



# Organic Food and Farming in Flanders



**NOBL**

Netwerk Onderzoek Biologische Landbouw & voeding

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# **Organic Food and Farming in Flanders**

Research 2015-2016



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Dear reader,

We are proud to present you the fourth edition of the publication "Organic food and farming in Flanders: Research 2015-2016". In this publication, researchers give an overview of research and activities to support knowledge development for organic food and farming in Flanders in 2015 and 2016. We focus on projects conducted under organic conditions and/or directed to the organic sector and give special attention to some research projects with high relevance for the organic sector.

Meanwhile, the Flemish Organic Research and Knowledge (FORK) network, a collaboration between CCBT (Coordination Centre for Applied research and Extension for Organic Production), *Biobedrijfsnetwerken* (Organic Farmers' Networks) and NOBL (Network for Organic Food and Farming Research), continues its activities. The network is becoming more active on the national level and in European research. This expansion has resulted in a number of interesting opportunities and collaborations in research projects.

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

Lieve De Cock, coordinator of NOBL







# **Organic agriculture in Flanders**

## Organic farming in Flanders keeps growing

*In Europe, organic cultivation totals 10.2 million hectares (5.9% of all UAA). Belgium has a share of about 5% of the European area. Within Belgium, Flanders' share is 0.8% of the national organic area. The European market of organic food products continues to expand. Worldwide, the European Union has a share of 38% of all retail sales of organic products. Within Europe, Germany is the largest market, representing €7.9 billion in consumer sales.*

### Steady growth

Although Flanders is a small player within Europe, the Flemish organic sector continues a trend of steady development. In 2008-2015, the area grew by 53% at an average annual 7% increase. In 2015, there were 370 certified organic farms (+8%) with a total area of 5,343 hectares (+6%), of which 929 hectares in conversion. During the same period, the number of farms increased by net 27 farms. Of the 370 organic farms, 46 were also certified for the sale of organic products and 50 process organic products on-farm. Interest in organic farming remains substantial. The number of participants in training courses on organic farming at Landwijzer vzw has doubled over the past five years. Moreover, 60% of all graduates is known to have found a job in the sector. The advice services of Bio Zoekt Boer contributed for almost a third of the new conversions in 2015.

### Organic crops and animals

According to the generally accepted farm typology, 81% of all organic farms are specialized and 19% are mixed farm units. Moreover, 45% of the organic farms are specialized in the cultivation of vegetables or fruit and 17% are specialized in animal production. The combination of various permanent crops (7%) is the most important type of mixed farming.

The total organic area consists of 46% of temporary and permanent grassland and area with spontaneous natural growth, unchanged in comparison to 2014. Protein crops make up 18% of the organic area, 95% of which are various types of clovers. Arable land makes up 16% of the organic area; potatoes, vegetables and herbs account for 11%; and 9% is used for the production of fruit. There are 120 organic farms with animal production. One out of three farms with animal production raise poultry. The organic livestock increased by 12% in 2015 to 422,266 head of livestock.



## Public expenses for organic farming

Regional government expenses for the organic sector were estimated at €3.9 million in 2015 for Flanders, an increase of 4%. Of the total expenses, 43% were paid directly to the organic farmers in the form of investment support, premiums, intervention in control costs and financial support in preparation of conversion. Of the remainder, 22% was spent on research & development, the same share as previous year. One-fifth was spent on market development and the remaining 15% was assigned to marketing and publicity and training organic farmers. Besides those specific expenses, 161 organic farmers received a total amount of €1.1 million in direct payments.

## Consumption and distribution

The total consumer expenses of organic products (food and non-food) in Belgium are monitored by GfK PanelServices Benelux. Their studies showed an increase of 18% in 2015 up to €514 million euro, €237 million of which in Flanders. The Belgian market share of organic products represents 2.7% in the total expenses for fresh products and continues to grow. Organic meat substitutes have the largest market share, while the share of organic meat products have a limited market share of 0.8%. In total, 88% of the Belgian households bought at least one organic product last year.

Organic fresh products are on average 33% more expensive than non-organic fresh products. The price difference has remained stable over the years. The traditional supermarkets are still the most important sales channel but they have lost some ground in comparison to specialized sales channels (e.g. BioPlanet, retail). The share of discount stores is quite small but is growing. Farm shop and village markets have a higher share of organic products to offer than average.

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# Research organisation

## Research on organic farming and the Government of Flanders

*The Strategic Plan for Organic Farming 2013-2017 is nearing completion. This plan, which maps out policies for organic farming, was developed and implemented in collaboration with the Flemish government, the Flemish Minister for Agriculture, Algemeen Boerensyndicaat, Boerenbond, BioForum Vlaanderen, Comeos Vlaanderen, Fevia Vlaanderen and VLAM.*

*The goals are qualitative and quantitative growth of the organic sector, balanced market development and the optimal development of organic farming as an example of sustainability. To achieve these goals, organic entrepreneurs must have access to professional knowledge so they can continuously improve their organic farm and business operations.*

*In the policy declaration 2015-2016 on Agriculture and Fisheries, the Flemish Minister for Environment, Nature and Agriculture states the policy goal of continued growth of organic production in Flanders. She affirms that knowledge development and exchange is essential for the qualitative growth of the organic sector. The Government of Flanders, Department for Agriculture and Fisheries therefore continued its support to research for organic food and farming in 2015 and 2016.*

### **Research highlights from 2015 and 2016**

The Flemish Government's Department of Agriculture and Fisheries continued to support and subsidize the operation of the CCBT, the NOBL and organic farmers' networks in 2015 and in 2016. Besides, the Department of Agriculture and Fisheries awarded research grants to several projects such as "Nitrogen delivery of cut-and-carry fertilizers in relation to application method and soil condition", "Grazing Corn in the crop rotation on the home plot of organic (milk) farms ", "Conference for comparison of different types of fertilizer in organic fruit cultivation" and "Networking day for organic horticulture". Also in the 2016 call for project proposals the Department will subsidize two research projects.

Flanders continues to seek its place within the European organic research scene. From the CORE Organic PLUS call, the innovative project "Soilveg"





(Inagro, UGent, and ILVO) emerged as best project. This project is a collaboration between 14 scientific institutes in 9 European countries. The focus is agro-ecological service crops (ASCs) and the best way to destroy them using mechanical methods. The ultimate aim is to preserve and improve European agricultural soil quality and broaden use of natural resources in organic vegetable production systems. In 2015 and 2016 NOBL and the Department of Agriculture actively participated in the negotiations leading up to the next call to maximize the connections between Flemish research and the selected themes. That call is expected in 2017.

In 2015 and 2016, the Department of Agriculture and Fisheries remains committed to publishing an annual report on organic farming in Flanders. This report is still the main reference on the status, progress and special features of organic farming in Flanders. It also provides an overview of government spending for the organic sector (including research and knowledge) and the distribution and consumption of organic products.

In addition, the preparations for the drafting of the new strategic plan on organic agriculture (starting in 2018) have begun. We expect research and knowledge to remain an important part of the strategy to support farmers.

