the air by means of spore catchers in function of warning systems

rust, internal fruit rot of bell pepper, boxwood blight, potato wart disease, *Verticillium* (in potato, flax, trees) and apple scab.

Viruses: the exception within the plant diseases

The lack of direct control strategies makes viruses rather exceptional compared to other plant pathogens. Control and prevention of virus diseases thus relies mainly on alternative strategies including weed management, vector control, cultivar choice and hygienic cultivation. In different research projects on plant viruses and viroids, the importance of weeds as reservoir plants and the risk of dispersal by vectors (e.g. insects and nematodes) is studied. The preparation and implementation of weed and pest control is weighed against the benefits of the higher biodiversity on which organic farming relies. In combination with research to breed tolerant cultivars and recommendations for hygienic measures, these results can be immediatel applied in organic farming.

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Integrated management of the invasive tomato leaf miner *Tuta absoluta* in Flanders

Since its first detection in Flanders in 2009, the tomato leaf miner Tuta absoluta *is now frequently encountered in tomato greenhouses. The leaf mining caused by the larvae can greatly reduce the level of photosynthesis and thus lower production levels. The larvae can also enter the tomato fruit itself, making the fruit unsuitable for sale and export. In the framework of the European Directive 2009/128/EC and the subsequent National Action Plan on sustainable use of pesticides, a consortium of the Research Station for Vegetable Production, the Laboratory of Agrozoology of Ghent University, the Research Centre Hoogstraten and ILVO has been working since late 2011 to develop an integrated control strategy against this pest in Flanders. The main focus is on the use of natural enemies.*

Exotic *Tuta absoluta* can overwinter in Flanders

The first step in integrated pest management is to take preventive measures to slow down pest buildup. It was assumed that the low temperatures commonly associated with Belgian winters would prevent this exotic species, which originated in South America, from successful overwintering. Experiments in the laboratory, however, demonstrated that the adults and pupae of this leaf miner can overwinter in crop-free greenhouses for about two weeks. Therefore it is important to strive for the lowest possible level of *T. absoluta* populations towards the end of the production cycle. Minimising the number of overwintering adults and pupae allows the new crop to start in a clean environment.

Scrutinising the natural enemy *Macrolophus pygmaeus*

Macrolophus pygmaeus is the most commonly used commercial natural enemy against *T. absoluta*. Unfortunately, the population of this predatory bug is slow to build up, making it difficult to control *T. absoluta* at the beginning of the production cycle or when pest level is high. Through observations and experiments in the greenhouse we now know that the efficacy of *M. pygmaeus* can be optimised by releasing the predator as soon as possible after planting combined with providing food supplements. This stimulates an optimal population growth and distribution in the greenhouse.

Second line of defense by entomopathogenic nematodes

The predatory bug prefers to eat the eggs of *T. absoluta*, however, preying only to a limited extent on the larvae of the pest. Entomopathogenic nematodes

(EPN) are already being used successfully against weevils, fungus gnats, leatherjackets, grubs and many other harmful soil organisms. Laboratory tests now show that the EPN are also particularly effective in the cryptic environment of a leaf mine and have the potential to kill high numbers of larvae. In the next step, the EPN will be tested in infested commercial greenhouses

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More info: www.innovatienetwerk.be/projects/1752
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Management of wireworms and leatherjackets in organic crops

new

Wireworms and leatherjackets are often found on organic cultivated fields, where they can cause damage to a number of organic crops. The damage level can vary significantly from one field to another and from one year to another. Various environmental and field-specific factors play a role in the damage potential of these soil pests in the field. To improve the understanding of these factors, Inagro started a two-year project in 2013. For both pests, monitor methods were tested and on-farm demonstration research on possible control measures was made.

Polyphagous soil pests

Leatherjackets – the larvae of the crane fly – attack young plants of vegetable crops (cabbage crops, lettuce, beans, etc.) as well as field crops (beets, cereals, etc.) in spring. The larger instars in the soil come to the surface at night to feed on the leaves, the root neck or stems of plants. The damage risk period for crops is limited to 2-3 months in springtime, but the larvae can reside up to 11 months in the soil.

Wireworms – the larvae of click beetles – have a slower development than leatherjackets. Depending on the species, they can reside up to five years in the soil during which they can damage various crops in spring as well as in autumn. Particularly in organic potato production wireworm damage has been increasing during recent years.

Monitoring is of essential importance

Inagro has monitored wireworms and/or leatherjackets on about 10 organic fields in 2013 and 2014. Wireworms were sampled using bait traps and leatherjackets using brine-based traps. After sampling in spring, the crop damage caused by the pest larvae was assessed. The results in 2013 confirm that the applied methods to sample wireworms and leatherjackets in the soil give a good estimate of the damage risk on a specific field. However, as a quantitative measure, the capture results should be interpreted with caution. For example, the extent to which wireworms are attracted to the bait traps depends strongly on environmental factors like soil moisture and temperature. The bait trap method therefore needs further refinement.

Species of click beetles on Flemish crop fields

In Flanders there are no precise data on the occurring species of click beetles and their actual spread on arable land. Nevertheless, this knowledge

on wireworm populations is crucial for the development of efficient control strategies. Therefore, wireworms as well as the adult click beetles are monitored on a number of fields. The species of click beetles found in the pheromone traps are identified by the entomology department of the Royal Belgian Institute of Natural Sciences (KBIN, Brussels).

Exploring organic control methods

There are currently no effective and economically viable methods for control of leatherjackets and wireworms in organic crops. To reduce damaging populations of wireworms in the soil, it is clear that a long term strategy with control measures on crop rotation level is needed. Possible cultural control measurements aiming to avoid or reduce the population build-up of the soil pests often have a significant influence on farm management and therefore need to be considered carefully. In this consideration, the sampling of the larvae in the soil offers a valuable support tool. This also applies for control measurements aiming to limit damage risk, e.g. sowing later or harvesting more early. The on-farm research in the present project confirmed this. Hence, we conclude that monitoring of wireworms and leatherjackets in early spring can help when making management decisions.

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More info: www.biopraktijk.be, www.CCBT.be/projecten

Parasitoids as a biological control agent against aphids in fruit tree crops (BIOCOMES)

new

The European Union is placing increasing emphasis on the value of an integrated approach to pest management (IPM) in agricultural crop systems. In this strategy a biological, mechanical or non-chemical control is preferred above the use of chemical crop protection agents. Furthermore, the general public is also asking for more qualitative and sustainable products. To encourage the use of biological control agents, the EU is financing a four-year project (BIOCOMES) in which several pests will be investigated to find and develop efficient and sustainable control methods. Aphids in pome and stone fruit crops are one of the pests for which new biological control agents will be developed. The research on this topic will focus on at least one of following economically important fruit tree crops: apple, pear, cherry and plum.

Biological pest management of aphids

In nature, parasitoids or parasitic wasps are very efficient against aphids. During their short life span, these minuscule creatures can easily parasitise 50 to 200 aphids using their ovipositor. The larvae of the parasitoid will develop inside (koinobiont) the aphid, eventually causing the aphid to die and in turn giving birth to a new generation of parasitoids. Under field conditions, parasitoids can have several generations a year (5-6). In a natural ecosystem, plants can survive thanks to the help of the aphid's natural enemies. But in many fruit tree crops, aphids like *Eriosoma lanigerum, Dysaphis plantaginea* and *Myzus cerasi,* are more numerous than parasitoids or they appear much earlier, causing important economic damage.

Which parasitoid for which aphid?

The research will concentrate on finding, screening and developing efficient parasitoids against aphids harmful for fruit tree crops. Currently, the following species of aphids are in the limelight of the project: *Myzus cerasi, M. persicae, Hyalopterus pruni, Brachycaudus helychrisi, B. cardui, B. persicae, B. schwartzi, Aphis pomi, A. spiraecola, Dysaphis plantaginea*. For two years, aphids will be sampled in fruit tree orchards and adjacent plant communities for the different EPPO zones. For Central Europe, pcfruit will screen orchards in Belgium on aphids. Parasitised specimens (mummies) will be collected and the host plant noted. The emerged parasitoids are identified by the Faculty of Biology of the University of Belgrade and will then be tested for their usability as a biological control agent by the company

Viridaxis in collaboration with pcfruit. Besides life span and fecundity, all potentially valuable identified parasitoid species will be evaluated for their efficiency in parasitism and production. This will start on small-scale laboratory conditions. When successful, the production process for mass rearing will be set up and tested. Additionally, other insects of influence in the fruit tree orchards, like ladybirds, hover flies, ants, etc. will be monitored and taken into account during the testing period.

Release strategy

In the final phase of the project, a method will be developed to release the parasitoids in the best conditions in the fruit tree orchard. This is the final step to the real field application. Finding an adequate and cost efficient way to eventually release these beneficial organisms is essential in this research programme. This phase will take three years in at least one fruit tree crop. The first year will be situated on 10 locations in Belgium, the next two years in two different EPPO zones. Establishing and fine-tuning the release calendar for the selected parasitoids will be one of the most important tasks in this process. Aphids are notorious front runners: if the parasitoids are released after the first aphids' development, it will be too late to control them effectively.

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More info: www.pcfruit.be, www.biocomes.eu

Rational and orchard specific management of scab on apple

new

*Scab (*Venturia inaequalis *on apple and* Venturia pirina *on pear) is the key parasite on pome fruits. If primary infections (by ascospores originating out of the overwintering infected leaves in the orchard) of the pathogen are well controlled, less secondary infections (by conidia originated out of the lesions developed after primary infections) will occur during the summer period. A better strategy to advise fruit growers in their scab management is the development of a more accurate scab warning system.*

Current scab management strategy

The current scab warning system is based on the climatological infection risks calculated by the weather data gathered by the agrometeorological network in Flanders. In addition, at the pcfruit research station, the ascospore release at a specific infection moment is measured during the primary scab season based on a 'worst case' scenario. Leaves from orchards with a high scab pressure are collected during leaf fall and overwinter on the ground under a 'net'. At the beginning of the season a burkard spore trap is placed above the leaves. At each rain event ascospores are captured by the burkard spore trap and the trapped ascospores are counted in the lab. For the growers, this is important additional information to estimate the importance of the infection. It helps the fruit grower to better determine and position his treatments, product choice and dose rates. Nevertheless, each year problems with scab still occur. The current warning system is based on the worst-case scenario. However, the real inoculum pressure for each specific orchard might be lower but cannot be determined up until now. Furthermore, scab models (like RIMpro) use a fixed initial inoculum, without taking into account the actual initial inoculum in an orchard. This can give a wrong impression of the intensity of a specific scab infection.

Optimising the scab management strategy

Until now the real initial inoculum has not been determined nor incorporated in the scab models. The knowledge of this real initial inoculum pressure is important to have an idea about the potential ascospores that are present in the orchard. In this way, the fruit grower can react more accurately to a specific scab infection moment. For example, with a low initial scab inoculum pressure in an orchard, some treatments at a very low infection

risk can be skipped, while this is not possible when a high initial inoculum pressure is present. By having this additional information a fruit grower can better manage his strategy throughout the season. This is important for both organic as well as integrated fruit growing.

During a 4-year study a molecular tool (qPCR) will be developed to determine the initial inoculum based on the fungal DNA present in the leaves. Besides the determination of the initial inoculum pressure, the level of resistance towards strobilurine fungicides will also be determined using a molecular technique. For the fruit growers, this is also important information to optimise their scab management strategy. The information concerning initial scab inoculum will be integrated in scab models so that a more accurate scab management strategy can be obtained.

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More info: www.pcfruit.be, Pcfruit vzw - TWO Mycologie

Investigation of alternative beneficial arthropods for the suppression of pear suckers

new

*For many years the pear sucker (*Cacopsylla pyri*) has been the most important pest insect in the Flemish pear growing regions. Its notoriety can be attributed to the phenomenon of 'black pears', in which sooty molds develop in the honeydew secreted by pear psyllids on the fruits. In addition to these unmarketable pears, psyllids are able to transmit phytoplasmas and weaken the following season's flower buds.*

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

Thus far, integrated pest management of pear psyllids is predominantly to fully focused on predatory bugs (*Anthocoris* and *Orius* spp.). However, these key beneficial arthropods are not host-specific, and often they fly in too late into the orchard in order to prevent damage from pear sucker populations that have already developed. As a consequence, many growers are forced to wait and pray for the predatory bugs to come, and often the conventional growers 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 eat pear psyllids?

In this research project, we aim to develop a substantially 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 have identified several alternative beneficial arthropods which could play an important role. Spiders dominated the biodiversity in the orchards (almost 100%, in both organic and IPM) during winter and spring, as most other beneficial arthropods were still in hibernation. During summer, the total beneficial population consisted of 65% spiders, both in IPM and organic farming. The most abundant spiders were *Theridion* spp., followed by *Philodromus* spp. and different Araneidae. In IPM, more predatory bugs were found during summer (± 25% of the total population), whereas more velvet mites were present in the organic orchards (± 25% of the total

population). Mirid bugs were only present around July. Lacewings and ladybirds were less abundant (< 10%) and were almost exclusively present at the end of summer and during harvest.

Second, the consumption of pear psyllids by these predators was determined with the aid of a new research technique: prey-predator PCR. Anthocoridae had the highest chance for detection of psyllid DNA in their gut (40-60% positive samples). Velvet mites also scored particularly well for the PCR detections (40%). *Orius* spp., lacewings (both adults and larvae) and mirid bugs displayed a lower frequency (20-40%), whereas spiders, ladybirds (both adults and larvae) had the lowest chance of detection (0-20%).

Subsequently, for the most important predators some important aspects like their migration characteristics and their persistence in the current orchard management will be studied. Finally all data will be compiled 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 whole year.

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More info: www.pcfruit.be

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

new

Several important diseases can occur in fruit growing. Two of these, apple proliferation and pear decline, are both caused by a phytoplasma (a bacterium without a cell wall). The culprits causing these two diseases are Candidatus *Phytoplasma mali and pyri, respectively. Recent years have seen increasing incidence of symptoms attributable to an infection with phytoplasma in our neighbouring countries. Especially for organic fruit growing these diseases are a real threat, as no chemical crop protection agents can be sprayed as control measure (directed against 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. There are many symptoms which are not always visible on any part of the plant. Most typical symptoms are the witch broom and early red colouring 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. 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 previously detected. In the ongoing monitoring this phytoplasma has already been found in 4 of the 45 surveyed communities.

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

In future project 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 such as stink bugs might play a role. The first results pointed out that several psyllids (*Cacopsylla mali, C. melanoneura, C. picta* and *C. perigrina*) which were 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. For stink bugs, effective transmission of phytoplasma could not be demonstrated either. 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 work out a range of control actions. This will stop the further spread of the phytoplasmas

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Insights into stink bug related problems and their control in organic pear growing

new

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

Which stink bugs are responsible for the damage?

In order to be able to work out effective control measures, we first have to gain more knowledge about these insects. The stink bugs are a collection of tree-, shield- and forest bugs of different species (*Pentatoma, Palomena, Carpocoris, Acanthosoma, Coreus, Gonocerus* sp, etc.). At the start of this project research it was unclear to which extent the various species are occurring and which species are mainly responsible for the damage. As a consequence, very little was known about the life cycle/population dynamics of the harmful species in organically managed orchards. The lack of this information made it impossible to work out control measures such as the determination of the right 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. The invasive brown marmorated stink bug *Halyomorpha halys* was thus far not detected.

What, where, when and how to control?

From the population dynamics study we learned that, in contrast to most of the other stink bug species, the forest bug *P. rufipes* overwinters as a nymph (N2). Hence, it is present as a small nymph (N2-N3) in early spring and autumn. This opens perspectives to focus the timing of control actions on these periods. Nymphs are generally more vulnerable to crop protection agents than adult bugs. Based on the knowledge of the life cycle of the forest bug we 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 case of treatments throughout the growing season, the best control effects were obtained when sprayings were executed twice (before as well as after flowering).

From knowledge to effective control strategy
In the current project an effective control strategy is being developed based on the acquired knowledge and insights of the past years. Well-timed sprayings with organic compatible control agents spinosad and pyrethrum in spring and autumn are crucial elements in this control strategy. Weather conditions which might play an important role in the final efficacy of these biological products will be registered and evaluated in field trials. Furthermore, pheromone traps will be optimised for better monitoring/ trapping of these pest insects.

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More info: www.CCBT.be/projecten

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 at the lower site 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 stopping plant growth.*

The research

Biological control can be done by the release of mite predating ladybirds (*Stethorus punctillum*), gall midges (*Feltiella acarisuga*) and/or predatory mites, several species of which predate on spider mites. Not only in organic producers are showing great interest in the use of these predators, because resistance formation against new acaricides is appearing so fast and the presence of natural enemies is more reliable than chemical control once the predators are established.

In the current research only predators 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 regularly and the prey/predator ratio, important to estimate the success of the release, was calculated.

completed

Did it work?

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 neighbourhood 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 under dry conditions. 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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More info: www.pcfruit.be

Bumblebees as fire blight fighters: Protecting apple and pear blossoms using biological control organisms (BCOs) applied via bumblebees

new

Apples and pears are important fruit exports from Belgium. The presence of fire blight can cause problems for export, especially to areas free of fire blight. Avoiding bloom infection with Erwinia amylovora*, the causal agent of fire blight, is thus imperative. The use of biological control organisms (BCOs) may help to solve this problem.*

Application of biological control organisms (BCOs) using bumblebees

The flower stage is very susceptible for fire blight infections. Protection of the flower clusters is therefore an important part of the control strategy of fire blight. Applying biological control organisms (BCOs) via bumblebees offers the possibility to continuously insert antagonistic microorganisms during the whole flowering period of apple and pear, during the primary bloom as well as the secondary bloom. One BCO currently registered in Belgium is Blossom Protect (*Aureobadidium pullulans*) (against bloom infections). Other compounds such as Vacciplant and Aliette are registered in Belgium but their aim is to enhance the plant's defence system. In this research project, known BCOs as well as new BCOs, isolated from flower stigma and flower nectar, will be tested. Some microbial strains are available as commercial BCO compounds (especially in the USA, Canada, New Zealand but also in Germany, Italy and Austria). Other strains are only described in scientific literature but will be interesting to include in the trials as BCO reference strains alongside the commercial strains. Although several known BCO reference strains are used to protect against flower infections, many of these strains have not been isolated from flower parts and were not adapted to the conditions specific to the flowers where they should be active (flower stigma, flower nectarthodes and nectar). Therefore, the flower microbiome will be studied in this project to isolate dominant microorganisms from flower parts and to test them as new BCOs against fire blight blossom infections.

BCO compounds are currently applied using classic spraying methods. But bumblebees may represent an improved method of disseminating BCOs. The BCOs can be introduced directly into the hive or indirectly through transfer from neighbouring flowers that have been inoculated early by BCOs. The BCOs cling to the bumblebees' legs and body and rub off on the flower's stigma and nectar as the bumblebees visit flowers of apple and pear to gather nectar and pollen. It is expected that by applying BCOs via bumblebees, the BCOs can be more effectively deposited in the flowers. One disadvantage

of spraying is that only the open flowers will be protected by the BCO at the moment of application. Using bumblebees, in contrast, may ensure that flowers are visited (and inoculated) continuously, including flowers that come into full flowering at different times. Bumblebees offer additional advantages for BCO dissemination: unlike honey bees, bumblebees can be used under hail nets and they are also active in bad weather conditions. Research on several aspects is needed: the compatibility between the BCOs and the bumblebees; the most efficient way to load the bumblebees with BCOs; and different carrier/BCO combinations. The internal structure of the primary and secondary blossoms will be examined with attention to the pollen production and the internal production of nectar, as both can determine the attractiveness of the flowers to bumblebees.

First we will test the efficacy of the bumble bee vectoring loaded with BCOs against flower infections under controlled conditions in the quarantine greenhouse. Later on, the efficacy of BCOs disseminated via bumblebees will be tested under natural conditions in the orchard: in healthy orchards as well as in fire-blight diseased orchards.

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The use of flowering borders as a potential attractant and safe haven for beneficial insects in pear orchards

new

Flowering borders consist of several perennial plants chosen for their attractiveness for beneficial insects and period of bloom. They are a good way to increase natural biodiversity in the surroundings. Research has shown that flowering borders not only attract useful pollinators but also increase the number of beneficial insects in surrounding areas. It is known that the nectar and pollen serve as a good alternative food source in periods when natural prey is rare.

The effect of flowering borders on the natural suppression of pear psyllids

In our research, a mix of 80% grasses and 20% herbs (*Centaurea, Trifolium, Vicia, Lotus,* etc.) is used. Whether these flowering borders have a positive effect on neighbouring pear orchards is investigated by using pear psyllid (*Cacopsylla pyri*) pressure as control. Pear psyllids are the most important insect pest in pear orchards, as high densities of pear suckers can result in abundant honeydew formation and the development of sooty mould fungi ('blackened' appearance on leaves, shoots and fruits). Furthermore, necrosis of leaf and flower buds, promotion of scald and a considerable drop in photosynthetic efficiency may appear. Last but not least, psyllids are able to transmit phytoplasmas and can weaken the next season's flower buds as well.

In addition of counting the number of pear psyllids on the shoots of surrounding pear trees, the limb-beating method is used in order to collect beneficial insects such as *Anthocoris, Orius* spp., ladybugs and lacewings which may have migrated from flower borders to the neighbouring pear trees.

A last step in this research involves the mapping of the migratory routes of these beneficials by using an ELISA technique with marker proteins.

Goal of the research

In this research project, we aim to develop a substantially improved integrated pest management strategy by using flowering borders as a potential attractant and safe haven for beneficials which could have a positive effect on neighboring pear orchards. More beneficials could lead to a higher biodiversity, a smaller number of pests related to pear trees and reduced use of crop protection products throughout the year

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Use of functional agro-biodiversity (FAB) for pest control in organic strawberry growth

new

Active substances in crop protection are not a cure-all. They can limit or eliminate the contribution of beneficial insects and mites when non-selective products are used. Even some products allowed in organic cultivation show insufficient selectivity to natural enemies. Harmful organisms also develop resistance to the active substances available. The artificial use of natural enemies, a well-established strategy in organic farming, is a possible solution for conventional farming as well. The use of the naturally present functional agro-biodiversity (FAB) is also gaining more interest. In some cases, good pest control can depend on sufficient support for the already-present beneficial organisms. In one trial, thrips in strawberry were controlled by the naturally present predatory bugs (Coll et al. (2007)). The presence of natural enemies can be encouraged by planting flowering borders that provide pollen and nectar as alternative feed when prey levels are low, as well as shelter during wintertime. These support measures can ensure the presence of natural enemies in the crop from the beginning of the next growing season.

Aphids

Aphids are a problem as early as February in the cultivation of strawberries under tunnel. Aphids spend the winter on the strawberry plants, then under sunny winter conditions, they can proliferate due to the high temperatures in the closed tunnels. No natural enemies are present that early in the spring, however. A preliminary test was performed in Research Centre Pamel: in August 2013 a floral mixture of large-flowered tickseed, corn marigold, reseda, cornflower, coriander, alfalfa and buckwheat was sown in the pathways between the strawberries to provide pollen and nectar for the beneficial insects already early in spring.

Thrips

Thrips are a major problem in strawberry cultivation (Melis, 2013). In organic farming, the use of the organic product Spinosad is an option for the control of thrips. But the product is not selective and also kills the predatory bugs that are the natural enemies of thrips (Biondi et al., 2012).

In September 2014, the PWO project 'Observing thrips in strawberry for Oost-Vlaanderen, towards a sustainable control by means of cultivation

techniques and flower strips' started. The project is carried out by University College Ghent (HoGent) and ILVO, Research Centre Pamel and several strawberry growers. The project has two major research objectives:

1) To understand the population dynamics of different species of thrips in strawberry cultivation
2) To investigate what preventive measures are effective against thrips. The use of flower strips to attract and enhance the predatory bug Orius is one of the cultivation measures that will be examined.

As part of this project, an organic trial will be set up for a detailed study of the impact of a flower strip on the presence of thrips and their natural enemies. One trial field with a flower border will be compared with an adjacent field without a flower border. Throughout the growing season, in both fields, both thrips and their natural enemies will be enumerated, both visually and with destructive methods. Yield variables will also be determined. This study will also consider whether the flower border have a possibly negative impact, since it is possible that the pollen from the flower border also attracts thrips that can then migrate to the strawberry plants.

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Opportunities for the prevention of thrips in strawberry

new

For the last few years, thrips have formed a growing problem in the cultivation of strawberries. Most of the growers have to deal with this pest. Thrips feed on flowers and fruits, resulting in reduced fruit quality and lower yield. To manage this problem growers usually start intensive and regular spraying of insecticides. The aim of this project is to develop a better understanding of the thrips species appearing in strawberries and their population dynamics. In addition, we want to investigate the impact of several measurements which could prevent thrips infestation.

Which thrips species appear on strawberries?

At the moment, there is a great uncertainty about which thrips species occur in Belgian strawberries and what kind of damage they cause. Besides the Western flower thrips (*Frankliniëlla occidentalis*), there are numerous other thrips species that can damage strawberries. The lack of this knowledge and the complexity of thrips migration are major obstacles for implementing an integrated thrips management. To gain a better understanding in these topics, we will monitor and identify thrips occurring in two cultivation systems of strawberries (under glass and in open field cultivations).

How prevent thrips infestation?

The weakening efficacy of curative treatments with insecticides is creating an urgent need for new strategies. An ounce of prevention is better than a pound of cure, so we are also exploring three possible strategies to prevent thrips infestations.

Strawberry plants in greenhouses can be infested by thrips in several ways. Infestation can occur in young plants before they enter the greenhouse, as thrips also hibernate in the soil. Treating the young plants and soil with micro-organisms that reduce or eliminate thrips populations could offer a solution. The first prevention strategy to test is the effect of a bacterial suspension on the survival of thrips under laboratory circumstances.

The second possible strategy is influencing nitrogen to affect the thrips-susceptibility of the strawberry plant. As reported in literature, a higher nitrogen dose results in a lower quality of strawberries. Moreover, it results frequently in a higher susceptibility to pests.

As a last strategy, we want to stimulate natural enemies of thrips in open field strawberries. Offering habitats like flowering borders provides alternative food sources and shelter for natural enemies and as a result may enhance their abundance in the adjacent fields. During the growing season, we will monitor thrips and their natural enemies in strawberry fields with and without an adjacent flower strip.

The final goal

This new knowledge will support the strawberry growers in an integrated management of thrips. Our results will be communicated to the growers, professors and students of agro- and biotechnology. By participating in this project our students will also become better get acquainted with the strawberry sector.

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Flowering borders and hedgerows. Do they have an impact on conservation biological control in tree nurseries?

*The positive effect of a flowering border and hedgerow on conservation biological control has already been demonstrated in several field crops (cereals, potatoes, sprouts, etc.). However, in tree nurseries the research on this subject is still in its infancy. To fill this lack of knowledge, we examine the impact of a native flowering border and hedgerow on the population density of key pest insects and their natural enemies on unsprayed lime trees (*Tilia cordata Mill.*).*

Who shows up when?

The main pest insects and their natural enemies were monitored bi-weekly during four growing seasons. This allowed us to assess the phenology of these pests and their natural enemies. The three main pests were the lime aphid, the lime rust mite and the oak slug worm. We further noted that the presence of natural enemies (ladybugs, lacewings, etc.) was strongly related with the occurrence of their prey-insects (aphids, slug worms, etc.). In other words, when the pests are present in the crop, their natural enemies are sure to arrive soon. We observed that these beneficial insects/mites occurred during the whole growing season with a peak period during the summer months (June, July and August).

Flowering border and hedgerow: a source of natural enemies and pest control?

Our results showed that the positive influence of the flowering border and hedgerow depends on the diet of the natural enemy. Natural enemies that mainly feed on prey-insects during their adult stage (e.g. ladybirds) were hardly affected by the presence of a flowering border or hedgerow. On the other hand, natural enemies that depend on pollen and nectar during their adult stage (e.g. lacewings) were positively affected. Because pests and diseases in conventional agriculture are controlled by pesticides, natural enemies cannot find prey-insects in the crop and have to find them elsewhere. A flowering border and/or hedgerow can then serve as a source of alternative food (prey-insects, pollen and nectar).

The influence of a flowering border and hedgerow on pest control varies among the pests and growing seasons. Lime-aphids were clearly suppressed on trees adjacent to the flowering border and hedgerow. The influence on the presence of oak slug worms varied among the growing seasons. No impact was observed on the presence of pest mites (rust and spider mites).

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What should we remember?

Our research shows that in the absence of plant protection products, tree nurseries create a very diverse ecosystem housing both pests and beneficial insects/mites. Several of these pests could be controlled by natural enemies present in the surrounding environment. But before we can make use of these natural enemies to control the pests, we need to recognise them. We have to take them into account in our plant protection strategy. A flowering border and/or hedgerow can be used as a preventive strategy to stimulate natural enemies and subsequent natural pest suppression

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Precision biocontrol and enhanced pollination of crops by bumblebees

For many years, a variety of horticultural and agricultural cropping systems have relied on the commercially available bumblebee Bombus terrestris *for efficient pollination. These pollinators may have a role to play in control of several insect pests and plant diseases in organic fruit and berry production. One of the most important diseases is grey mould (*Botrytis cinerea*) which often causes a strong reduction in fruit yield and quality. In the European project "BICOPOLL" (Biological Control & Pollination), Ghent University, together with 6 other European partners (Finland, Germany, Estonia, Slovenia, Italy and Turkey), is examining a potential role for bumblebees in crop protection. The use of these pollinators as a vector for application of biological control agents presents a promising and integrated crop protection solution.*

BICOPOLL: targeted biocontrol and improved pollination

The lack of effective disease and pest management tools is causing a rise in demand for biological protection methods. Using pollinators as vectors to disseminate biological control agents into crop flowers (so-called "entomovector" technology) is a new way to combat plant pathogens and insect pests. These biological control agents are naturally occurring enemies of the targeted plant pathogens or insect pests. In this way the bumblebees can do double duty: the originally-intended pollination services as well as targeted biocontrol. During the last four years, the BICOPOLL research project has improved the efficiency of the entomovector system by investigating, exploiting, and supporting natural ecological functions of biocontrol and pollination, and enhancing these via innovative management. The first two years were directed to an extended and explorative study of the multifaceted aspects of the system to unify the fragmented research in the areatogether. The last two years focussed on the practical implementation for organic berry and fruit growers as well as beekeepers and their organisations.

Entomovectoring, a new environmentally-friendly control strategy

Several studies within the BICOPOLL project have demonstrated the efficacy of the entomovector technology against plant diseases. The success of the entomovector technology is based on the interactions and compatibility between the vector, the control agent, the formulation and the dispenser. The most significant results and achievements are:

- The white-tailed bumblebee *B. terrestris* is highly suitable for greenhouse cropping systems because of its foraging behavior and the loading of the product. Good biocontrol requires homogeneous dissemination of the product.
- Toxicity and compatibility experiments showed that mycopathogenic and entomopathogenic control agents could be used, as long as an appropriate spore concentration in the formulation is achieved.

completed

- Microscopic–level research on particle interactions revealed that the corn starch 'Maizena' was very suitable as carrying substance for the control agent; use of that corn starch product reduced product loss during flight
- An optimised two-way dispenser fulfils all expectations to load bumblebees with a sufficient amount of the powdery control product.