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## Organic farmers' networks, the foundation for demand-driven research

*Organic farmers' networks (Biobedrijfsnetwerken) are networks of organic farmers that meet regularly to exchange experiential knowledge. Knowledge is not only the result of research in laboratories or research stations. Much knowledge is also the result of individual farmers' research on their own farm. Sharing this experience - hearing the experience of other farms as well as sharing their own farming experiences - is the driver behind these Biobedrijfsnetwerken.*

### **A network for every sector**

The network started in 2009 as an initiative of *Bioforum Flanders*, *Landwijzer* and the Dutch *Louis Bolk Instituut*. In each industry network, an experimental research station and an agricultural advisor active in that sector are involved in organizing the networks. In this way, every call for additional information that arises during meetings can be met with an appropriate source of knowledge. Extension research centers and advisors quickly help the farmers and coordinators to find information from previous research and take new research questions that arise in the networks back to the research centres with them. Today networks are active for fruit growers, dairy farmers, goat farmers, livestock farmers, poultry farmers, small fruit growers, arable/vegetable producers.

### **A vital part of the whole**

The *Biobedrijfsnetwerken* are embedded in the Flemish Organic Research and Knowledge Network (*Vlaams biokennisnetwerk*). In this partnership, *Biobedrijfsnetwerken* cooperate with CCBT and NOBL. These institutions make sure that questions from the networks are included in both practical research and applied/fundamental scientific research. In this way research is more driven by the demands of the farmers. Conversely, they also ensure that there is feedback from research results towards the organic sector.

Organic farming in Flanders is therefore at the height 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.



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*" (a consultancy project for conversion to organic farming).

### **Across sector boundaries**

Frequently the networks collaborate across the boundaries of different sectors (e.g. livestock farmers and farmers with arable production exchange knowledge about feed and manure). Within the sectors, the farmers also share experiences in specific theme groups (e.g., in the vegetable sector: short-chain, large scale vegetable crops, own seed production, etc.).

### **Do it yourself?**

Over the years, the network coordinators have done a great deal of work to develop 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 farmers.

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## CCBT vzw – Coordination and communication of applied research for organic farming in Flanders

*CCBT is an umbrella organization for applied research for organic farming, and functions as the bridge between research and practice. The annual subsidy from the Flemish government helps CCBT fund research projects. These projects are farmer demand-driven and carried out by the member-research centres with expertise in organic: Inagro, PCG, Pcfruit, Proefcentrum Pamel and Proefbedrijf Pluimveehouderij. The monthly newsletter *BIOpraktijk* reaches about 900 farmers and other interested parties with practical information for the organic farmer.*

### **Tailored to the farmer**

CCBT stands for “Coordination Center for Applied Research and Extension on Organic Agriculture”: its aim is to coordinate and stimulate applied research for organic farming in Flanders. The center was founded in 2010 as a part of the “Strategic Action Plan for Organic Farming” of the Government of Flanders.

The annual subsidy from the Government of Flanders funds a limited number of research projects, which are always initiated by the sector and ensure practically applicable results. The research needs that arise during the farmers’ networks or technical committees are translated into real research questions together with the research centers and then further into practical research projects. Since 2010 CCBT has already financed 58 demand-driven projects. The six research centres with a commitment to the organic sector are *Inagro*, *PCG*, *pcfruit*, *Proefcentrum Pamel*, *Proefbedrijf Pluimveehouderij* and *PIBO Campus*. For research related to ruminants CCBT is working with a private consultancy service, Wim Govaerts & Co CVBA.

CCBT ensures dissemination of practical information tailored to the farmer. Each finished research project is summarized in a popularized final report with the main conclusions and recommendations. Via the website and newsletter (*BIOpraktijk.be*) new research results are announced monthly. Subscription to the newsletter is free of charge and open to all interested parties. To disseminate all existing knowledge in Dutch, including knowledge generated in the Netherlands, CCBT engaged in a collaboration with Wageningen-UR under the flag “BioKennis.org”.



### CCBT in the FORK network

In Flanders CCBT, together with NOBL and the farmers' networks, are building a research and knowledge network for organic farming and food (FORK network). Within this knowledge network, joint actions to support research for organic farming are being taken.

Advising the government and updating the research agenda for Flanders are important tasks of this network. In addition, a research database is maintained that collects all current and finished projects for organic farming in Flanders. Expanding the national and international network is another important goal.

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

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**Funding:** Government of Flanders, Department of Agriculture and Fisheries

**More info:** [www.CCBT.be/english](http://www.CCBT.be/english)

## **NOBL: reflecting together about research for organic food and farming in Flanders**

*NOBL, the Network for Organic Food and Farming Research, remains committed to establishing and maintaining a favorable research climate for organic food and farming in Flanders. Members of the network – currently representatives from 17 organizations related to research, policy, farmers' organizations and other knowledge and research networks – share information, ideas and experiences and support activities to promote research and knowledge exchange for the organic food and farming sector in Flanders. ILVO is the NOBL coordinator.*

### **NOBL in action!**

NOBL has many tasks and activities: besides organizing regular meetings, the network is flexible enough to respond to the needs of the moment. Researchers and actors from organic industries are brought together to find answers to current questions, formulate advice on priority research topics and explore new opportunities for funding of new research projects. Cooperation and knowledge exchange is stimulated across borders via active participation in international and national working groups and networks (such as TPOrganic, COREOrganic II ERA-NET, Organic E-prints, [www.bioKennis.org](http://www.bioKennis.org), etc.) and publicizing NOBL as the contact point for organic food and farming research in Flanders.

NOBL does not work alone. Together with CCBT (the Coordination Centre for Applied research and Extension for Organic Agriculture) and *Biobedrijfsnetwerken* (Organic Farmers' Networks) it has become the Flemish Organic Research and Knowledge networks (FORK network). In addition to their specific tasks and objectives aimed at different target groups (farmers, researchers, policy) the networks are aligning their activities, 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](http://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 current development in the organic dairy farming sector in Flanders, where more and more conventional farmers are converting to organic milk production, inspired the network to organize a seminar on 30 November 2016. Farmers are seeking knowledge to answer their questions about animal health, feed quality and rations. But the recent doubling of organic milk production has doubled in Flanders also gives rise to many socio-economic challenges. During workshops with researchers and other interested parties, we looked how research can support organic dairy farming in Flanders and find answers to current questions.

### **NOBL ahead!**

In 2017, the time has come to evaluate the working and organization of NOBL. The members of the network will look forward how NOBL can support research for the organic food and farming sector in the future even better.

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# The Flemish Organic Research and Knowledge (FORK) 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) form the Flemish Organic Research and Knowledge network (FORK network). The link between the networks is the co-creation of knowledge: participatory research and knowledge exchange and dissemination of knowledge tailored to farmers.*

## Three networks, one mission

The three networks and their partners make up the foundation of a research and knowledge network for organic food and farming in Flanders (the FORK network). 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.