The efficacy of the entomovector system has been proven in control of *B. cinerea* in strawberry cultivation. When bumblebees were applied as vectors for dissemination of the commercial product "Prestop-Mix", a powdery formulation of the biocontrol agent *Gliocladium catenulatum* into the strawberry flowers, infection was successfully prevented.

A promising future

The broad potential of the entomovector technology represents a breakthrough for improving plant protection in cropping systems. The enhanced pollination services and simultaneous biocontrol result in improved fruit yield and quality, and thus progress in farm economics. Biological control agents also have benefits to growers and consumers: these products leave no toxic residues, they have no phytotoxic effects on plants and there is no loss of control efficacy due to resistance. These advances have led to an implementation of the entomovector technology in strawberry industries such as *'Proeftuincentrum Hoogstraten'* with the use the commercially available "flying doctors" dispenser from Biobest Co. At this time, the partners of the BICOPOLL project are completing a handbook that explains the theoretical background as well as the practical implementation procedure of the entomovector technology.

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More info: www.coreorganic2.org

Soil quality and weed control in tunnels

Fallow periods in the tunnel are an ideal time to address the soil structure, soil life and weed control. During cultivation, good weed control remains important.

Weed control between growing periods

Most companies, especially those who deliver to large supply chains (auctions, wholesalers, etc.), choose for cultivation in the tunnel during spring and autumn. In this way the cultivation and harvest can be forced or postponed in the growing season to a time when these crops are not available in outdoor cultivation. This is a logical choice because between these cultivation periods the supply of outdoor crops is very large. The tunnels thus remain fallow during summer and a short period in winter. During these periods, the tunnels still need attention to prevent rising weed pressure and/or desertification. Several techniques can be used, depending on the company's needs:

- Keeping poultry in the tunnel
  Chickens are less likely to remove grass, while Australian wood duck are more likely to remove grass. Use of wood ducks also leads to less moss formation.
- False seedbed
  After the weed sprouts, it is then milled in a superficial manner. This operation can be repeated several times per summer.
- Covering soil with anti-root cloth
  The existing weeds, at least those needing light to sprout, die due to lack of light
- Covering soil with anti-root cloth but opening it on a regular basis
  This practice eliminates different rounds of sprouting weeds
- Sowing green manure
  Both phacelia and Japanese oats are good green manures. Phacelia is slightly slower to cover the surface area, resulting in openings for the first several weeks. Phacelia has to be cut regularly to prevent seed formation. In contrast, Japanese oats easily cover the soil and form no problem for seed formation.

completed

Regardless of the treatment, regular irrigation is needed to preserve and stimulate soil life.

Weed control during cultivation

Depending on the cultivation and management, several options exist for weed control. For example, in celery cultivation, a comparison was made between planting in an anti-root cloth versus burning between the rows and classic weeding with a hoe.

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Weed control using soil cover materials in organic raspberry cultivation

The organic berry grower cannot use herbicides to control weeds. A possible solution is a well-chosen soil cover material that can control the weeds without disturbing the crop. In Research Centre Pamel, different cover materials of natural origin were tested. The search for a suitable soil cover for growing raspberries started in 2011. Tested materials include hemp, sieve overflow, straw pellets, compost, cocoa husks, coconut chips, bio-top, grass clippings and pine.

First results

The trials have already resulted in some interesting findings. Of all materials tested, cocoa husks are the least effective against weeds. However, this material helped the young shoots to grow better. Bark showed the best effect against weeds, but the shoot growth was far too late. For grass clippings we saw a full digestion of the added material at the end of the growing season, with a full development of the shoots. Certain materials like grass and cocoa husks are very attractive for animals. Coconut chips are subject to the influence of wind and rain. Straw pellets, currently available on the market, are not allowed in organic cultivation. Grass clippings must originate from an organically cultivated field.

Further experiments

Several of these cover materials were used on a young cultivation (2 rows) and on a one-year-old cultivation (2 rows). Each cover material was applied in each line: two repetitions in the young cultivation and two in the old one. The young cultivation failed under all of the cover materials tested.

In 2014 the trial in the older cultivation was monitored further and the use of soil cover materials on a young cultivation was repeated once more to determine whether this would lead again to the failure of the cultivation. One row was planted without covering as an untreated object.

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Legumes in cattle husbandry?

new

Grass/clover mixtures are essential in organic farming, but not all conventional farmers are convinced of the potential of these crop combinations. Lucerne cultivation is minimal, despite its high to very high yield of dry matter and protein per hectare. The Common Agricultural Policy can encourage the cultivation of these crops by demanding a third crop and the greening requirements. The Institute for Agricultural and Fisheries Research (ILVO) will do research into optimising lucerne crop cultivation.

Yield potential and nitrate residue

ILVO will examine the effect of the N-fixation capacity of clover and lucerne on the N availability in the soil and indirectly on dry matter (DM) yield, protein content and forage quality of the grass/legume mixture. Parameters such as level of fertilisation, seasonal evolution and nitrate residue at the end of the growing season will be evaluated.

Forage production with grass/clover: which combination?

Mixtures of Italian or perennial ryegrass with legumes like red and white clover and lucerne at different N fertilisation levels (0, 105, 265 $N_{available}$ per ha) have already been tested, along with white clover/perennial ryegrass in a range of N fertilisation levels (200-330 kg $N_{available}$ per ha). In an experiment started in 2011, several grass species (perennial ryegrass, tall fescue grass, *Festulolium*) are combined with a mixture of red and white clover with a moderate N fertilisation (150 N/ha). The results of these mixtures were compared with grass in pure stand with 300 N/ha (N-limit in MAP4) for yield, grass/clover ratio, forage quality per cut and per year. At the end of each growing season nitrate residue was measured in the 0-90 cm soil layer. These concentrations were always very low, beyond the threshold of 90 kg nitrate nitrogen per ha.

Grass/clover in practice

A parcel of grass/clover (max. 150kg $N_{available}$/ ha) is compared with grass (max. 150kg $N_{available}$/ ha) on three farms, including two that were part of the Advisory Service demonstration platform, during 3 years. DM yield and quality of the fresh grass, of the pre wilted forage before and after ensiling is determined. These results, in combination with the farmers ' experiences about management and valorisation in the ration, will be communicated to the sector.

Slurry application on grass/clover, lucerne and lucerne/grass.

In September 2014, ILVO started an experiment to test annual application of cattle slurry using a sward fertiliser at 0, 120 and 250 N_{total}/ha on grass/clover, lucerne and lucerne/grass in two fractions (spring and after 1st cut). The effect of slurry in terms of potassium and nitrogen will be measured. Nitrate residue will be measured as well. Results will be available in 2017.

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Towards a better protein supply for organic cattle

new

Rations based on grass-clover in organic stock farming are usually rich in rumen degradable protein. To improve nitrogen efficiency, the proportion of rumen un-degradable protein in the ration must increase. Inagro, in collaboration with Wim Govaerts & Co, examined different ways to contribute to a higher amount of rumen un-degradable protein in the ration in the CCBT project 'Towards a better protein supply for organic cattle'. Possibilities for more rumen un-degradable protein in the roughage were analysed, while farmers were guided in growing protein crops for a higher protein content in homegrown concentrate.

Sainfoin for more rumen undegradable protein?

The crude protein content of sainfoin, a leguminous crop, is not higher than in other leguminous crops such as clover. However, the presence of condensed tannins in the plant makes the ingested protein less degradable. The tannins bind to the protein and protect it from degradation in the rumen. The protein is then released in the acidic pH of the abomasum. This leads to a higher amount of rumen un-degradable protein and a higher total protein supply.

In an exploratory trial, sainfoin was sown in 2014 at eight organic farms. The cultivation of sainfoin is similar to that of alfalfa. Sainfoin grows very thin in the first year, however, limiting its competitiveness and weed suppression. The development of the crop will be further observed in the coming years to gain insight into the potential of sainfoin.

Mixed crops: a combination of advantages

In the past years, combinations of triticale with forage peas or winter field beans have emerged as a reliable production crop. With a mixed crop (peas-cereal, field beans-cereal, etc.) the advantages of two crops are combined. The peas or field beans fix nitrogen and supply a high content of crude protein in the feed. The winter cereals suppress weeds at the early growth stage and in a later stage, provide support for the peas or field beans. The yield of a mixed crop is usually higher than the yields of the individual components. The disadvantages of a mixed crop are the possible differences in ripening of the components. This makes it difficult to determine the time of harvest. In 2013 and 2014, Inagro actively supported farmers in their cultivation of mixed crops.

Triticale with forage peas and winter field beans

In a comparative trial as part of the COBRA project, the potential of different available varieties of peas and field beans in mixed crops was examined.

The yields of 2014 confirm the high yield potential of winter mixed crops. In trials with forage peas, Arkta, Assas and EFB33 had rather stable yields the last two years. Assas is an early variety with a sturdy vegetation and a good yield. Arkta and EFB33 are more winter hardy and are less prone to lodging. Of the winter field beans, Diva is known as the most winter hardy variety. In the last two years, Diva, Irena and Organdi had similar yields within each year.

Triticale serves as a cover crop as well as the backbone in the mixed crop. That is why it is sown at considerable density and a sturdy variety with good growth vigour is needed. Borodine is one of the new triticale varieties with repeatedly good results. Borodine has been used in mixed crops with success in 2014.

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More info: www.inagro.be, www.cobra-div.eu, www.biopraktijk.be

Solitary bees and their role in the pollination of apple

new

*Bees are important pollinators of many agricultural crops and are thus a crucial link in the food production chain. In the past years, one of the prime pollinators, the honey bee (*Apis mellifera*), has suffered heavy losses. This is probably due to a combination of several potential harmful factors like the varroa mite (Varroa destructor), viruses, the Nosema-fungus, malnutrition (decrease of biodiversity), stress and certain pesticides. Wild or solitary bees can help the honey bees to pollinate fruit trees, as they have proven to be efficient pollinators. A cooperation between the* Regionale Landschappen Zuid-Hageland *(RLNH),* Noord-Hageland *(RLZH) and pcfruit has been set up to investigate if placing nest boxes for solitary bees in pip fruit orchards can result in a better pollination, especially of apple trees.*

Cooperation with Hageland's fruit growers

The goal of this two-year Leader+ project, "Natuurlijke bestuivers ter ondersteuning van de Hagelandse fruitteelt", is to find out which bees occur in the orchard during the blossom period, which species inhabit the nest boxes, if the bees really visit the apple flowers and if – as a consequence - fruit set and pollination level are increased. This year more than 670 nest boxes were placed in orchards of 30 growers in *Hageland*. A monitoring programme will be carried out in eight parcels of a Jonagold cultivar, four with nest boxes and four without. In addition, a detailed analysis of the environment will be provided and might reveal important obstacles or opportunities for the wild bees.

Which bees occur in the orchard ?

To anwer this question, transects were established and colour traps were set out during sunny days during the blossom period. The colour traps were set out early in the morning and collected in the evening. The transects were walked between 10am and 6pm and consisted of walking slowly in four rows in the orchard, two at the borders and two in the middle. In orchards with nest boxes, five minutes were spent counting at four nest boxes. Bees were identified to family level or in case of the honey bee to species level. Nearly 2000 bees were counted and identified.

How is fruit set and pollination level ?

In each orchard 128 flower clusters were marked and followed during the

season in order to get an idea of fruit set (number of fruits/number of flowers per cluster). Fruits were counted between June drop and thinning as well as just before harvest. Seeds of 32 apples of each parcel were counted. This should be a good indicator for the pollination level.

Are the bees in the orchard pollinating the fruit ?

Some 60 specimens of 10 bee species carrying pollen were collected during the survey. Further analysis should help to find out if the carried pollen is originating from apple flowers.

Preliminary results

The honey bee *Apis mellifera* is the most abundant (61%), followed by bumblebees *Bombus spec.* (18%) and Mason bees *Osmia spec.* (13%). The latter group is of particular interest for this project because they like to inhabit the nest boxes. In 2015, we will be able to provide information about the impact on fruit set and pollination level. What we already see is that the Jonagold apples in general contain few seeds (an average of 2 to 3 for a maximum of 10). It will be interesting to see next year to what degree the pollination level will have changed. The pollen analysis is still ongoing.

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

Replant diseases are an increasing problem in all fruit crops, organic as well as integrated. The specialisation of recent decades has effectively eliminated crop rotation. Unlike integrated fruit growing, however, 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 as soil disinfection, 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 still difficult to solve. 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 may 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. Therefore, 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 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. Because this parcel requires a thorough approach, it was ideal for testing the different products (mycorrhiza strains, seaweed lime and soil conditioners).

Because this trial was performed in a new planting, it was possible to break the disturbing layer with a subsoiler. The organic material and/or soil conditioners could also be incorporated.

completed

Limited rooting zone as a result of a disturbing layer

Results

Despite the low vitality that the previous generation of trees had on this parcel (see CCBT-project "Replant problems with apple in organic fruit growing") the vigour of the young trees is very good so far. The incorporation of manure and breaking the disturbing layers have solved part of the growth problem. After two years no treatment has given a significantly greater tree volume. For production, no object scored significantly better than the control. However, one treatment did score worse: the application of Physiomax.

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Location: Janssens Paul and Bert, Rode 26A, 3380 Glabbeek
Funding: CCBT-project '*Aanpak van herinplantproblemen bij een nieuwe aanplant binnen de biologische fruitteelt*' (Department for Agriculture and Fisheries, Government of Flanders) (1/4/12 - 31/12/13)
More info: www.CCBT.be/projecten

Possibilities to obtain organic plant material for the Flemish strawberry grower

Until recently, no organic plant material was available for the Flemish organic strawberry grower. The only possibility was to ask for permission to use conventional plant material (derogation). But, in particular for short-term crops based on refrigerated plants, this implies a real risk for the presence of residues. Legislation in neighbouring countries has evolved to a prohibition of derogation in short-term crops; this rule is also likely to be implemented in Flanders. In the Research Centre Pamel, research on the possibilities to obtain organic plant material of strawberry started 6 years ago. In 2012 and 2013, the CCBT project 'Organic plant material for strawberry' was performed, with the intention to make organic plant material available for the Flemish strawberry grower.

Propagation: technique

Farmers are only allowed to propagate a limited number of varieties themselves. The Research Centre Pamel made a roadmap with an overview of the legal and technical elements related to the propagation of plants.

Plant material in organic strawberry growth

Initial situation (2012)

At the beginning of the project, the use and origin of strawberry plant material was inventoried. The inventory was based on a survey among organic strawberry growers and on the data of the derogation requests. Twenty companies participated in the survey; a total of 65,500 plants were noted.

Finally available (2013)

As part of a CCBT project, the Research Centre Pamel worked very actively on the provision of organic plant material through intensive communication with growers, plant breeders and suppliers, experts and representatives of the industry and certification organisations. Two plant breeders were willing to offer organic plant material of strawberry varieties. They were companies with a complementary product range. In 2013, organic plant material became available for 25 varieties: 16 June bearers and 7 everbearers. In the same year, a joint purchase of plant material of June bearers (in August) and everbearers (in autumn) was organised. The response to the offer was large: more than 100,000 plants were ordered by 26 Flemish, Walloon and Dutch growers in total.

completed

Propagation trial field

(At least) as good as conventional plant material

In 2013, conventional plants of Clery were compared with organic plant material of this variety. In previous comparative trials between organic and conventional planting, differences in plant type or origin of the plant were still present, but this was the first test at the centre with plants that were propagated by the same company. This means that the plants were propagated using the same techniques and delivered as the same type of plant. No differences between the organic and the conventional planting material of Clery were observed for productivity, fruit sorting, fruit weight or brix. Based on the different trials over the years, we can conclude that differences between different plant breeders and different breeding techniques are larger than differences between conventional and organic planting.

Future

The actions within the project led to the availability of organic plant material for a wide range of strawberry varieties. But this does not mean that all desired varieties are organically available. There is still much work to be done. From 2013 on, the Research Centre at Pamel will make maximal use of organic plant material. The Centre will only deviate from this principle for new breeds or for specific tests

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More info: www.CCBT.be/projecten

Towards sustainable and productive EU organic greenhouse 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, but production and productivity are too low to meet society's demands. This COST Action project joins more than 50 researchers and experts from more than 32 research institutes in nearly 15 countries. Five working groups have been formed to discuss the different topics. The Research Centre for Vegetable Cultivation (PCG) is mainly involved in the working groups about robust planting material and energy.

Aim of the project

This COST Action coordinates, strengthens and focuses the activities of the partners. It improves the communication, offers a common agenda, provides more and better knowledge for less money, shares new techniques, improves dissemination to OGH, and creates the 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 disease 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 that the results will be comparable;
- Non-chemical methods of seed treatment approved by EU standards for organic cultivation.

Soil fertility, disease 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 manures, 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 greenhouse production in the same region. This is explained by the need to control climate more strictly than in conventional greenhouse horticulture for disease prevention purposes. Energy is a very high fraction of production costs (some 20%), even more so in organic greenhouse production, where cogeneration is usually too expensive due to the small size of the farm.

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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Research on crops grown under protected conditions

Since 2001, the Research Centre for Vegetable Cultivation (PCG) has been researching organic crops grown in greenhouses or plastic tunnels. This practice oriented research encompasses many breed and rootstock experiments, but also includes demonstration research. The experiment schedule is set annually by a technical subcommittee for organic agriculture that includes organic growers.

Demonstration trials

For the demonstration trials in the heated greenhouse, fertilisation is an important research subject. Dosage is important of course, but also the sort of fertiliser can affect yield, taste, quality and shelf life. Also the costs of fertilisation are taken into consideration.

Demo trials in the tunnels are mostly summer crops. During these trials, we search for alternative crops and how the harvest season of certain crops such as melons can be extended.

Variety and rootstock trials

Variety and rootstock trials are an important part of the research in protected organic cultivation. With this knowledge growers can make an optimal selection when ordering planting material and seeds. Different parameters are considered: quality, yield, shelf life, brix-value, disease resistance, etc. Growers select the varieties and rootstocks to be included in the trials. The seed companies then give their best or newest varieties and rootstocks. Depending on the scale of the trial a selection is made on the basis of the availability of organic seed. The table below gives an overview of the kind of research in greenhouse or in tunnel performed in 2012-2013.

Crop	**Most suitable variety /rootstock**
Heated greenhouse	
Cucumber spring crop - variety	Toploader (Vitalis) Carambole (Rijk Zwaan)
Cucumber autumn crop - variety	Amazone (De Ruiter) E23L.2198 (Enza)
Loose type tomato - variety	Arvento (Rijk Zwaan) – fijn Admiro (De Ruiter) – middel Kanavaro (Vitalis) – middel Rebelski (De Ruiter) - grof

Tunnel	
Small type tomato – variety	Kerstomaat: Conchita (De Ruiter), Nun 09011 (Nunhems); Prune tomato: McDreamy (Vitalis), Delicacy (Sakata)
Cabbage lettuce – autumn variety	Briweri (Bingenheimer) Volare (Vitalis)
Spinach – autumn variety	Regenade (Bejo) Revere (Bejo) Racoon (Rijk Zwaan)

Variety and rootstock trials

Growers are actively involved in the research to the degree possible. Varieties and rootstocks similar to the one that are tested at the research centre are delivered to the growers so they can add an additional contribution from their own experience. On the basis of these trials, additional repeats are created and there can be verified, for example , if soil influences the trial results. Random factors can also be eliminated in this way.

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Possibilities for the cultivation of herbs

new

In 2011 the Provincial Centre for Vegetable Cultivation (PCG) started research on the cultivation of herbs, thereby creating a platform where growers can ask technical questions. The trials already performed cover a wide scope: herbs in open air or in the greenhouse, in pots or in the ground, kitchen herbs or medicinal herbs, spices for industry or fresh market. The trial subjects are determined by the herb growers. At an annual meeting they can consult with each other or indicate their research requirements.

Open air cultivation

Growers doing open air cultivation often request variety trials of kitchen herbs, together with technical and crop protection questions. Ongoing or recently-completed trials include:

- Technical cultivation trial on mint: efficient harvesting and weed control
- Crop protection trial on parsley: testing products against false and powdery mildew
- Variety trials on parsley, coriander and basil

Greenhouse trials: herbs in pot

According to the organic specifications, organic herbs can be cultivated in pots on the condition that the herbs are sold to the consumer together with the soil-filled pot. In this type of cultivation, the herbs are ready for immediate consumption. A big challenge in this cultivation method is to obtain mineralisation in a small volume of potting soil. Adding fertilisation in the pot is not as easy as it seems. This is a technical assignment which is not always obvious for growers. In the trials described below, growers can check which potting soils are commercially available and which soils need no fertilisation or lower additional fertilisation, depending on the type of crop.

- Trials with basil in pots: is it possible to grow basil in a pot (fast cultivation) without using additional fertilisation?
- Trials with rosemary in pot: which type of potting soil is most suitable for a slow cultivation that must hibernate?

Trial field and company visits

All the knowledge that the PCG generates on this subject is open knowledge and is thus extensively communicated with the sector. Knowledge exchange between colleagues is stimulated through company visits in Belgium and abroad. These company visits are organised by the PCG.

Processing and marketing

The market for herbs (for kitchen and medicinal use) is limited, thus production should not be separated from marketing. There are many opportunities for growers but appropriate distribution must still be found. Additionally, the processing of herbs will possibly create alternative distribution channels. PCG tries to stimulates contacts between producers and marketing.

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'Cultivation of herbs: niche or promising diversification' (1/11-6/13)
'Herbs: processing and marketing' (1/13-6/15)
More info: www.pcgroenteteelt.be

Agroforestry in Flanders: A profitable way to implement agro-ecological production

new

Agroforestry is a land use management system in which trees are grown among crops or grassland. It offers many opportunities to enhance farm resilience and respond to future challenges in Flemish (and West European) agriculture. Some examples are diversification in production and supplying a wide range of ecosystem services. Economically speaking, the expected increase in demand for biomass and high-quality wood products may make agroforestry a shock-proof investment for farmers. Agroforestry potentially meets the social demand for eco-efficient agro-ecological production methods while being economically profitable. Experience with agroforestry in Flanders is very limited, however. Besides the legal and administrative obstacles, many technical, organisational and economical questions remain unanswered.

Recently-started research project

The aim of this project is to increase the opportunities for agroforestry in Flanders through (1) integrated collaboration throughout the entire chain of stakeholders, (2) co-development of research knowledge and practical experience, and (3) provision of solutions and guidance for the target group. We primarily focus on the soil-bound agricultural sector, but we also include other stakeholders such as tree nurseries and wood and biomass processing plants.
The overall project objective is to create a relatively fast breakthrough of feasible, profitable and effective agroforestry systems in Flanders. This will be accomplished by conducting a participatory process with relevant stakeholders, fuelled both by in-depth research and effective dissemination of knowledge and experience.

Specific objectives are:

- Evaluating opportunities for various agroforestry systems in Flanders;
- Increasing knowledge of ecological interactions, ecosystem services, technical impact and especially economic opportunities for a selection of agroforestry systems relevant to the Flemish agricultural context;
- Obtaining an increased understanding of intention, attitude, norms, perception and social identity of those involved, to overcome the psychological and social barriers to agroforestry adoption;
- Providing decision support guidelines, practical suggestions and innovative solutions to farming enterprises with regard to the application of agroforestry;

- Encouraging and assisting stakeholders with the implementation of agroforestry measures, adapted to a given set of farming and environmental conditions. This responds to the current demand for well-founded support for farmers having a specific demand for transition towards the application of agroforestry. With this project we therefore not only aim for a change in attitude but also effective adoption.

This project uses a participatory methodology that enables co-development, consultation of stakeholders, transdisciplinary guidance of practitioners and capture of grassroots ideas. The aim is to maximise the relevance and validity of the knowledge and experience that is gained and disseminated. This participatory course runs through the entire project with regular feedback to and from other work packages.

Major outputs of the project are the development of an online knowledge platform, a practical guide and an integrated decision support tool.

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Funding: Agency for Innovation by Science and Technology (IWT) (1/9/14 – 31/8/19)
More info: www.agroforestryvlaanderen.be, www.vlaanderen.be/landbouw/boslandbouwsystemen

Composite cross populations: an alternative breeding concept in cereals?

new

CCPs: a genetically diverse crop

Composite cross populations (CCPs) are generated out of a cross of a number of varieties from which the seed yield of the entire population is used to create the next generation. This results in populations with an extremely high genetic diversity. The diversity benefits the resilience of the crop, which is very important in organic agriculture and is becoming more important with increasing climate change. By retaining some of the grain yield year after year and using it as sowing seed, the population can maximally adapt to the environment and to the way it is grown. This is structurally different from the concept of traditional 'farm-saved' seed, which typically has its origin in just a single variety. Composite cross populations also differ from variety mixes, where a few distinguishable varieties are sown together. Because by definition CCPs do not comply to the DUS testing requirements (dinstinctness, uniformity and stability), they cannot be registered in the European variety catalogue and thus cannot be traded as sowing seed.

In the United Kingdom in 2000, the Organic Research Centre developed their own composite cross populations of winter wheat. Twenty varieties were mutually crossed and the resulting populations were grown under organic conditions in the UK and since the 5th generation (F5) also in other European countries. Among others, the University of Kassel in Germany is doing extensive research on these populations since 2005. Since F8 the CCPs are divided into one part that is grown further on one location and another part that circulates annually in 7 European countries (UK, DK, NL, F, DE, CH, HU). At the moment this has resulted in 11 F13 CCPs, all of which originated from the same composite cross population.

CCP field experiments as part of COBRA

The purpose of the European project 'COBRA' (Coordinating Organic plant Breeding Activities for diversity) is to gather and improve the ongoing research on organic breeding in cereals (wheat, barley) and legumes (pea and field bean) in Europe by coordinating the European activities. The project involves 41 partners from 18 countries. The Organic Research Centre is the coordinator. In Flanders, Inagro and the University of Ghent participate in the project.

In the COBRA project, Inagro received 4 selections out of the aforementioned F13 generation and was able to test the value of these composite cross populations of winter wheat in Flemish growing conditions in 2014. The CCPs were sown at the organic experimental farm in Beitem. At the 'open field day' in June, farmers showed great interest in the trial plot and in the concept of CCPs. The results showed that the CCPs performed equally well in comparison with four reference winter wheat varieties of northern France, even under high pressure from yellow rust. Other countries also reported positive results on the CCPs resilience against the disease. Composite cross populations promise to be a good supplement to common varieties.

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Funding: Core Organic II ERAnet (Flemish partner: Department of Agriculture and Fisheries, Government of Flanders) (3/13 – 2/16)
More info: www.inagro.be, www.cobra-div.eu, www.organicresearchcentre.com, www.coreorganic2.org

Evaluating disease tolerance during the admission of new varieties to the national catalogue

Disease tolerance is a very important variety characteristic under organic growing conditions. Even under conventional agricultural practices, the European Integrated Pest Management (IPM) legislation emphasises the importance of growing tolerant or resistant varieties. ILVO evaluates the disease tolerance of new varieties towards several important diseases.

Rassenproeven

Each year, candidate varieties are sown in variety trials according to the VCU (Value for Cultivation and Use) 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. The final goal is to compare candidate varieties with already admitted reference varieties. Only the best performing candidate varieties are admitted to the Belgian catalogue and can be commercialised. In addition to agricultural characteristics such as yield and quality, disease resistance or tolerance is studied intensively.

During the growing season no fungicides are applied. This allows the researchers to evaluate the intrinsic value of a candidate variety. Variety information for several diseases is available for winter cereals, grasses, white and red clover, fodder beets and maize. In 2014, trial fields of winter wheat were confronted with a high disease pressure of yellow rust. Clear variety differences could be observed as illustrated in the following table.

Tolerance yelluw rust in winter cereals	
Variety	Yellow rust tolerance
Rustic	7,4
Manager	6,7
Julius	7,2
Homeros	4,8
KWS Ozon	7,7
Edgar	8,5
Espart	6,1
Liessart	7,8
Memory	7,3

Damage to winter wheat by Yellow rust in an early stage

Atomic	6,7
Campus	3,9
Balistart	7,3
Limabel	8,5

scale 1 to 9
9 = very good disease tolerance
1 = very poor disease tolerance

At the final evaluation of a variety, new varieties with high disease tolerance/ resistance are more likely to succeed for the VCU trials. In this way, several varieties which guarantee a high production level without fungicide treatments can be admitted onto the Belgian catalogue. Because of the new (IPM) European legislation, the importance of disease tolerant varieties will increase.

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A new generation of late blight resistant potato varieties

*Each year, 20 to 30 potato varieties are tested at Inagro's organic experimental farm. The humid and warm weather in 2014 was ideal for an explosive development of late blight (*Phytophthora infestans*). Some new varieties possess natural resistance, however, and resisted the pressure until the end of the season. These varieties offer perspectives for the future.*

Organic potato cultivation

In Flanders, around 150 hectares of potato are grown organically. This area is growing but it is still small in comparison to the total area of potatoes in Flanders and the area of organic potatoes grown in the Netherlands and Germany, for example. No synthetic fungicides are used in the organic cultivation of potatoes. To control potato blight, the organic farmer must therefore take other cultural measures. The aim is to reach good production before the blight fully manifests. Planting early, pre-germination and moderate fertilisation are important measures. Formulations based on copper are allowed in limited quantities. The choice of variety is also a very important instrument to control potato blight. Earliness, resistance to blight in foliage and resistance to blight in the tuber are important criteria. These criteria are gaining importance in the selection of new potato lines by potato breeders.

Variety testing

Annually, the Department of Organic Production at Inagro examines 20 to 30 potato varieties under organic conditions and without any treatment against *Phytophthora infestans*. Varieties are chosen based on the offer of commercial seed potato companies in Belgium and abroad. In accordance with the standards for organic agriculture, these varieties are exclusively the product of natural breeding techniques. In addition to a few standard varieties, mostly new varieties are tested which are ready for introduction in the market.

In the 2014 trial, 25 potato varieties were planted on the 14th of April. The end of May and beginning of June were very wet. On the 12th of June (about 60 growing days after planting) the first infestations of potato blight were observed in multiple varieties. Despite a drier period in the second half of June, the infection continued to develop. In mid-July, the following classification of varieties was made regarding their sensitivity to potato

completed

blight in the foliage:

- Very sensitive / nearly dead: Agila, Agria, Almonda, Antonia, Jelly, Magistral, Miss Malina, vdz 03-94, Ballerina, El Mundo. These varieties had a growth duration of less than 90 days.
- Moderately sensitive: Allians, Richill, Biogold, ELZ 04-42, Franceline KWS 05-656, Triplo. These varieties had a growth duration of approx. 90 days.
- Highly tolerant to resistant: Alouette, Carolus, CMK 2006-070-005, Connect, VOS 2006-001-001, Sarpo Mira, Vitabella, Toluca. These varieties had a growth duration of 100 to 110 days.

On the 5th of August, practically all varieties had either been killed by potato blight or were in the stage of senescence, at which point the foliage was burned. At that moment, Carolus, Connect and Sarpo Mira were quite green and still had some growth potential.

The trial was harvested on the 12th of September. In the classes 'very sensitive' and 'moderately sensitive', the gross yield varied from 10 to 25 tonnes per hectare. Some very sensitive varieties still had a reasonable yield. The class 'highly tolerant' achieved an average gross yield of about 50 tonnes per hectare.

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Search for resistant and/or less susceptible apple varieties

new

Variety testing is and remains important for organic fruit growers. Because they and their integrated cultivation colleagues mostly grow Jonagold, disease-resistant varieties are a top priority.