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
- optimize the use of research and knowledge exchange capacities for the organic sector
- disseminate and exchange research results and knowledge

## Strength in unity

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. 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 research-created knowledge returns to the farmers via the different information channels of CCBT, NOBL and Biobedrijfsnetwerken.

The FORK network has found its place in the national and international research area. The jointly published "Research strategy for organic food and farming Flanders 2013-2017" is used to advise Flemish and European research programmes about the Flemish research priorities. This has resulted in a number of interesting projects and created new opportunities for cooperation in project in a European context.

The FORK network aims to continue its facilitating role in supporting research that is demand-driven and implemented via a co-creative process in the future. Different disciplines and expertise work together. Farmers and other chain actors are actively involved in the planning and implementation of research on organic agriculture.

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# The research strategy for organic food and farming in Flanders

*In 2014, the Flemish Organic Research and Knowledge network (NOBL, CCBT and Biobedrijfsnetwerken) (FORK network) 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" thematically describes 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 as well as 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 that 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 optimizing soil fertility, increasing biodiversity and implementing the best environmental practices and strong standards in the



field of animal welfare. Innovative strategies and technological developments are essential in the further development and optimization 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 at a price that covers the costs of the whole chain.

Optimization, 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 implies more than working with organic ingredients alone. This 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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# Analysis of research on organic agriculture



new

*"Knowledge development and exchange" is a supporting objective in the strategic plan for organic agriculture 2013-2017. Some policy instruments financed by the Department of Agriculture and Fisheries (AF) within Flemish organic research are analyzed as input for the next strategic plan. The analysis focused on the current use of the financial instruments and the actors involved, on the organization of organic research and on some quality characteristics of Flemish organic research.*

## **Budget**

Between 2013 and 2015 organic agriculture counts for about 3% of the total budget for research and knowledge exchange. In 2015, the share of structural support in the expenditure for organic research and knowledge was 5% higher (32% in total) than in 2012. The Department for Agriculture and Fisheries is responsible of 45% of the project grants of organic agriculture in 2012-2015. The remaining part is an estimation of the relevant part for organic agriculture of the projects financed by the Agency for Innovation and Entrepreneurship (VLAIO). These "agricultural trajectories" try to provide innovative solutions for concrete and demand-driven opportunities of a group of farms from the primary sector. Several projects are (partially) relevant for organic farming and are included in the analysis based upon an expert evaluation.

Most (78%) of the approved projects are done by experimental research centers. The average project grant is almost €23,500. Although their average project grant is four times as large, universities and colleges do much less research on organic farming. The evaluation methods within the (Flemish) academic world discourage young researchers, among others, to choose subjects related to organic agriculture. Building up and maintaining the necessary (social) capacity is not easy in such a context.

## **Sectors and themes**

The organic research project corresponds roughly with the degree of specialization of Flemish organic farming. Vegetable crops accounted for 69% of the projects. Fruit takes almost half of the plant projects. Arable crops are the least common. Cattle (38%) and poultry (31%) are the most



important animal sectors. Research related to goats is also common (19%). This indicates that a properly functioning organic farmers' network enhances a successful signaling of and channeling of research questions. The current organic research focuses mainly on crop husbandry techniques and is immediately applicable on the farm. Almost 70% of the research deal with fertilization, soil, crop protection, cultivation techniques and systems. Economic research or efficiency research concerning water, energy, closed cycles, packaging and logistics is barely or not addressed.

### **The role of the government**

The government has various roles in the knowledge and innovation system. It not only finances research, innovation and knowledge transfer, but also directs it and is above all a system controller. From that responsibility the government defines the general framework from which research organizations operate. Its system responsibility requires the government to steer the direction taken at the macro level. This can be done with and without the consultation of the stakeholders. Within the context of government savings and the debate on the core business of the government, it is important to make policy choices in the strategic plan 2018-2024. It is an opportunity to improve the efficiency and effectiveness of existing and new policy tools.

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# A European vision of knowledge and innovation systems in agriculture

new

*During strategic discussions, the readiness of agricultural knowledge and innovation systems (AKIS) for the future is regularly questioned. Can AKIS continue to support farmers and growers to meet challenges such as food security, climate change and reduced environmental impact?*

## Three lenses to look at the future

Because of the many changes in technologies, environmental factors and policy, among others, AKIS must - together with farmers and growers - be able to adapt to the major societal challenges. Three possible future scenarios were developed and analyzed:

1. The **high-tech scenario** is characterized by multinational companies and advanced technology. A strong European Union remains, but industry drives research and innovation.
2. In the **self-organization scenario**, key features are new business models and diversification. Regions and cities play an important role.
3. A **collapse scenario** comes with climate change, mass migration and political tensions. All of these elements lead to the disintegration of the European Union.

Reality will probably be a mix of these scenarios but separate examination of the three scenarios best supports strategic discussions. The main question is: what can we do today to make AKIS more robust and more future-proof? The discussion shows that there a number of action that will increase the resilience of AKIS systems at European, national and regional levels, independent of the future scenario.

## Recommendations

The report concludes that the AKIS of the past are not fit to tackle the future challenges. This is a result from analysis of the scenarios as well as the developments in ICT and e-science, the focus on the interactive innovation model and the convergence of agricultural research and agricultural research for development.



More attention is needed for the role of various actors in the AKIS, the interaction between the subsystems (such as research, extension and education), the link between agriculture and related sectors and the AKIS policy. The organization of AKIS should also be adapted. In this process, the government has a clear role in steering the system, while farmers should be supported to find their way within the AKIS and between the various (public and private) advisors. Big data and other ICT developments can have a major impact on agriculture and all processes in the AKIS. Moreover, agriculture is not an isolated entity; many benefits can be realized by building bridges to other sectors. Finally, more efforts are needed to explicitly connect the knowledge system with the educational system. By doing so, students can get the necessary basic knowledge and basic skills to engage in participatory processes and transdisciplinary research.

Regarding AKIS policy, attention is needed for cross-overs with other areas of research, interactive and transdisciplinary processes, experiments with public-private partnerships, (hard and soft) research infrastructures, international cooperation with partners from other continents and a real European Research Area.

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**Duration of the project:** 2014 - 2016

**More info:** [www.vlaanderen.be/landbouw/studies](http://www.vlaanderen.be/landbouw/studies) en

[https://ec.europa.eu/research/scar/pdf/akis-3\\_end\\_report.pdf](https://ec.europa.eu/research/scar/pdf/akis-3_end_report.pdf)



# Compilation and exchange of practical and expert knowledge in the organic farming sector

completed

*In Flanders, no two farms are alike. Every farm, every farmer has his or her own identity, preferences and abilities and a specific relationship with the socio-economic environment. However, the ultimate objective of each farmer is to pursue a coherent, balanced farming system, where personal, farm- and environmental specificities are aligned. A balanced farming system, however, is the result of a long-term process of learning and doing by the organic farmers themselves. The objective of this project was to develop and apply a methodology to expose, share and compile this knowledge obtained after many years of experience.*

## **Involving the farmers and a systems approach**

Farmers mainly use experiential knowledge which is presumably practical and is applied at the farm level. Experts, on the other hand, often draw from insights that apply to the agricultural sector as a whole, operating within a socio-economic environment. To integrate these complementary types of knowledge, experts and farmers were closely involved in the process from the start by sharing data, exchanging experiences in the organic farmers networks, conducting interviews, etc. Application of a systems approach enabled us to integrate both tacit and expert knowledge, and to reveal insights into the relationships and trade-offs between different components of the farming system.

## **Three general phases ...**

The conceptualization of the methodological framework is the result of a demand-driven application of different qualitative and quantitative exercises in three organic sectors (beef cattle, dairy cows, arable crop and vegetable producers). This framework is based on three stages that were followed in each of these sectors once or several times. First qualitative techniques such as observation, interviews and participation in groups with farmers were used to expose key elements perceived as necessary for a successful farming system. During the second phase, both quantitative and qualitative data on these key elements was collected, structured and exchanged. Third, techniques were used to analyze how these key elements interact with each other and with other socio-economic and environmental aspects within and beyond the organic farm.





### ... with a sector-specific implementation

The effectiveness, timing and sequence of implementing these three phases was different for each sector and was based on the needs of the farmers and/or the coordinators of the organic farmers' networks. This means that not only the knowledge resulting from the implementation of the framework, but also the development of the framework itself is based on co-creation of researchers and other actors. The speed of the process and its effectiveness depends on the actual involvement of the farmers and the initiators of the process and on the collaboration with the researchers.

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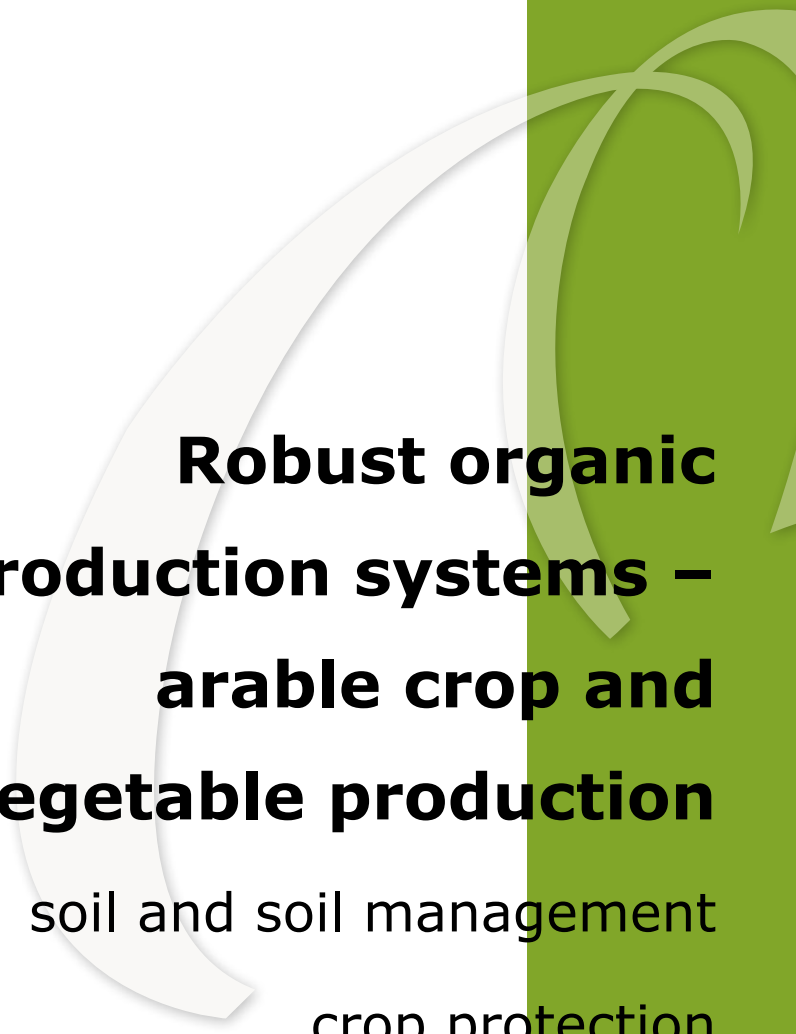

**Partners:** Bioforum, Inagro, Wim Govaerts en co cvba, Proefbedrijf Pluimveehouderij

**Funding:** ADLO-project "*bio in beeld: ontwikkelen van kengetallen via systeemgericht onderzoek en participatorisch traject*" (Developing a framework for evaluating new strategies on organic farms) (Government of Flanders, Department of Agriculture and Fisheries)(2013 - 2015)

**More info:** [www.nobl.be/nl/node/200](http://www.nobl.be/nl/node/200)







# **Robust organic production systems – arable crop and vegetable production**

soil and soil management

crop protection

cultivation techniques and systems

varieties and breeding

technology

# Bacteria and fungi in the organic soil: a convivial and complex relationship

completed

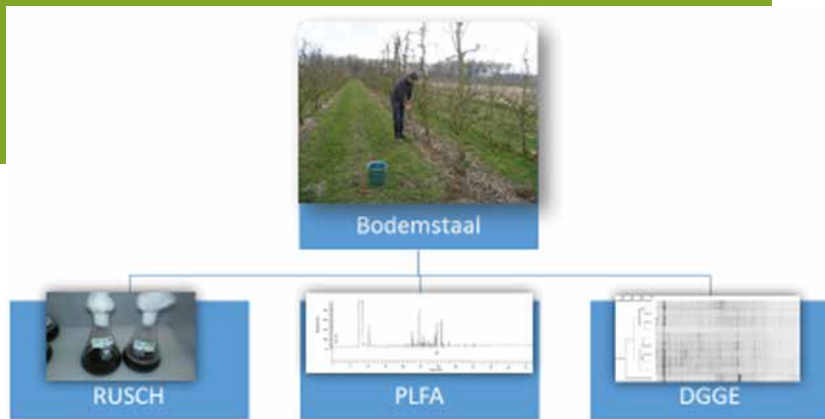
*Microbial soil life is extensive and diverse, consisting of bacteria, fungi and other microbes. But when does agricultural soil harbor the desired microbiology? Is there a simple indicator for soil quality? In a CCBT-project, ILVO and several extension research stations joined to seek answers to these questions.*

## **Analysis of the organic soil using different methods**

Soil samples were taken on fields of organic growers and in existing fertilization and soil management trials executed under organic growing conditions at extension research stations. When investigating these soil samples, three analytical methods for soil microbiology were compared: the RUSCH test, phospholipid fatty acids (PLFA) analysis and a molecular technique (DGGE). Besides soil microbiology, a number of chemical soil quality indicators were considered because they might partly explain the observed differences in soil microbiology. We determined total organic carbon content (TOC), total nitrogen content (N<sub>tot</sub>), "hot-water-extractable-carbon" content (HWC) and soil acidity (pH-KCl). TOC as well as N<sub>tot</sub> are a proxy for the soil organic matter content and HWC is a measure for the more accessible soil organic matter.