Testing for susceptibility to scab, powdery mildew, nectria canker and storage diseases

Within the Experimental Garden for Pome and Stone Fruits at pcfruit, all new apple varieties are tested for their susceptibility to scab, powdery mildew, nectria canker and storage diseases. To do so, four trees per variety are planted in a separate parcel which is not sprayed against powdery mildew, nectria canker or storage diseases. Spraying against scab is only done under very heavy infection pressure. In this way we get an idea of the susceptibility of the new varieties and their opportunities for organic fruit growing.

New apple varieties for organic fruit growing

Since 2009 potential new apple varieties for organic fruit growing are also planted in a separate parcel with an organic spraying scheme. Currently the parcel contains 33 new apple varieties. 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, a black strip under the trees is kept free of weeds in spring by hoeing and later in the growing season by mowing with a mower with a swinging arm. Against scab and powdery mildew only copper and sulphur are used. Only organic fertiliser is applied. In the planting year predatory mites are introduced into the orchard and the codling moth and leaf rollers are controlled with mating disruption (and if necessary with virus preparations).

When choosing a new apple variety the aspect of "sustainability" is very important. Previously, the focus was primarily on scab resistant varieties. But also susceptibility to powdery mildew, storage diseases and susceptibility to pests such as woolly aphids and spider mites will play a role in future variety selections.



Examples of scab resistant apple varieties

Results

If promising varieties for the organic fruit growers are found in the first screening, more trees are planted to find solutions for the specific problems of the new variety (especially concerning cultivation techniques). At this moment we have three varieties in the second screening, namely Sweetango®, Isaaq and Natyra.

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 there are varieties suitable for organic fruit growing. Sweetango®, Isaaq and especially Natyra are possible candidates.

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More info: www.pcfruit.be, Pcfruit vzw - Experimental Garden for Pome and Stone Fruits

British strawberries are top three varieties, led by Elegance

new

Every year, approximately 40 varieties of strawberries are planted in full soil at the Experimental Garden for Soft Fruits at pcfruit. These varieties are evaluated for production, fruit classification, yield progress and fruit quality. Besides measurements of objective parameters, much attention goes to judging taste and fruit quality as evaluated by an independent jury. The variety trials are conducted under conventional production conditions but the results give a good indication of the potential of the varieties under organic conditions.

Elsanta, the reference strawberry variety

The Belgian market is dominated by the Dutch strawberry variety Elsanta. Due to the mild winter and the warm spring of 2014, Elsanta had a 50% picking date three weeks earlier than in 2013. Of the total production, 59% (1.28 kg per plant) consisted of class I fruits. This is more than 100g above the upper limit of production realised with Elsanta in full soil in the experimental garden during the last 10 years.

Elegance captures the market

During the last five years, Elegance has regularly claimed the first place during the judgement of fruit quality by a jury of external experts. The nice red colour and the firm, homogeneous fruits with an almost artificial shine which even stayed during cool storage made it unbeatable again in 2014. Besides that, the combination of a good productivity (1.43 kg/plant) and an excellent fruit classification (77% class 1) resulted in 1.1 kg/plant fruits of top quality (45% more than Elsanta). In a tunnel crop it was even possible to pick 1.33 kg/plant class 1 fruits. Several tests proved an unchanged production per plant with a higher plant density of 5 plants per square meter. Elegance fruits up to a week later than Elsanta. Another small disadvantage is the rather limited taste. With continuous good results and a superb shelf life, it looks like Elegance has conquered a place on the market. In the future there will still be a spot on the market for really tasty varieties.

EM 1677, the all-rounder par excellence

This selection, also from the British East Malling, has earned a proper name. In 2012 this selection became second during the judgement of the fruit quality. During the same judgement in 2013, EM 1677 was narrowly beat by Malling Centenary. In 2014, the overall result of EM 1677 came close to that of Elegance. While Elegance and Malling Centenary both have clearly their

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strong and their weak points, the fruit quality of EM 1677 is judged good overall. Almost one kg of the total production (of 1.34 kg/plant) could be classified as class 1 fruit. Besides a considerably better taste, the production of EM 1677 is also up to one week earlier than Elegance.

Malling Centenary: early, nice and tasty

In 2013, this early selection was nominated as the revelation of the June bearer variety trial based on its excellent fruit quality. A production deficit of 20% compared with Elsanta could be compensated with an outstanding fruit classification. In 2014, the shelf life of Malling Centenary was rather disappointing, but the presentation of the shiny, conical, homogeneously coloured fruits was again excellent. Its sweet taste is the biggest advantage of this selection. An important additional advantage is the early production of Malling Centenary (up to one week before Elsanta). On top of this, it is probably possible to increase the plant density without production loss per plant.

Promising newbies

After several years without Belgian entries, we could again welcome some Belgian strawberries in the June bearer variety trial of 2014. The selection Moors 59 was characterised with a good fresh presentation and a promising fruit quality. Nearly 890 gram class 1 fruits were plucked per plant.

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Everbearers that even taste good?

The production and fruit class of the everbearers variety trial in full soil was considerably better in 2013 than the bad weather year of 2012. In contrast, 2014 can be described as an extremely early year (50% yield end of July – beginning of August) with somewhat unfavourable August weather conditions. In the everbearers variety trial, taste and fruit quality weigh heavily next to the objective measurements such as fruit weight, fruit color, firmness and brix value. The variety trials are conducted under conventional production conditions but can give a general indication of the potential of the varieties under organic conditions.

Portola, the reference variety

In 2014, Portola was tested for the eighth year in a row. This Californian variety has good production (1.2 kg/plant), a very good fruit classification, nice presentation and a very good shelf life. Unfortunately, its rather limited brix value translates into inferior taste. The taste can be ameliorated by a lower picking frequency, but this affects the fruit color (darker fruits). Due to the nice presentation and the good shelf life. Portola has earned a place of honour during the blind variety judgement with an independent jury every year. Taste and consumption keep Portola away from first place.

Furore absolute number 1

This selection (07-75-10) was the absolute number 1 during the annual blind variety judgement. The fruit quality was valued superb overall. Attractive presentation and good shelf life are also completed with a good production (1.5 kg/plant) and an excellent taste (!). The only disadvantage is a rather average fruit size. In addition to nice coloured and firm fruits, Furore is an early producer. This variety certainly has potential.

No progress for Verity

For the last two years now, Verity has lost its place in the spotlight. It was not even selected during the blind variety judging of 2013, but it did get second place in 2014. Characteristics such as a very good fruit classification, a good production, a remarkable shelf life (> Portola), nicely red coloured, firm strawberries with a healthy shine and a fresh fruity taste with an acidic flavour make it impossible to put this variety aside. The biggest disadvantages is the late production of this vegetative crop, together with the white colour inside the fruit and the large calyx.

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Vivara and Florina take 4th and 5th place

Vivara, an Italian selection of CIV, is gaining attention due to good production, a decent fruit classification and a very good fruit quality. It has extremely large fruits with a nice calyx, and despite a low brix value it's taste is good enough. In 2013 Vivara was ranked just outside the top 5, but due to an extremely nice presentation and a nice average score for all other subjects, Vivara can be found again on a fourth spot in 2014.

In 5th place, the Dutch variety Florina impressed the judges with a brilliant production and fruit classification, combined with a decent fruit quality. The brix value and the fruit weight are still somewhat low, but Florina has nice, firm fruits with a good colour and shine and early production.

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Variety trials in organic strawberry production: june bearers and everbearers

For over thirty years, Elsanta has been the most common strawberry variety in conventional cultivation. But breeders create new varieties every year, which are tested against Elsanta as a benchmark. The varieties are usually evaluated in substrate cultivation; in soil cultivation the evaluation usually occurs according to principles of conventional cultivation. The results from these tests therefore do not show how a variety will behave without chemical fertilisers and without chemical plant protection products. The Research Centre for Soft Fruits at Pamel (PKK) therefore conducts variety testing under organic conditions.

Variety trials

Several variety trials are performed per year. A recent evolution is the availability of organic plant material. Since 2013, organic plant material of different varieties of June bearers and everbearers is available.

In 2013, two variety trials were performed

- **June bearers, planted in August 2012** (1 observation): 17 varieties
- **Everbearers, planted in March 2013** (1 observation): 12 varieties.

Most varieties had sufficient production to achieve a good financial return. The June bearers Lambada and Sasha seemed less appropriate for organic cultivation methods due to high sensitivity to powdery mildew. Everbearers allow for an extended production period in accordance with the lower demand later in the year.

In 2014, four variety trials were performed. Parameters that were determined are: productivity, yield curve in time, quality classification, weight, brix value, and hardness.

- **June bearers, planted in August 2013** (4 repetitions). Varieties: Gariguette, Cigaline, Ciflorette, Clery, Primy, Donna, Dely, Cireine, Elsanta (Mart), Joly, FF 1004, Elsanta (Mazz), Candiss, Asia, Laetitia and Elegance.
- **Everbearers, half of them planted in fall 2013**, the other half in spring 2014 (3 repetitions). Varieties: Capri, Charlotte, Linosa, Cijoseé, Cirafine, Mara des Bois, Florina, Vivara and Florentina.

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- **Everbearers, planted in March 2013** (1 observation). Second year of production. Varieties: San Andreas, Florentina, Eve's delight, Ava, Charlotte, Verity, Sweet Eve, Favori, Florina, Cirafine, Maika and Mariguette.
- **Old varieties of June bearers, planted in August 2013** (1 observation). Varieties: Favette, Anablanca, Sequoia, Belle et Bonne, Cambridge Favorite, Souvenir de Charles, Surprises des Halles, Korona, Pajaro, Frau Mieze Schindler, Red Gauntlet, Fleurette, Vibrant, FF 1005, Symphony, Madame Moutot, Talisman, Belrubi, Lucy, FF 1004, Valeta, Souvenir de Charles, Gorella and FF 1003.

Taste

Variety choice largely determines the profitability of strawberry cultivation. Disease sensitivity is reflected in yield and in fruit size (fruit quality). The maturity date is decisive for labour organisation. One last important parameter is taste. Although hardness and brix value give a first indication of taste, the actual taste is a subjective factor that is difficult to value. Objective tests with taste panels exist, but they are expensive. Moreover, the taste of a strawberry not only depends on its variety, but also on harvest conditions and maturity. Each year, growers get the chance to taste the varieties that are grown in the trials at the PKK.

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Variety trials with floricane-fruiting and primocane-fruiting raspberries under organic growing conditions

In Research Centre Pamel, trials are set up with different varieties of raspberry to test the suitability of these varieties under organic cultivation methods. Variety choice largely determines the profitability of raspberry cultivation. Susceptibility to disease has a major impact on productivity and fruit quality. By choosing disease resistant or less susceptible varieties, raspberries can be grown in a more sustainable way.

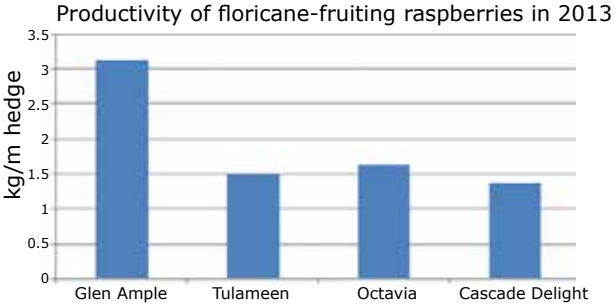
Variety trials

The raspberry varieties are tested under polyester tunnels. Fertilisation is based on the advice based on soil analyses. The raspberries are picked at different dates. The harvest records give information about productivity and yield curve.

In 2013, two variety trails were evaluated:

- **Floricane-fruiting raspberries, planted in 2011** (4 repetitions): Glen Ample, Tulameen, Octavia and Cascade Delight. The planting was done on the basis of short plants.

The trial showed a large difference in productivity between Glen Ample and the three other varieties. The harvest of Octavia lasted longer than the harvest of Tulameen.



- **Primocane-fruiting raspberries** (4 repetitions): comparison between Kweli and Imara. The planting was done on the basis of small root cuttings.

Productivity of primocane-fruiting raspberries in 2013

	kg per m hedge (avg.)	st.dev.
Imara	2,33	0,39
Kweli	2,42	0,59

Imara and Kweli showed similar results, for productivity as well as for yield curve.

At the end of the growing seasons, both of these trials suffered from a severe infestation of vine weevil (*Otiorhynchus sulcatus*). Therefore, for 2014 only results of a new variety trial with primocanes will be available.

- **Primocane-fruiting raspberries, planted in spring 2013** (3 repetitions): comparing Kweli, Imara and Kwanza.

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Pink rot in celery: developing resistant cultivars

Pink rot is a soil-borne fungal disease that can cause severe problems in conventional and organic celery crops. Traditional breeding involving artificial inoculation and selection of healthy plants allows ILVO scientists to develop more resistant celery cultivars. Such cultivars are needed to further reduce pesticide use in conventional farming, and to decrease the risk of having organically cultivated celery plants be rejected by the vegetable auctions.

Celery crops in Flanders and the influence of pink rot

Celery is a minor but important crop in Flanders. In 2013, about 1061 ha celery was grown in Flanders: 173 ha green celery, 108 ha white celery, and 780 ha celeriac. "Sprout celery" and "green hollow-pipe celery" are locally cultivated varieties. Celery is produced both in the field and in greenhouses, and is either sold in the vegetable auction or processed by the freezer industry. While most celery in Flanders is produced conventionally, organic production of celery is also important. Organic farming definitely needs more resistant celery cultivars but conventional farming does too.

Pink rot, a devastating disease caused by the fungus *Sclerotinia sclerotiorum*, is a major threat to celery crops. This fungus has a wide host range, including various vegetable crops. Pink rot predominantly appears late in the season, when a high humidity and moderate temperatures are present between fully-grown celery plants. In such conditions the fungus grows from the soil into the leaf stalks and later into the leaves, causing the leaf stalks and leaves to rot away. Because no completely resistant cultivars exist, pink rot can easily spread between plants in a field or greenhouse. In a later stage of infection, *S. sclerotiorum* forms survival bodies named 'sclerotia' that can survive multiple years in the soil. Pink rot is therefore a soil-borne disease. Farmers should absolutely avoid infection of pink rot in celery, because vegetable auctions and processing plants reject even slightly infected plants. Today, organic farmers can only act preventively against pink rot in celery.

Inoculation, screening, and selection

ILVO attempts to increase resistance to pink rot in celery through traditional breeding. Celery plants are artificially inoculated with pink rot, then the least infected plants are selected and crossed. To start, S. sclerotiorum isolates were collected from various infected fields and seed lots. Second, an artificial inoculation protocol or bio-test was optimised. The effects of plant age, incubation time, temperature and relative humidity during incubation and other factors on the disease development were investigated, along with the influence of the number of isolates used for inoculation. These studies allowed to optimise a reliable bio-test that could be used to breed for increased resistance in celery.

New celery cultivars are bred through family selection. Six-week-old celery plants are inoculated with mycelium fragments of five different *S. sclerotiorum* isolates. This is done in a greenhouse with moderate temperatures and very high humidity. Ten days after inoculation, the least infected plants are selected. By repeatedly crossing the most resistant plants from the most resistant families and subjecting the progeny again to the bio-test, plants with higher and higher resistance levels are attained. After three generations of selection, ILVO now possesses distinctly more resistant germplasm that should give rise to new celery cultivars with increased resistance to pink rot.

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Insect parasitic nematodes as organic insecticide in leek and cauliflower: field application not yet ready for practice

Entomopathogenic nematodes are commercially available as a safe alternative for chemical insecticides. Despite some applications with good results in greenhouses, the application in open field cultures remains out of reach. During the past four years ILVO, Ghent University and Inagro have been examining the possibilities to improve the application of nematodes against insect pests in leek and cauliflower.

Nematodes as organic pesticide

The nematodes *Steinernema carpocapsae* and *Steinernema feltiae* are used in the biological control of black vine weevil and various leaf-eating caterpillars in greenhouse crops, but they can also infect various other pest insects. Despite their success in greenhouses, their effectiveness in outdoor soil or crop applications is highly variable and in most cases insufficient. Earlier research concluded that failures are most likely due to an incorrect application technique and due to adverse environmental conditions during or after application. Applied nematodes are subject to environmental factors such as moisture and temperature that influence their survival both on the plant and in the soil. In suboptimal conditions, a large number of the nematodes die before they can infect their hosts. ILVO, Ghent University and Inagro investigated these environmental factors to optimise techniques for applying entomopathogenic nematodes in the field. The research focused on spray applications directed towards the foliage, against the leaf-bound caterpillars of the cabbage moth (*Mamestra brassicae*) and against onion trips (*Thrips tabaci*) in leek, and on soil applications against the soil-bound maggots of the cabbage root fly (*Delia radicum*) in cauliflower.

Insufficient survival on the leaf

For both the foliage and soil applications, entomopathogenic nematodes are suspended in liquid and sprayed over the crop. ILVO's Agricultural Engineering team studied the influence of the spray application techniques on the survival of the EPN and on pest control. Ghent University's Department of Plant Protection investigated which adjuvants could be used in combination with the nematodes to improve the pest control results. This research resulted in a number of new guidelines for the application of nematodes with foliar spray treatments. Based on the findings of these two research groups, Inagro carried out field trials with nematodes against caterpillars in cauliflower and trips in leek. In cauliflower, an adapted spray boom configuration with vertical extensions and underleaf spraying nozzles was used to reach both the top and the bottom of the cabbage leaves. Two selected adjuvants were added to the tank suspension. The combination of the adapted spray boom and the spray formulation with adjuvants improved the control of the leaf-bound cabbage moth caterpillars with *S. carpocapsae* nematodes in the field, but not to such an extent that EPN applications could compete with spray applications with Bt (*Bacillus thuringiensis*).

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The field experiments against trips in leek did not provide promising results either. The cause of this low efficiency has to be sought in other factors such as the temperature of the environment, the crop and the strains of the nematodes used.

Soil applications look more promising

A soil application against cabbage root fly looks more promising because the nematodes are applied in their natural habitat, the soil. The nematodes were applied by spraying them in the planting pots before planting, by pouring them near the plant foot in the field, or by injecting them near the plant root locally. Some of the tested applications significantly reduced the plant losses caused by cabbage root fly compared to the untreated control. In addition to the application technique, the dose of nematodes and the time of application seem to be crucial for a good control effect. Still, the nematodes could not reach the efficiency of the reference product spinosad in any of the trials.

No suitable practical application available yet

In their current commercial form, entomopathogenic *S. feltiae* and *S. carpocapsae* do not offer a ready to use alternative to control caterpillars and cabbage root fly in cauliflower and trips in leek. To improve the efficiency in outdoor fields, further research is necessary to find new species or strains of nematodes that more actively search for a host and/or that can survive longer in the soil.

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More info: www.biopraktijk.be, PhD thesis of Bert Beck – Sustainable insect control in vegetables through optimized applications of entomopathogenic nematodes

Nebulisation of Biological Control Organisms (BCOs) in cold storage to control postharvest diseases

new

Management of storage diseases with biological control organisms (BCOs) is a safe and environmentally-friendly approach that has potential for application in organic and integrated farming. Furthermore, this type of strategy fits the objectives of the European guideline concerning the sustainable use of plant protection products. Different yeasts have already been selected for the control of storage diseases. Their mode of action is based on a competition for food and space.

Efficient application of BCOs

Preharvest as well as postharvest treatments are performed with BCOs all over the world, but research trials pointed out that postharvest treatments are more efficient than treatments in the orchard. Until now, only a pre-harvest treatment with one BCO (BoniProtect) is registered for pome fruit in Belgium. Traditional applications like dipping or shower treatment have some disadvantages like high investment or operational costs, cross contamination and the removal of the wastewater.

Nebulisation of BCOs in cold storage to control postharvest diseases

Research concerning the application of fungicides in cold storage rooms using thermos-nebulisation was performed in a previous IWT-funded project. One disadvantage of this application technique was the non-homogeneous distribution of the BCO in the cold storage room. This resulted in some residue levels being above the legal standards, which may cause strong restrictions in sales for retail or export. Based on these findings and the limitations to use this technique in practice, the idea arose to use this technique in combination with BCOs.

Efficacy of different BCOs towards postharvest diseases

In this project some (new) BCOs are tested for their efficacy towards postharvest diseases. The first results indicate that a couple of the BCOs tested obtain good efficacy towards postharvest diseases. Some additives have a synergistic effect on the efficacy of BCOs towards storage rot diseases. The other challenges addressed in this project are 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.

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More info: www.pcfruit.be, Pcfruit vzw - unit TWO

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

All growers - 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 reduce energy costs. However the application of CHP is not always possible for growers with a small surface area or a great variety of crops, as is often the case in organic horticulture. The Provincial Research Centre for Vegetables (PCG), which has been doing research in organic protected horticulture for many years, is searching for a practical solution for (small) organic companies.

Semi-closed greenhouse

In 2010, PCG invested in a new greenhouse with an energy efficient heating system that applies the concept of a semi-closed greenhouse. The setup had to be appropriate for organic culture, with a high energy saving potential of 50% and had to increase production potential by 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 CO2 that is produced by combustion which can be used in the greenhouses. Cold is also produced by the heat pumps, which can be used for dehumidification. When active dehumidification is applied, greenhouses can be closed more often, resulting in fewer losses of heat and CO_2. Because organic growth has a higher humidity because it is done in full soil, dehumidification is used to maintain a steady level of humidity.

For short-term storage, cold and heat are stored in two water tanks of 45 m³. For long-term heat storage, heat can be transferred to the ground using BTES (Borehole Thermal Energy Storage). This BTES field allows for 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 recuperated using a heat pump.

Measuring energy use

Since January 2012, measurements have been carried out to identify energy and CO_2 flows. Measurements were carried out for tomato in 2012, 2013 and 2014. In 2012 an energy use of 418 kWh/m² was measured between 20 January (plant date) and 27 November (end of season) with an average

yield of 41.8 kg/m² (Beef Heart tomatoes). The primary energy use was 298 kWh/m² when the Coefficient of Performance (efficiency) of the heat pump of 140% was taken into account. In 2013 an energy use of 298 kWh/m² was measured between 22 January (plant date) and 20 November (end of season) with an average yield of 36.6 kg/m² (eight varieties of loose tomatoes). The primary energy use was 213.6 kWh/m² with a COP of 141%.

Energy savings and payback time

The primary (thermal) energy saving was 35% in 2012 and 53% in 2013 when comparing the measured values were compared to a reference situation of 460 kWh/m² or 40 m³/m² natural gas for a year-round cultivation of tomatoes. The measurements in 2013 show that the proposed energy saving of 50% can be realized. The use of an energy saving climate control (use of energy screens, limited use of ventilation windows, lower tube temperature, limited use of minimum tube temperature, and so forth) is an important part of the achieved energy savings. The extra production of 5% that was anticipated when the system was built is difficult to estimate because of the lack of a good reference situation. When comparing the yield of the old organic greenhouse, with a shorter growing season taken into account, we can state that there is a trend to a higher yield in the new organic greenhouse. On this basis of the measurements and energy savings realized in 2013, a payback time of 7 years was calculated when installing this system in an existing 2-ha greenhouse.

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6189

Robust organic production systems – Animal production

Animal welfare and health

Animal feed

Production systems

Improving the health and welfare of organic laying hens in Europa – "HealthyHens"

Through an epidemiological study, risk factors were identified that are associated with the health, welfare, mortality and production results of organic laying hens. By participating in this study ILVO contributed to improving the health and welfare of organic laying hens in Europe.

International identical implementation of the project

ILVO conducted this research as part of the HealthyHens project, a European project (CORE Organic II) with partners from eight European countries (GE, DK, IT, UK, NL, AT, SE, BE). In each of these countries an observational study was conducted using a standardised methodology on a total of 115 flocks. Farms were selected according to pre-defined criteria. Belgium contributed by evaluating 7 organic laying hen farms. The project focussed on (1) endo-and ectoparasites, (2) the use, design and management of free range opportunities, (3) feather pecking and cannibalism, and (4) other health and welfare problems, such as keel bone injuries and foot health. In addition to data collection on the Belgian farms, ILVO has contributed to the development of standardised methodological protocols and to training observers to ensure that data were collected in a uniform and comparable manner in all countries.

Provisional summary results

Preliminary results show a wide variation between flocks, both within countries and between countries. Some provisional findings are listed below.

Ecto-and endo-parasites:

- Red mites were found during summer and winter.
- 55% of the manure samples taken during peak-of-lay and 61% of the samples taken near the end of the laying period were infected with *Ascaridia galli* eggs (large roundworm) and *Heterakis gallinarum* (small roundworm).
- During dissections at the end of the laying period 68% of the flocks were infected with *Ascaridia Heterakis* worms and 28% with *Heterakis* worms.
- Eggs of *Capillaria* (hair worm) were found in about one-quarter of all flocks.

Keel bone injuries:

- Almost all hens showed signs of keel bone injuries (fracture or deviation).
- 0 to 88% of the hens had a fracture of the keel bone (flock average 31%).
- 0 to 84% of the hens had a deviation of the keel bone (flock average 23%).

Leg Health:
• On average 29% of the hens had a lesion and 33% showed hyperkeratosis on the foot pads.

Feather pecking and cannibalism varied substantially between flocks. There were flocks in which this damaging behavior was totally absent and other flocks in which all the hens showed signs of injurious pecking.

Benchmark and recommendations

After completing data collection, risk factors will be identified using statistical techniques. The results will also allow comparison of the Belgian farms with other European farms. Recommendations will then be formulated as well prevention strategies for optimising the management of organic laying hens. These recommendations will be communicated to farmers and advisors and will be made available through publication in scientific journals.

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Development and application of a welfare evaluation instrument on organic dairy goat herds

new

Consumers are becoming increasingly aware of the origin of their food, which is linked to increasing criticism of the current welfare standards of production animals. Organic dairy goat farmers are required by law to fulfill certain rules supporting the welfare of their animals. Economically, organic goat farmers may profit from high animal welfare because stress and production parameters like growth and milk production are closely related. This gives the welfare issue both ethical and economic relevance. But in the final analysis, the goats are the ones who benefit the most from animal welfare research.

Towards a simplified protocol

The final aim of the ongoing research is to develop a simplified protocol for on-farm evaluation of the welfare of dairy goats. The protocol must be simple, clear, easy and quick to use. The dairy goat keeper may use the results of this protocol to make decisions about future investments.

Approach

Based on scientific literature and the welfare protocols already in use, such as the Welfare Quality® protocol for dairy cattle, we will develop a comprehensive science based welfare protocol adapted to dairy goats. This protocol will be applied to Flemish and Dutch organic dairy goat herds. Additionally, fecal samples will be taken for cortisol analysis. Cortisol is regarded as a physiologically validated welfare measure which reflects the amount of stress experienced by the goats. The results of the protocol and cortisol analysis will be compared. After statistical analysis, we hope to be able to make a selection of some parameters in the comprehensive protocols which proved to be the most prominent welfare indicators. This selection should result in a simplified protocol which will be discussed and further processed in consultation with the dairy goat farmers participating in an organized organic dairy goat network. Before and after application of the protocol, an economic analysis of the dairy goat herds will be made. We hereby hope to provide a link between welfare and economy of these dairy goat herds.

First steps

This research started on 1 November 2013 with a literature review. Since then, two meetings with the dairy goat farmers group have taken place. During these meetings the farmers were asked to formulate their ideas and wishes concerning the welfare protocol. An effort was made to integrate these findings into the protocol. The protocol is now complete and was applicated in sixteen organic dairy goat herds during November 2014 – January 2015. An economic herd overview (= benchmark) of those herds was already made during September/October 2014.

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Funding: PWO (Project based scientific research), University College Odisee (1/11/13 - 30/4/16)

Early growth in goat kids improves subsequent milk production

*Coccidiosis, one of the most important diseases of young stock on goat and cattle farms, can delay growth and lower milk production later in life. 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 and then penetrate the intestinal cells and multiply there, damaging the intestinal cells. 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 a lower productivity due to reduced growth.*

Better growth with herbal feed supplement

During a prior project on phytotherapy, an herbal feed supplement was tested on goat kids during 3 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 4kg.

The Flemish organic dairy goat farmers were interested to find out if this weight difference could also be translated in a better performance during the first lactation. The kids that participated in the earlier trial were therefore monitored during 7 months after their first kidding.

Monitoring first lactation

Before the start of the kidding season the goats were weighed. The goats from the herbal group were still heavier and retained the weight difference during lactation.

The age at kidding of the goats of the herbal group was 381 days old, while the mean kidding date was 16 days later in the control group.

Milk production was monitored during 7 months. Early in lactation, the goats in the herbal group produced 0.4 litres per day more than the control group. This difference was reduced towards the end of the monitoring period. Because there was a difference in kidding date between the groups, milk production was calculated within the same period, namely between day 46

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and 120 after kidding. In this period the goats in the herbal group had a mean production of 388 litres, while the goats in the control group produced 344 litres. The 44-litre difference was statistically significant.

Is supplementation economically relevant?

A higher milk production also means more farm income. During the trial period the milk price was €0.75 per litre, which means a surplus income of €33 per goat. This was more than enough to cover the cost of the herbal supplement (€7 per goat).

Even when accounting for higher feed costs associated with higher milk production, the cost of the herbal supplement is still acceptable due to the better youth growth and subsequent increase in milk production.

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CCBT project 'Coccidiosis in goat lambs and calves' (2011) and
CCBT project 'Follow up of the Coccidiosis project: impact of the growth advantage of goat kids in later production periods' (1/4/12 - 31/12/13) (Department of Agriculture and Fisheries, Government of Flanders)
More info: www.CCBT.be/projecten, Kruidenleverancier: http://biomuehle-kraeuter.de/

Native plants as anthelmintics in organic goat farming

new

Gastrointestinal parasites affect animal health and leads to production losses in ruminants, including significant decreases in milk production. Parasitism leads to both direct and indirect losses and result in several symptoms: diarrhea, weakness, decline of growth, anemia and in severe cases, even death. Animals get infected by ingesting infectious larvae located on the grass. Non-organic farms avoid infections by applying zero-grazing management, or by preventively administering anthelmintics when grazing is applied. Organic farmers are legally bound to provide access to pasture, however, and can only use anthelmintics for curative purposes. A workable alternative to traditional helmintics must be found.

Gastrointestinal parasitism in Flanders

To date, no data are available on the magnitude of gastrointestinal nematode infections in dairy goats in Flanders. Ten organic Flemish goat farms will be sampled in 2015 on a monthly basis. Fecal samples will be analysed to quantify the worm burden. Evolution of the infections will be monitored between February and November 2015. An EPG value (eggs per gram faeces) will be determined to estimate the amount of eggs present in the faeces. Co-proculture will be used to identify the worm species. Students at the University College Ghent's Department of Agro and Biotechnology will help to collect and analyse the faecal samples.

Going native: can plants offer an alternative?

Phytotherapy or the use of extracts of natural origin is as old as mankind. However, the knowledge on the use of medical plants needs to be supported by scientific research. The lack of information from the field demonstrates the need for further research. Native plants (herbs and ligneous vegetation) will be screened for their possible anthelmintic properties. The first step will be a literature search. Agricultural plants that are easy to cultivate will be subject to an in vitro screening, using an easy-to-grow, commercially available nematode species. The most promising plants from the in vitro trial will then be tested in vivo.