## **Analytical methods for soil microbiology, what and how?**

The RUSCH test is a relatively cheap and simple method that was developed by the German Hans Peter Rusch. Until now, this technique has been poorly scientifically explored and is little used. With a microscope, bacteria are counted in a soil extract. In a second extract, the release of exudates in the soil by the root system is simulated by the addition of sugars, which results in the activation of rod-shaped bacteria that are beneficial for plant development. With the PLFA method, the phospholipid fatty acids in the cell membranes of the soil micro-organisms are determined by gas chromatography. Six different functional groups can be distinguished: non-specific bacteria, gram-positive bacteria, gram-negative bacteria, fungi, actinomycetes and mycorrhizal fungi. The higher the content of fatty acids characteristic for a certain group, the higher the biomass of that group in the soil sample. With the DGGE technique, the genetic diversity within just one specific microbial group is considered.



### What did we learn?

Using the RUSCH test, no differences were found between soil treatments in fertilization and soil management experiments. However, the test suited well for a fast soil quality screening of farmers' fields as we found a relationship between the readings of the RUSCH test and certain chemical soil quality indicators, i.e., TOC, N<sub>tot</sub> and HWC content. The PLFA method successfully distinguished differences between soil treatments. However, PLFA is not a fast indicator because it is a specialized technique. The outcome of the PLFA method was also correlated with some chemical indicators. HWC seems to be a promising chemical indicator for the overall soil quality as it is both a measure for the microbial biomass as determined by the PLFA method and an indicator for the soil organic matter quality. DGGE did not seem to be a suitable indicator for overall soil quality.

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**Funding:** CCBT-project: "*Effecten van bodembeheer en bemesting op de bodemmicrobiologie - Zoektocht naar een eenvoudige indicator voor bodemkwaliteit*" (3 Effects of soil management and fertilization on soil microbiology – search for a simple indicator for soil quality)(Government of Flanders, Department of Agriculture and Fisheries) (2014 - 2015)

**More info:** [www.CCBT.be/projecten](http://www.CCBT.be/projecten)

# Multi-year fertilization trial confirms the need for organic fertilizer

*In the period 2003-2015, Inagro conducted a multi-year fertilization trial on the experimental organic farm in Beitem, Belgium. The test was set up on sandy loam soil. The effects of six practice-relevant fertilization strategies on soil quality and crop yield were assessed. This article presents the most striking findings.*

## Six fertilization strategies

The trial field went through two full crop rotations with leek, carrot, spring wheat with under-sowing of clover, cabbage, potato and a one-year clover, respectively. The reference treatment (1) was standard practice on the experimental farm: a yearly application of farmyard manure and slurry, tailored to the crop demand and a maximum nitrogen (N) application of 170 kg N/ha. In a second treatment (2), an annual application of 10 tons/ha of green compost was added to this reference. Two other treatments were based on the annual application of 20 tons/ha green compost on average (5) or CMC compost (4), fine-tuned with the help of organic granular fertilizer to equal an equal amount of N as in the reference treatment. Another treatment (3) was based on a minimal supply of organic matter, by application of the amount of N of the reference object in the form of slurry and organic granular fertilizers. A final object (6) was based solely on farmyard manure.

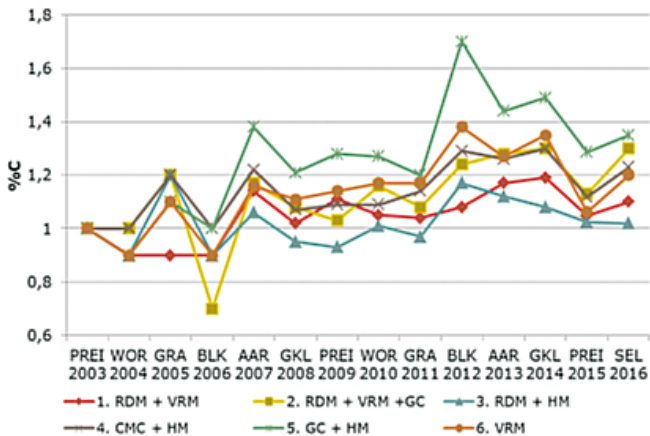
## Green compost main supplier of organic matter

Application of green compost was especially responsible for a significant increase in the organic carbon content in the soil. The carbon content increased consistently from 1.0% to 1.4%. The highest microbial mass was found in this treatment as determined by PLFA analyses conducted by ILVO in the last year of trial. CMC compost and manure provided a slight rise in carbon content. In the treatment with minimal supply of organic matter, the carbon content remained stable thanks to the robust crop rotation.

Nitrogen dynamics was dominated by the effects of leguminous catch crops, including under-sowing of clover in wheat and one-year grass clover. In addition, year-dependent weather and cultivation conditions were decisive for crop yield. More stable yields and less risk of nitrate leaching was observed where treatments had an organic matter buildup than with the treatment with minimal supply of organic matter.



The evolution of phosphorus content (expressed as P-AI) for all treatments was stable to slightly decreasing, independent of the amount of phosphorus that was added each year through organic fertilization.



Organic carbon content (%C) in the soil of 6 treatments during 13 trial years. An individual sample was taken per plot.

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# Nitrogen delivery of cut-and-carry fertilizers in relation to application method and soil condition

new

*A cut-and-carry fertilizer is a cut of grass-clover or another green manure that can be applied as fertilizer on another field. ILVO, Inagro, PCG and Ghent University investigate the effects of cut-and-carry fertilizers. They also study whether the application method affects the degradation rate of this fertilizer type and consequently its nitrogen delivery. Furthermore, the effect of the soil condition on the nitrogen delivery of cut-and-carry fertilizers is investigated.*

## Good reasons to use cut-and-carry fertilizers

Cut-and-carry fertilizers allow nutrients to be recycled on-farm. The Flemish Manure Decree (MAP5) limits the use of animal manure by reducing fertilization limits for phosphorous. Furthermore, availability of animal manure and logistics can be problematic for a sufficient supply of the desired quantity of animal manure. For this reason, interesting strategies for organic vegetable farms are the use of manure types with a high nitrogen/phosphorous ratio (more supply of nitrogen per unit phosphorous) and the use of leguminous green manures that can fix atmospheric nitrogen, like a clover component in grassland. The grass-clover cuts can then be used as a cut-and-carry fertilizer. It can either be applied fresh or stored temporarily (e.g., ensiling) for field application during the next growing season.

## Research approach

For organic vegetable cultivation, both in open field and protected cultivation, the nitrogen delivery of cut-and-carry fertilizers is studied during two subsequent growing seasons (2015-2016) in (i) newly established field experiments, to investigate the effect of application method and (ii) existing long-term field experiments (on soil management) to study the effect of soil condition. In this way, we can gather knowledge on the effectivity of cut-and-carry fertilizers in relation to soil management strategies. The quality of the cut-and-carry fertilizers used and the soil quality in the various experiments are determined in the lab. Furthermore, the nitrogen delivery of the cut-and-carry fertilizers is analyzed in the lab under standardized conditions.