Possible future research

Introduction of the selected plants into the pasture will be considered. In addition to the technical demands, the demand of labour and cost will be taken into account as well as the susceptibility of the plants to pests and disease. An important factor to consider is whether the selected species affect the flavour of the milk.

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Funding: University College Ghent (PWO project)
(22/9/14 - 30/9/16)
More info: http://pure.hogent.be/, click 'Projecten', typ 'GINGEIT'

Sulphur supply for cattle, plant and soil

new

Now that the problem of acid rain has been solved, the free supply of sulphur on agricultural soils has disappeared and an increasing lack of sulphur is being observed. Sulphur is important for animal and plant production because it is a key factor in the assimilation of amino acids (e.g. methionine and cysteine) and is thus important for protein formation.

Sulphur shortage for cattle

Inagro and Wim Govaerts & co identified the sulphur level in organic livestock in the context of the CCBT project '*Zwavelvoorziening voor dier, plant en bodem*' ('Sulphur supply for animal, plant and soil'). In 2013, 17 Flemish organic dairy and meat farms were monitored. The cattle on more than half of these farms showed a shortage of sulphur in spring. The animal's health improved when supplemented with magnesium sulphate (Epsom salt). But supplementing the cattle does not solve the problem of suboptimal sulphur content in the soil and plants. Moreover, supplementation with magnesium sulphate has an acidic effect in the rumen of the cows and thus must be treated with care.

Sulphur shortage in grass-clover

The monitoring on several of these farms revealed a lack of sulphur in grass-clover and in the soil. Sulphur shortages in the soil can be determined based on the 'sulphur delivering capacity' of the soil. However, the results were not clearly related to the sulphur content of grass-clover. Analysis of silage or fresh grass-clover give more reliable information on the sulphur content on plant and soil level. Fertilisation trials in 2013 and 2014 showed that sulphur fertilization with a sulphate based fertiliser is useful if the sulphur content of grass-clover is below 2 g/kg DM or if the N/S ratio is above 12. This type of fertilisation led to a higher sulphur content in grass-clover, thus ensuring the sulphur supply of cattle. Moreover, a reliable sulphur content in soil may lead to a higher grass-clover yield.
Bovendien zorgt een voldoende zwavelvoorraad in de bodem voor een hoger opbrengstpotentieel van de grasklaver.

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CCBT project 'Klaver troef!' (4/13 – 12/14) (Departement of Agriculture and Fisheries, Government of Flanders)

More info: www.inagro.be, www.CCBT.be/projecten

Improving free range use of chickens housed in mobile stables combined with production of short rotation coppice

new

How does planting short rotation coppice in an outdoor area for free-range broilers affect the chickens' behaviour and their quality? And how do the chickens affect the growth of the short rotation coppice? ILVO is testing this with an experimental setup that combines a willow cultivation with broiler management.

Free range chickens don't always range freely

Chickens with free range access often do not use it optimally: only some of the birds go outdoors and when they do, they usually stay close to the house. Chickens probably stay indoors because of the sense of being unprotected against predators and aversive weather conditions while outside. Scientific literature indicates that shelter plays an important role in the use of the free range area. It remains unknown, however, which type of shelter is most suitable for use in the free range area. Increased use of the outdoor run, with the chickens distributed more evenly over the entire area, would benefit both the animals and the environment (e.g. lower point emissions).

Research approach

At ILVO's experimental farm, a plot has been planted with 50% short rotation coppice (willows) and 50% grass. Several rounds of slow-growing broilers are to be housed on this plot in mobile stables to give them access to either the willows or the grassland. In addition, one group of chickens is housed indoors. Free range use is studied using cameras and observations to see whether there is a difference between chickens with access to grassland or to willows. It will also be studied if environmental enrichment early in life (i.e. before they have outdoor access) will lead to less fearfulness in the animals, and therefore increased use of the free range area. Welfare parameters, meat quality, taste, bone quality and production results are also assessed. In addition, we study the effects of the chickens' presence on the growth and production of the willows as well as nutrient balances in the soil.

Besides observations with cameras, we also plan to monitor individual animals in the future. The chickens would then have access to both the willows and the grassland, and their position would be followed using an

automated system. In this way, we will be able to determine whether they prefer willows or grassland. With individual data we can also investigate relations between outdoor use, personality characteristics, meat quality and welfare parameters.

Relevance and valorisation

Full use of the available outdoor space would increase the space available per bird and the birds would have more opportunities to perform natural behaviours such as foraging and dust bathing. This would also benefit the environment, because the concentration of faeces close to the stable would decrease. Scientific knowledge is lacking about how to best design a free range area; this study helps to fill that knowledge gap. Short rotation coppice would not only provide shelter for the chickens, but also represents a source of extra income for the farmer due to increasing demand for biomass. Short rotation coppice farmers would also be able to house broilers in mobile stables on their land for extra income.

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When do laying hens use the free range area and the nest site?

new

The Experimental Poultry Centre (EPC) conducted two literature studies in 2013 and 2014. The first one describes the use of the free range area by laying hens (end of 2013). European legislation does not specify the following statement: "when weather conditions don't allow access to the free range". During audits, organic poultry farmers and auditors have lengthy discussions about this non-specified statement. The purpose of this study is to inventory and explain criteria in literature which can offer a basis for a more concrete interpretation of when it is comfortable and responsible to keep laying hens in a free range.

Ambient temperature plays an important role

An animal can only maintain a constant body temperature (without adapting its metabolism) between certain limits of the ambient temperature, called the comfort zone. When ambient temperature drops beneath this zone, heat production is needed to maintain the thermic balance between animal and environment. When ambient temperature is higher than the upper limit of the comfort zone, heat loss is needed to keep a thermic balance. Both situations weaken the thermal comfort and start up regulation mechanisms. The width of the comfort zone depends on the age and bodyweight of the animal, the feed requirements, the housing system and the animal's health.

Other important factors?

Air movement and air velocity also influence the hen's comfort. A higher air velocity at cold temperatures can be felt as a draught. Draughts at animal level should be avoided because they can cause discomfort and illness. However, at high ambient temperatures (25°C-30°C), a higher air velocity can have an agreeable cooling effect. Rain and snow can also result in less intensive use of the free range.

Definition of "usable area"?

In the second study, which will be completed at the end of 2014, we look for arguments to prove that the nest site can be accounted for as "usable area" for the hens. The term "usable area" is defined in the reports of EGTOP (Expert Group for Technical Advice on Organic Production).

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The legal stocking density is based on the "usable area", which is in turn used to calculate the number of hens allowed at the onset of the laying cycle. In the current definition of "usable area", the nest site or nest area is not included. However, the nest site is necessary for laying hens to display their natural behavior and is frequently visited by the animals. Well-trained hens produce a low percentage of floor eggs (eggs laid outside the nest), supporting the need to have an attractive nest site. Because such a nest is frequently used and visited by the hens, it should therefore be considered as part of the definition of "usable area". In Flanders, accounting for the nest in the definition of "usable area" can have economic consequences, as it increases the number of hens that can be kept in production and therefore directly influences the farmers' financial results.

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CCBT-project 'Exploring the literature for criteria for the responsible use of a free range area in organic poultry' (Department of Agriculture and Fisheries, Government of Flanders) (1/4/12 - 31/12/13)
More info: www.provincieantwerpen.be, www.CCBT.be/projecten

Closing cycles in organic poultry

new

In 2014, the Experimental Poultry Centre, in collaboration with ILVO and Inagro, is searching for opportunities to close cycles between organic poultry and arable farming at the sector level. Closing cycles starts with optimal use of regionally and economically valuable resources. However, nutritionists and poultry farmers are inadequately familiar with this notion, which results in an incomplete use or exploration of the possibilities of regionally available feed components.

What is currently known and available?

To start, a literature review and interviews with stakeholders reveal information about regional and profitable crops which can potentially be used in feed for organic poultry. Based on this information, with the focus on poultry feed requirements, five potential feed formulations and accompanying crop rotation plans will be drawn up. Starting from these potential feed formulations, we can calculate the required amount of different resources per 1,000 animals. In the next step, we can calculate the necessary crop area and evaluate what is technically and economically feasible.

Practical possibilities?

In the second part of this research, we will try to use the acquired information in practice. Modern feed experts are less in touch with arable farming and crop experts have insufficient knowledge of the nutritional requirements and preconditions of poultry. As a practical case, the partners want to advise an organic poultry farm. Based on the farmers' technical goals, a concrete business plan will be elaborated.

Exchanging information

The exchange of information between theory and practice is essential in this project. The opinions of different stakeholders can help in the formulation of different feeds and crop rotation plans. The results of this project will serve as a strong basis for a round table discussion between poultry farmers, arable farmers and intermediates (animal feed companies, nutritionists, etc.).

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More info: www.provincieantwerpen.be, www.CCBT.be/projecten


Fruit, nut & oat

Flexible organic chain systems

FOOD4SUSTAINABILITY

Food4Sustainability is a Belgian research project financed by BELSPO. Three universities (ULB, KU Leuven and Université Catholique de Louvain) are working on the governance of collective actions in sustainable agro-food systems from 2014 to 2018. Intrinsic and extrinsic motivations of the actors in the food chain play a key role in the project.

Together, the provision of agricultural inputs and the production, packaging, processing, transport, and distribution of food, contribute 19-29% of global anthropogenic greenhouse gas emissions. They exert an important pressure on natural resources, water, nitrogen and phosphate, with arable land being particularly affected. Reforming food systems towards greater sustainability is therefore essential for a transition towards a low-carbon and resource-efficient society. Though important, economic incentives (including subsidies and fiscal incentives) alone will not suffice to achieve this.

Obstacles and barriers

We aim to identify the conditions for a transformation of food systems that accounts for both the extrinsic (external rewards) and the intrinsic (personal values and social norms) motivations that shape the conduct of actors of food systems, the obstacles and barriers to transition as identified by these actors, and the institutional and governance conditions that must be created in order for such a transition to succeed. Consideration of the heterogeneity of actors' motivations and preferences not only provides a more realistic understanding of behaviour, it also improves our ability to guide a transition towards more resource efficient food systems that contribute to mitigating climate change.

We will study possible transition pathways in both the mainstream food systems that rely on large processors and retailers, as well as in alternative food systems that have typically emerged in a bottom-up way, often through local and citizen-based initiatives. Using extensive semi-structured interviews, we will highlight the motivations of actors and which policy innovations can be most effective, including the values and beliefs of the actors of the various food systems.

The final aim of Food4Sustainability is to formulate a road map that facilitates actions as well as policy recommendations that enhance the path for transition towards a sustainable food chain.

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More info: www.food4sustainability.be

The performance of local and global food systems: a multidimensional approach

The last 10 years have seen an emerging trend in many Western countries to relocalise food consumption. Examples are community-supported agriculture vegetable boxes, farmer's markets, regional products and farm shops. But how exactly do these local food systems differ from the global food system? What do we mean when we talk about 'local' and 'global' food systems? And what is the difference in their impact? As part of the European FP7 research project GLAMUR, KU Leuven is trying to answer to these questions.

The quality of food systems

Before assessing the performance of food systems, one needs to know the necessary evaluation criteria. These criteria depend on the societal context and the biophysical reality in which the food systems are embedded. To investigate which criteria are important to evaluate the performance of food systems in Flanders, we performed a discourse analysis. In other words, we analysed how stakeholders and food actors communicate about the performance of food systems. In this analysis we looked at five dimensions: economic, social, environmental, health-related and ethical. We analysed 140 documents from four social spheres: the public sphere (mainly newspaper articles), the market sphere (publicity, marketing, year reports from companies, etc.), the policy sphere (mainly reports) and the scientific sphere (scientific articles). We also interviewed various stakeholders. The evaluation criteria that resulted from this study are 'affordability', 'productivity', 'profitability', 'risk and stability', 'contribution to the local economy', 'fair distribution of costs and benefits', 'job satisfaction', 'food waste', 'water pollution', 'energy use', 'biodiversity and land use', 'transparency', 'taste', 'authenticity', 'contribution to a healthy diet', 'animal welfare' and 'cultural identity'.

An organic apple from food teams or a conventional apple from the supermarket?

In the next phase, done together with our European partners, we selected case studies from five food product groups: 'vegetables and fruits', 'dairy', 'meat', 'cereals' and 'wine'. Our research group concentrates on the fruit and vegetable group. We evaluate and compare three chains: a short chain, that is organic apples sold directly to a food team; a long chain, that is apples produced with integrated fruit production techniques, transported to the auction and sold in supermarkets; and an international chain in which apples are produced in New Zealand and purchased in Belgium. Based on indicators linked to the abovementioned attributes we are comparing the performance of the three chains. This is an ongoing project. The same approach is used to evaluate and to compare asparagus food chains destined for Flemish consumers.

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More info: http://glamur.eu/

Short and strong: cooperation for logistics in short supply chains

new

The strategic plan on short supply chains created by the Government of Flanders was made to remove barriers and supporte and stimulate the actors involved by optimising distribution and logistics (amongst others). 'Logistics' means getting the right goods on time, in the required quantities, in the correct condition, at the lowest cost, to the right place. Logistics are thus organised differently in short supply chains than in regular supply chains. Logistics in short supply chains have to cope with restricted volumes, a lack of efficiency and a lack of professionalisation. Although actors in the short supply chain underestimate the impact of logistics (and the impact on time and cost), organising the logistics as efficiently as possible is of great importance in order to achieve profitable short supply chains, happy consumers, better prices, lower costs and better accessibility.

Cooperation: the key to the most efficient logistics

The goal of this research report was to analyse how cooperation can improve logistics, by giving an overview of the (sometimes fragmented) literature, current and completed projects, and the recommendations on logistics resulting from case studies. According to the literature, cooperation helps to avoid unnecessary logistical costs and to achieve a better use of capacity, economies of scale, more frequent deliveries, lower transaction costs, etc.

Practical examples in the report also showed how logistics improve when done in partnership. This cooperation can stretch out horizontally (with fellow farmers), vertically or in a network and around different activities: matching demand and supply, order systems, transport, packaging, processing and storage.

Some examples only pay attention to logistics when they reach a certain growth (e.g. the number of distribution channels) and turn to specialised, external logistical partners (cooperation or outsourcing) for support. Strategic collaborations with companies, organisations, … with complementary knowledge and expertise are well worth the effort. An efficient organisation of logistics requires time, money and knowledge. Furthermore the logistics have to be adapted to all the other elements of the business model (mission, strategy, marketing, etc.).

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Custom-made? Farmers and government in action

Because of the specific features of the short supply chain initiatives, the region where they operate, its current logistical flows, the existing means, and so on, (cooperation about) logistics is often custom-made. Although no one recipe for success can be found, a number of general success factors and focus points can be defined: to assess and to divide the costs and benefits, to put the consumer first, to choose partners deliberately, to start small, to be able to rely on trust and commitment, to have an inspiring and responsible leader, fixed agreements, a business plan, and so on.

The report synthesised the literature and case studies in a checklist targeted at new and existing short supply chain initiatives. Just as this initiative is developing and evolving, the logistics and the cooperation (and the checklist) must be re-evaluated and adjusted. The role of the government is limited to the creation of the right framework for initiatives to start, to develop and to exchange knowledge. The collaboration is then set up by the initiating parties themselves.

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More info: www.vlaanderen.be/landbouw/studies

Delicacy vegetables: growers and chefs meet at the PCG

new

The demand for high-quality delicacy vegetables has rapidly increased in the last couple of years. More and more attention is drawn to local vegetables and specialties like mini vegetables, new crops, and 'forgotten' vegetables. Chefs increasingly prefer to buy vegetables grown in direct collaboration with local growers where they can see and feel the vegetables growing. They want a fresh, qualitative product and are prepared to pay a fair price for it.

Trial planning

To decide which kind of vegetables to test, a small group of growers was assembled. All have several years of experience with growing delicacy vegetables for restaurants. Together they decided to plan a variety trial with mini beets, mini carrots and pea pods as well as testing some alternative vegetables, herbs and edible flowers. Sensory analysis is also a part of the project. After all, the food on our plates not only has to look good but also taste great.

Demonstration trial with delicacy vegetables

In August, the Research Centre for Vegetables (PCG) welcomed a visit to the specially-installed demonstration trial. More than 35 growers visited PCG and about 15 chefs were present. Even Peter Goossens from the restaurant 'Hof van Cleve' (a 3 star restaurant) came to take a look.

Preliminary results

In the variety trial for mini carrots, 12 varieties were compared at three sowing dates. Besides orange carrots, white, yellow, purple and a mix of different colours of carrots were studied, as well as spherical carrots. The purple carrots were very popular with the chefs. When looking at the variety 'Purple haze', they saw that the purple colour was limited to the exterior of the carrots. Mini carrots are not peeled however, so the purple colour stays visible. The spherical carrots 'Ronde Parijse markt 5' were also greatly appreciated.

In the variety trial of mini beet, different varieties with different colours were compared at three sowing dates. Besides red (spherical and cylindrical) beets, white and yellow beets were included in the trial as well as the chioggia type that shows white and purple concentric circles in cross-

section. In total, 14 varieties were compared. The goal was to have 3-cm beets at harvest.

The variety trial for pea pods contained 10 varieties including the normal green pea pods as well as yellow and purple pea pods. The chefs appreciated the look of the purple pea pods ('Desiree' from Vreeken's and 'Paarse peultjes' from *De Nieuwe Tuin*) but they appeared to be very tough and stringy.

Besides the three variety trials, other alternative vegetables and herbs were tested. Vegetables like mustard leaf, oyster leaf, sea aster, olive herb and wasabi are not well-known with consumers but are definitely popular with chefs. Edible flowers such as the ABC herb, licorice plant, hemp-leaved hollyhock, red crimson, and Japanese chrysanthemum could be observed and tasted in the demonstration trial.

Sensory analysis

The eight varieties of mini beet that showed the best results in the field up to that point were included in the sensory analysis. White, yellow and red beets and the chioggia type beet were compared for appearance and taste.

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More info: www.pcgroenteteelt.be

Networks are essential for innovation

To strengthen their competitiveness in ever-changing context of societal expectations, farmers need to innovate. The knowledge required for innovation is complex, highly dispersed and often insufficiently specific for the individual farm. The family character of many companies with low staffing levels and limited power in the chain complicates access to external knowledge. Cooperating and participating in networks then becomes an important resource to gather information and knowledge more efficiently, share development costs and accelerate the innovation process.

Innovation characteristics

In this IWT project, a wide range of networks with relevance for agriculture were viewed from an innovation perspective. Typical in each process of innovation are five characteristics: vision, knowledge, communication, coalition and social innovation. An innovation always needs balance between existing processes and new 'wild' ideas and hence needs to be anchored within a well-thought-out vision. Participating in a network can help to consolidate this vision. A network functions as a 'safety net' for new knowledge. It is crucial for detecting upcoming changes and linking them to innovation opportunities. The more contacts, the higher the chance of discovering something new. Face-to-face communication is much more efficient than one-way communication directed at farmers. A network also has the aim to strengthen coalition formation. Depending on the network goals, this will entail a strategy to manage conflicting interests or strengthen shared interests. Finally, innovations do not come into existence in a social vacuum; successful innovation processes emerge outside single (organisational) units, when mutual learning is stimulated and when routines can be shaken up.

Organic agriculture and innovation networks.

Organic agriculture was a specific case in this project. The project yields insights for existing networks in organic agriculture and illustrates potential evolutions on the basis of findings in other sectors. The five aforementioned innovation characteristics hint at the results so far. Peer-to-peer farm visits are an important resource for strengthening vision. Both narrating the business story as well as listening to it creates understanding in the proper business strategy. What does remain is the development of a vision on the sectorial level: 'how can the great diversity in farming practices and sales channels that characterise organic agriculture be framed in a clear course for the future?' When meeting a challenge like this, knowledge

completed

and communication play an important role. The existing peer-to-peer networks maintain a good relationship with research and policy and these contacts could be used to develop networks and collaborative structures on specific topics (productivity, marketing channels, cooperation in the market, communication with society and consumers). A thematic approach could also be fertile ground to create new innovation coalitions. Concrete examples are networks with schools in which education is coupled to local food procurement (e.g. farm-to-school) and networks where farmers and catering industry co-position themselves in the tertiary sector (e.g. farm-to-chef).

New and progressive

Our research shows that in Flanders, organic agriculture is effectively supported by existing networks. Since this concerns a relatively new and transparent sector, the chances of building networks in a stepwise and orderly manner are high, which avoids the danger of unthinkingly adopting routines or market structures based on conventional agriculture. In this effort one can both opt for learning networks from an overarching perspective (e.g. farm succession, labour) or concrete networks focussed on organic agriculture (e.g. development of outlet concepts).

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More info: brochure 'Netwerken en innovatie' (in Dutch)
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Increasing the competitiveness of low input and organic dairy farms through strategy development

Organic and low input dairy farms have clear environmental advantages. However, the risk of lower competitiveness compared to conventional farms is clear. The European project "SOLID" (Sustainable Organic and Low Input Dairying) wants to address this risk by developing farming strategies that will increase the competitiveness of these farms.

Defining strategies

Together with stakeholders, we identify promising strategies to increase the competitiveness of organic and low-input dairy farms. We attempt to determine the effects of implementing these strategies on dairy farms with the help of socio-economic models. The effects are examined at process, farm, sector and policy level. At the process level, for example, models can assist with analysing the contribution of strategies in optimising rations or improving the carbon footprint. At farm level, the effect of new strategies on farm management, the use of production factors or sustainability can be investigated. Sector models look to the impact of these strategies at regional or country level, while policy models may examine how policies can deal with these strategies and possibly promote their adoption on the farm. An example of a farm level model is ORGplan, developed in the United Kingdom. This model evaluates business plans to explore how companies can switch from conventional management to organic or low-input management.

Analysis of typical farms in Belgium and Europe

In Europe, different dairy farming production systems can be found. Typical farms are identified for researching the effects of strategies for different production systems at different levels. As a result, it will become possible to make connections between the effects on process, farm, sector and policy level. In every country we identify organic farms as well as low input and high input dairy farms based on the SOLID indicator. This indicator is calculated from the costs from purchased feed, fertilisers, crop protection and energy divided by the number of grazing livestock units on the farm. For each country, typical farms are selected that comply the most with the characteristics of low input and high input typical farms. The defined strategies are investigated on these typical farms.

Resilient organic and low input dairy farms

The competitiveness of dairy farms is partly related with the resilience of these farms. The increasing volatility of milk and feed prices causes an increasingly uncertain income for the farmer. This research examines the impact of a trend scenario and a shock scenario on the income of typical organic, low input and high input farms. The trend scenario includes the change of milk and feed prices over the last 10 years, while the shock scenario considers the low milk and high feed prices from 2009. Preliminary results indicate that low input farms are less affected by the price fluctuations in the trend and shock scenario, despite the fact that they have lower incomes. The organic farms perform also well, but the positive outcome for these farms is influenced by the high level of subsidies

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Critical success factors for a successful organic farming system

new

Organic farming differs from conventional farming in terms of marketing and crop/animal production. Because organic farms are not cookie-cutter farming systems, a farm-specific approach is needed to optimise the system. In addition, it is often difficult to quantify or even put into words the success factors of well-functioning organic farming system. Through an efficient compilation of data, knowledge and experiences, this study aims to identify the critical success factors to help farmers to successfully meet current and future challenges.

By and for the farmers

Identification of critical success factors will be done via a methodology that is supported by the organic sector itself. Researchers, advisers, Bioforum and the farmers themselves are involved throughout the project. By starting from the needs raised by the farmers, we guarantee a targeted and accurate collection of knowledge and data. This transdisciplinary approach is not straightforward, but rather demands continuous feedback of intermediate results to the farmers. This feedback occurs mainly during 'organic farmers meetings' that has been set up to share experiences and knowledge between farmers. The frequency and approach of how to optimise farmer involvement is also part of the research, and will be described in order to support similar processes in the future.

The whole picture

Before a well functioning organic farming system can be achieved, sufficient insight into the relations and trade-offs of different aspects must be created. Technical optimisations to achieve maximum crop yields is not satisfying if there is no suitable sales channel for the end product; and fattening animals might increase carcass quality but it also simultaneously increases the need for concentrates, which implies higher costs. A systemic approach is thus needed that enables assessment of the impact of new strategies on each aspect of the system.

Measure first, then talk it over

Critical success factors are identified for crop farmers, dairy farmers, farmers with suckler cows, and vegetable growers. Qualitative and quantitative data are collected. If possible, quantifying indicators and benchmarks for the critical success factors is pursued to allow comparison of farm results. However, since relations and trade-offs between different aspects of the farming system are difficult to quantify, these are mainly based on qualitative data. Figures alone are often insufficient to fully describe farm systems. However, they can trigger group discussions on farm specific strategies and reveal what works the best.

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High quality food

What determines the taste of organically produced tomatoes?

new

One important reason why consumers buy organic tomatoes is their belief and confidence in the perfect taste of those tomatoes. But what determines the taste of these fruits? Using sensory analysis, in 2013 and 2014 we investigated the effect of variety, culture techniques and fertilisation on the taste and consumer acceptance of tomatoes.

Sensory analysis at the PCG

Sensory research on fruit and vegetables has been conducted at the Provincial Research Centre for Vegetables, or *Provinciaal Proefcentrum voor de Groenteteelt Oost-Vlaanderen* (PCG) since 1998. A sensory test room was equipped according to international standards (ISO 8589). In this room with 14 individual booths, equipped with colour filtering on the lighting to mask possible colour differences between samples, the panelists taste and assess the fruit and vegetables. The sensory tests use good sensory practices and are "blind", i.e. the panelists don't know from which variety or culture the samples are.

PCG has several panels for this research. The consumer panel of approximately 200 men and women of different ages is used to determine which products are tasty and/or which properties are good/not good. The panelists of the trained, analytical panels have perfectly working senses. They are trained in distinguishing and assessing the different sensory attributes of specific fruit or vegetables. This panel is used to quantify the appearance, taste, texture, flavour and odour of a specific product with the human senses, just like a machine would do.

Research in 2013-2014

At the end of August 2013, 70 consumers assessed organically grown tomatoes of the varieties Kanavaro and Admiro, from five growers. The tomatoes were judged for tastiness (general acceptance), taste, texture and appearance. Consumers gave both varieties high marks. General acceptance, taste, texture and appearance also differ according to grower. The most important differences between growers are infrastructure, plants used, rootstock, plant density, heating regime and fertilisation. More research is needed to determine if and which of these factors are responsible for this difference.

At the end of August 2014, 66 panelists examined different varieties of organic cluster tomatoes on general acceptance, taste, texture and appearance. Tomatoes of the variety Avalantino (Vitalis), a cocktail flavour tomato, were the most tasty and the most attractive tomatoes in this trial.

In September 2014 organic prune tomatoes, grown without and with extra fertilisation using animal- or vegetable-based organic fertilisers, were scored for general acceptance, taste, texture and appearance by 85 consumers. Split fertilisation has a positive influence on general acceptance and tomatoes were judged to be tastier when they had received extra fertilisation during the season, but the type of fertilisers used (animal- or vegetable- based) did not influence taste.

All these results are published in professional journals, the PCG newsletter and PCG website so they are available to growers for use in their cultures.

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Modelling cadmium uptake by leaf and root crops

new

Cadmium is a heavy metal with a negative impact on the health of humans and animals. In vegetables, cadmium is mainly found in leafy vegetables, roots and tubers. Therefore, researchers and companies involved selected spinach and carrot for this research project. Researchers from Inagro, Ghent University and the Centre for Research in Veterinary and Agrochemistry are currently working on an empirical model to predict the cadmium uptake by spinach and carrot on Flemish farmland.

Empirical model for spinach and carrots

Plant and soil factors determine the cadmium accumulation in the edible part of the plant. Because of the multiplicity and complexity of these factors, no mechanistic model can predict accurately the plant uptake based on measurements.

On the other hand, it is possible to develop empirical models that make correlations between measurable parameters, such as the total metal concentration in the soil, the soil properties, and the cadmium concentrations in the vegetable. These models should always be validated or re-calibrated based on the local groundwater and environmental conditions.

This future model shall be a useful tool that growers can use during the sowing period to assess whether there is a risk of exceeding the limit for cadmium in the crop.

European norm

Europe wants to tighten the standards for cadmium, which for some crops can become problematic. The current European regulation fixed the limit for cadmium in spinach at maximum 0.2 mg/kg on the fresh material, whereas in carrots, it is 0.10 mg/kg. In certain vegetables, maximum levels shall be exceeded by the uptake of cadmium from the soil.

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More info: www.flandersfood.com/projecten/foodcad

Controlling yeasts and mould in food using alternative (natural) preservatives

new

This research involves systematic efficacy screening of commercial natural preservatives, tested on relevant yeasts and moulds in food.

Preservatives

Today the conventional food industry uses chemical preservatives to prevent spoilage by yeasts and moulds. The substances normally used are benzoate, sorbate and propionate.

But consumers increasingly are demanding natural products without these chemical additives. The sector is also legally obliged to work without these additives.

Potential of a natural preservative

Many natural components are known and are available on the market. But for a food processor, either conventional or organic, it is often difficult to assess the effectiveness of a natural preservative.

When testing the effectiveness of natural preservatives in the laboratory, the water content, proteins, pH, salt, presence of antioxidants, or the influence of temperature on the operation of such systems are often not taken into account. For this reason, many alternative systems often lose their effectiveness when they are used in real food products.

In this project, the researchers first searched for many kinds of natural antimicrobial systems that are active against representative yeasts and fungi. They also looked for the applications, advantages and drawbacks, and the cost of these systems.

completed

Shelf life testing

Subsequently, the impact of the major food components was separately tested on the antimicrobial activity of these systems. Based on these results, it was verified if antimicrobial systems can be applied in any type of product.

Shelf life tests were done on foods and antimicrobial systems chosen together with the companies involved.

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More info: www.flandersfood.com/projecten/funcofood

Fibre and bio-actives in fruit- and vegetable-based by-products for food and feed applications with the development of a pectin production chain

In this project, two by-products were characterised for fibre, vitamins, antioxidants and minerals. The final goal was to develop fibre-rich food products. New food products with a gluten-free source of fibre such as the pectin fraction of certain waste streams would improve the diet and health of the consumer.

Production of fibres

In this study, we developed a sustainable method to extracting pectin from two by-products. The technological development is underpinned by a market study, scale-up trials and an industrial-scale economic simulation. We also compared our process with the current production of pectin from citrus fruits. Subsequently the chemical and microbial food safety was determined, as well as the rheological properties of the pectin.

Western diet

Fibres are an essential part of our Western diet, but our daily fibre intake is much lower than the recommended amount. Furthermore, most commercial food products with a high fibre content contain gluten. For consumers with gluten allergy it is therefore not easy to consume the daily amount of fibre because they must avoid all fibre sources derived from cereal products.

According to a European Regulation, if a food processor adds fibre to a product, the claim "source of fibre" or "fibre-rich" may be put on the packaging. The fibre-rich products developed in this project can be added directly into food products, or after a structure determination of pectin, they will result in a product with desired properties.

completed

Valorisation of by-products

The potential of fruit and vegetable by-products is insufficiently known. A better understanding of the composition allows us to better appreciate the value of these by-products.

Today, the food industry produces large quantities of plant-based waste. Companies mainly recycle the waste as feed or as materials for energy production. Optimising the agricultural chain by limiting these current activities increases the profitability and competitiveness of the agri-food sector.

The NOWASTE project of Flanders' FOOD ended in 2014.

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