## First results

In 2015, field experiments were established at Inagro and ILVO where the cut-and-carry fertilizer (grass-clover) was applied to the field at the start of the growing season using different application methods: (i) before





ploughing, in order to deeply incorporate the fertilizer, (ii) after ploughing, after which the cut-and-carry fertilizer was shallowly incorporated, and (iii) after planting the potatoes, as a mulch layer.

The first results indicate that the nitrogen delivery of the cut-and-carry fertilizer was probably faster when the cut-and-carry fertilizer was incorporated at shallow depth compared to a greater depth. However, this was not translated into a higher yield of the potato tubers. In 2015, potato yields were generally high to very high (> 60 t/ha). Incorporating the cut-and-carry fertilizer at shallow depth resulted in the highest yield (63 t/ha) at Inagro, although there were no statistical differences in yield between the treatments where cut-and-carry fertilizer was applied. ILVO also reported no difference in tuber yield between incorporation at shallow and at greater depth. The experiment at Inagro, where also a treatment with farmyard manure was included, showed that cut-and-carry fertilizers can be used as a comprehensive alternative for farmyard manure.

Furthermore, in 2015, in the context of this project on cut-and-carry fertilizers, field experiments were conducted with cabbage (Inagro), tomatoes (PCG), and spinach. In 2016, experiments with cabbage (ILVO), potatoes (Inagro), pepper (PCG) and pak choi (PCG) were installed.

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**Funding:** Government of Flanders, Department of Agriculture and Fisheries (2015 - 2017)

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## Solutions for building soil organic matter in organic farming

*As a result of the stricter phosphorus standards in the Flemish manure legislation (MAP5) the allowed amount of organic fertilizers is strongly reduced for certain fields. This results in fewer opportunities to maintain the organic matter in these soils, which is of great importance for organic farming. Well-considered crop rotation and optimal utilization of the farm's own organic matter are even more important tools to close the nutrient cycle and to maintain healthy soil. An ongoing project demonstrates practical techniques that, within the legal limits of MAP5, provide a build-up or at least maintain the soil organic matter on organic farms.*

### **Building soil organic matter**

Fertilization in organic farming relies on crop rotation, manure, compost and (leguminous) cover crops. The stricter phosphorus standards limit the supply of organic fertilizers, which can threaten organic matter content. A grant from the Flemish Department of Agriculture and Fisheries allowed the partners of CCBT to start a demonstration project specifically for organic farmers. The project "Practical solutions for building soil organic matter in organic farming under MAP5" is coordinated by CCBT and carried out by the partners PCG, Inagro Organic Department, Proefcentrum Pamel and pcfruit.

These partners demonstrate practical and achievable techniques in the various sub-sectors (vegetables, agriculture, berries, pome fruit and protected crops). The emphasis lies on maximizing use of own-farm organic matter and on a balanced fertilization strategy of the crops in the rotation. Necessary hygienic measures will also be taken into account to prevent the build-up of potential pests through the reuse of organic material on farm. We also remain mindful of the economic conditions.

For **arable crops and vegetables**, the focus lies mainly on the value of cereals with undersow of clover and grass-clover in organic arable and vegetable rotations as well as on the valorization of the clover yield in the form of cut-and-carry fertilizers.



For **berries**, the use of cut-and-carry fertilizers is also promising. Other solutions are found by recycling pruning waste. For strawberries, key project elements are how the crop is established and how the crop is cleared (e.g. use of organic matter from the picking paths, incorporation of crop residues, and the like).

In a **pome fruit** orchard, the only opportunity to incorporate organic material directly into the soil is during planting. Because nutrients can be calculated at farm level instead of at parcel level, a double amount of nitrogen can be applied to one parcel. Therefore, at the time of planting a larger amount of organic material can be incorporated into the soil.

In **protected crops** organic matter can be applied by different types of compost, which will be demonstrated in this project. Also, some products supply pure carbon such as "Enriched Biochar Soil Improver" (Carbon Gold).

Finally, the project will explore whether the Demeter tool of VLM can be extended to berries and protected crops.

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**More info:** [www.ccbt.be](http://www.ccbt.be)

# Optimal valorization of organic-biological byproducts from the primary sector through composting, ensiling and digestion

completed

*Within one of the PhD trajectories of the ILVO GeNeSys project, Jarinda Viaene and her colleagues spent four years exploring the possibilities to valorize byproducts from the primary sector, with a focus on composting. Local on-farm composting fits within the view of a sustainable bio economy and agricultural systems, in which sustainable soil management and other agro-ecological practices have an important role to play. However, both composting and compost application are not common practices in (Flemish) agriculture. Therefore, the first objective of this project was to identify the challenges and hindrances to on-farm composting and the application of compost in agriculture. Those barriers were used to further refine the aims of the thesis.*

- 1. What are the barriers to on-farm composting and compost application?** The main barriers to on-farm composting are the shortage of available woody biomass, strict legislative preconditions, considerable financial and time investment, and lack of experience and knowledge are hindering on-farm composting. At the same time, the complex regulations, manure surplus, variable availability and composition of compost, as well as transport limitations are additional barriers to compost application.
2. To help remove certain barriers, a set of experiments was conducted with locally available organic residues, both from vegetable and animal origin. First, for **N-rich vegetable crop residues**, a comparison between co-ensiling, co-composting and anaerobic co-digestion led to the conclusion that all three valorization options can be used to process and/or store these crop residues during winter. This reduces the risk for N losses linked with the fast decomposition of fresh crop residues. Soil amendment of silages, which are still highly biodegradable, resulted in highest C mineralization and microbial biomass C, and temporary N immobilization. In contrast, application of mature composts led to low C mineralization and no net N mineralization or immobilization. Second, field storage conditions and treatment of **cattle farmyard manure** were studied, again with a focus on limitation of environmental impact (N losses to the soil) and optimization of the agronomic value of this manure. The treatments in our experiments differed in terms of storage method (stockpiling, extensive composting or co-composting with bulking agents) and covering (no cover, plastic or geotextile cover). In all the treatments, the ammonia-N concentrations under the piles in the 0-90 cm soil layer amounted to a maximum of 4.2% of the initial manure N content. For cattle farmyard manure with a relatively high straw content or with added bulking agents, composting appeared to be



the better technique to have the least N leaching and most stable end product. In contrast, for cattle farmyard manure with a high volumetric moisture content and low C/N ratio (low straw content), stockpiling and covering appeared to be the better technique. When composting N-rich byproducts with a high moisture content, more porous and C-rich feedstock materials should be added. However, farmers experience a shortage in the latter type of feedstock. For our research, we concluded that chopped heath biomass and spent growth media can be used as **alternative bulking agents** for wood chips during compost production, resulting in stable composts with an organic matter content suitable for use as soil amendment.

- 3. Providing tools for farmers, policy makers and other stakeholders** to stimulate on-farm composting and use was another important objective of this work. One of the most important conclusions of part (1) of this thesis was that alternative collaborative forms of on-farm composting might function as a potential lever to overcome some of the most stringent legislative, market and financial barriers. To gain more insights into the feasibility of some of these alternative production forms, three action research case studies were performed on different locations in Flanders, in collaboration with stakeholders and relevant policy advisors and implementers. Compost quality, production costs and applicable regulation per case were monitored. We concluded that cooperation between different partners for the production of on-farm compost resulted in a better and economically more feasible composting process.

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**Partners:** UGent, wide range of stakeholders

**Funding:** ILVO (1/10/12 - 30/09/16)

**More info:** [www.ilvogenesys.be](http://www.ilvogenesys.be)

- Viaene et al., 2016. Field storage conditions for cattle manure to limit nitrogen losses and optimize fertilizer value.
- Viaene et al., 2016. Opportunities and barriers to on-farm composting and compost application: a case study from northwestern Europe.

# Nitrogen dynamics in relation to soil management and soil quality in field vegetable cropping systems

*Soil management, particularly organic amendments and soil organic matter dynamics, are decisive for soil quality. Correct N fertilization accounts for the N supplying capacity of the soil. In organic agriculture, most of the crop N demand is met by the N release from soil organic matter.*

*In his doctoral research, Koen Willekens investigated how soil quality improving management practices and soil quality affect N availability in the soil and N utilization by the crop.*

## **Three-year field survey and multiyear soil management trial in a conventional field vegetable cropping system**

In 2009, leek was grown as test crop on all surveyed fields. In the first half of the growing season, N availability in the soil was clearly related to the total N content in the arable layer and therefore to the N release from soil organic matter. Better soil quality due to a higher soil organic matter content resulted in a higher leek yield and less residual mineral N.

Compost application and non-inversion tillage prevented soil degradation in the three-year soil management trial (2008-2011) by sustaining the soil organic matter content, buffering soil acidity and reducing nutrient leaching. The yield level of the grown vegetables was not reduced by non-inversion tillage. Compost application and non-inversion tillage only had a limited effect on N dynamics. Introducing these soil quality improving management practices does not require any change in the N fertilizer application in the short term.

## **Multiyear soil management trial in an organic field vegetable cropping system**

In this multi-year experiment (2010-2012) in the frame of the TILMAN-ORG project (CORE Organic II ERAnet), the factor "green manuring" was also investigated in addition to soil tillage and compost application. In the first year of investigation, late termination of a temporary grass-clover ley, repeatedly mulched in springtime, resulted in the best results for the main crop leek with an acceptable risk of N leaching losses, a good yield and the highest N sequestration in soil organic matter. The type of soil tillage





did not affect the soil N availability, the leek crop N uptake and yield. Both the application of a cut-and-carry fertilizer and the use of compost were beneficial for celeriac crop development in the next growing season.

### General findings

The multi-year soil management trials in the conventional and organic field vegetable cropping systems confirmed that non-inversion tillage, compost application and the use of cover crops favor soil quality. The field survey showed that better soil quality increases the N availability and enhances N utilization by the crop.

In both in the field survey and the multi-year soil management trials, net N mineralization was observed in the first half of the growing season when the soil was bare or slightly covered by a young crop, whereas net N immobilization occurred in the second half of the growing season when the root system of the main crop had fully penetrated the arable soil layer.

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**Funding:** Government of Flanders and SYMBIOS vzw (2009 - 2015)

**More info:** <http://www.ccbt.be/?q=node/816>, [www.tilman-org.net](http://www.tilman-org.net)

## Comparison of different types of fertilizers in an organic fruit orchard of Conference pear

*Until now, little attention has been paid to fertilization in organic fruit growing. Which makes that the 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 just a slow re-lease manure or slurry. But it is not sufficiently clear whether these products release sufficient nutri-ents at the most important moments of the season. Therefore, it is tested in this project, among other things, whether combinations of fast-acting blood meal and slow release manure can be an improvement.*

### **Use of digestate as alternative source for N**

For Conference N and K are the most important nutrients. In the different organic materials, which may be used such as manure and slurry, both elements are present. But in order to obtain a higher N content in the fruits, it is not so easy to increase the dose. This is often accompanied by an over-supply of P and K, which hampers the uptake of other elements. Therefore, it is checked out whether combinations of classical materials with blood meal (only consists of N) can be an option.

In addition, new waste streams such as digestate exists containing both N, P and K. But, the nitro-gen of digestate is slower released compared to blood meal. Especially the K-fertilization with can be a problem when the dose is increased. Therefore, the combination with the fast-acting blood meal is also tested. On the other hand, a high nitrogen gift, in combination with hoeing, which is a classical weed control in organic fruit growing, can cause a high peak of nitrogen in the soil. The question is whether this nitrogen will be absorbed or will rinse rather to the groundwater.

Furthermore, humic acids are also offered. These are substances which would accelerate the min-eralization process in the soil. But even with this, there is so far still lack of experience, in order to know whether this can be a supplement.

In order to get a better view of the release of the nitrogen of the different fertilizers, during the season several soil samples shall be taken to determine the  $\text{NO}_3\text{-N}$  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 and we shall look at the fruit quality and the leaf quality.





*Application of organic material*



*Organic manure*

### **What we have learnt**

In 2014, there were no significant differences in N uptake between the objects. In 2015, the differences were larger and it were actually the objects of which it was not immediately expected, that scored worse. The blood meal was just added to the slurry and the digestate in order to get an early and better uptake of N.

The results of blood meal and soybean meal are positive with respect to N. The disadvantage of these fertilizer is that there is no organic material applied, and also no other nutrients, such as P and K. This, however, can in the long term cause problems.

The humic acids were only applied in 2015. The higher N content in the fruits compared to just slurry + blood meal may be an indication that the humic acids in spring have caused a better uptake. But after one season, it is too early to draw already conclusions.

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**Funding:** CCBT-project "Optimalisatie van de N-bemesting in biologische fruitaanplanting van Conference" (Optimalisation of Nitrogen fertilization in organic fruit orchard of Conference pear) (1/04/2014 - 31/12/2016)

**More info:** Pcfruit vzw - unit Proeftuin pit- en steenfruit, www.pcfruit.be

## Optimization of the N fertilization in an organic Conference pear orchard: combinations of organic fertilizers with alternative N fertilizers

new

*Leaf analyses from an organic fruit orchard reveal problems with nitrogen uptake. Lower N uptake results in lower fruit quality and fewer and weaker flower buds. In practice organic fertilizers and fast-acting N fertilizers such as blood meal are often combined. This practice appears to be insufficient to meet the N needs of the fruit trees, however. In this project, several other formulations being used in practice are compared in combination with organic mushroom manure or green compost.*

### Combination of organic fertilization with alternative N fertilization

N and K are the most important nutrients for Conference pears as they affect fruit quality, fruit size, shelf life and production. A good balance is needed between the nitrogen in the plant, the level of growth of the trees and a good K/Ca ratio in the fruits. Trials from recent years show sufficient K and Ca uptake in organic pear orchards, while N uptake is insufficient. N levels are particularly low early in the growing season.

In organic hard fruit production, organic fertilizers are commonly applied in combination with blood meal. But this nitrogen fertilizer does not meet the needs of the trees at the beginning of the season. Flowering and fruit set are the times when the trees need then most N. If N is already deficient at the beginning of the season, remediation of N levels during the growing season is difficult. A late nitrogen application goes to shoot growth, which is not desired. An extended period of shoot growth is not only detrimental to the flower bud formation for the following year, but also increases the pressure of pear psylla.

Within MAP5 the P norm is always the limiting factor for the use of organic materials. Supplements with other N sources are therefore needed to achieve good fertilization. In this project we compare several commercial available formulations (Fontana, OPF, Biovin, humic acids, Protifert 8% foliar feeding, DX10). Because these fertilizers provide little or no organic material, these products are combined with organic mushroom manure or green compost.

Based on the soil analyses of recent years, a Conference orchard was chosen in agreement with the *Vakgroep Biologische Fruitteelt* (Network of organic fruit growers) at a farm of an organic fruit grower, where in spring 2015



*Application of organic manure*



*Taking of soil samples*

a trial was started with 8 objects. This pear orchard has a relatively low organic matter content and therefore low mineralization. These conditions make the specific effect of the different fertilizers more visible.

At the beginning of the season 2016 the amount of available nitrogen in the zone 0-30 cm was determined. At the end of May a first leaf sample was taken to evaluate the release of nitrogen and any N uptake. At harvest a second leaf sample and a fruit sample were taken to determine the mineral composition. In addition, fruit quality was determined at harvest and after storage.

## Results

Preliminary results indicate that the use of Fontana in combination with humic acids looks promising.

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**Funding:** CCBT-project "Optimalisatie van de N-bemesting in biologische fruitaanplanting van Conference" (Optimalisation of Nitrogen fertilization in organic fruit orchard of Conference pear) (1/04/2015 - 31/12/2016)

**More info:** Pcfruit vzw - unit Proeftuin pit- en steenfruit

# Determination of the nitrogen fertilizer value of various organic fertilizers

*Organic agriculture can only rely on fertilizers of organic origin. These organic fertilizers can vary greatly in terms of composition and release of the nutrients, especially nitrogen. The general aim of this research is the market-oriented characterization of different organic fertilizers. It is important to know the fertilization value of these products so that organic fertilizers can be deployed in the best possible way. To do this, both the composition and the effectiveness coefficients have to be determined.*

## **What is the nitrogen fertilization value of organic fertilizers?**

Seven organic fertilizers are being analyzed. The following elements are determined during a characterization of the products:

- organic matter
- total N and total P
- total K
- mineral N

The working method used in order to determine the mineralization (or possibly immobilization) of N from the final products is:

1. determination of the rapidly released nitrogen.
2. the product to be tested is incubated in a reference soil under controlled conditions.
3. soil samples are taken during a 4-month period at regular intervals (every 15 days) in order to determine the amount of mineral N contained in the soil.



The seven fertilizers tested are:

- compost
- chopped woodcuttings
- mowed grass clover
- blood meal
- ecomix 2 (NPK 7-3-12) produced by the DCM brand
- OPF from Plant Health Cure B.V. in the Netherlands, a public limited company
- Viano organic plant food (NPK 6-5-10)

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**Funding:** Province of Flemish Brabant (2016)

**Partners:** Soil service of Belgium, a non-profit organisation

## Lowering soil pH in organic cultivation of ligneous small fruit by applying forest-sourced cut peat

*Several small fruit crop varieties require slightly acidic to very acidic soil. For blackberry and raspberry, this is a pH of 5.8 to 6.5; for blueberry, it can be as acidic as pH 4.0 to 5.0. In organic cultivation growers are not permitted to use fertilizers with an acidic effect nor are they permitted to acidify irrigation water. The resulting use of compost or alkaline rainwater causes the pH of these crops to rise. The result is that it the crop is not profitable with the risk of chlorosis caused by a reduced uptake of nutritional elements in a less than ideal pH level.*

*Some possible solutions include the incorporation of garden peat for the planting of a new crop, the incorporation of elemental sulphur or the application of cut peat. The addition of the bacterial species Thiobacillus thiooxidans or Thiobacillus ferrooxidans are possible solutions, but are not yet commercially applicable. The pH-lowering effect of garden peat and elemental sulphur has already been demonstrated.*

### **Can cut peat be the answer?**

Within a Master's research project (University of Leuven – Technology Campus Geel) forest-sourced cut peat was tested as a possible strategy to lower soil pH in the cultivation of organic small fruit crops. Cut peat is applied in heathland restoration, to turn grass dominated areas or outdated heathland into new, young heathland or when transforming former forests into heathland. When peat is cut, the humus-rich upper organic soil layer along with the sand is excavated and removed. Cutting can be done manually and small-scale with a special peat-cutting shovel, or by machine using a crane if peat has to be cut from larger surface areas. Peat is usually cut from a depth of 5 to 10 cm but the ideal cutting depth depends on the soil structure.

### **Germination tests, composting tests and pot test with forest-sourced cut peat**

The suitability of forest-sourced cut peat was tested in three experiments. First, a germination test with forest-sourced cut peat was performed. The cut peat contained weed seeds capable of germination but only a limited number of weed seeds actually germinated, even under favorable conditions of sufficient heat and moisture. Applying a 6-cm thick layer of forest-sourced cut peat showed to suppress weed growth from the underlying sand-clay soil.



Second, a composting experiment was performed to test whether cut peat could be composted to create a more homogenous and purified soil-improving agent. Only the forest-sourced cut peat with addition of either blood meal or freshly mowed grass achieved a sufficiently high temperature ( $\pm 55\text{ }^{\circ}\text{C}$ ) and thus was able to complete the entire composting process. Composting increases significantly the pH making composted forest-sourced cut peat inappropriate for reducing soil pH.

Third, a large-scale pot test with 44 treatments was repeated three times in a heated greenhouse to determine the extent to which cut peat could reduce the pH of a sand-clay soil. Results show that only the treatments with a 6-cm layer of forest-sourced cut peat created a soil pH appropriate for the cultivation of small fruit crops.

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**Partners:** KU Leuven and Technology Campus Geel

**More info:** Master Thesis submitted to obtain a Master of Science degree in the Life Sciences of agriculture and horticulture at KU Leuven, Campus Technology Geel (located in Geel Belgium)



# Building soil organic matter through maximum use of proprietary sources of organic material with strawberries and small fruit

new

*Delicious fruit needs good soil and sufficient organic matter. In organic agriculture, fertile soil is considered vital for the production of a healthy crop; organic matter is an essential component of healthy soils.*

## What is organic matter?

Organic matter (OM) forms just a fraction of the soil (2-5%) but has great value. OM consists of:

- Living organisms (plant roots, soil fauna, etc.)
- Fresh organic material (plant waste, manure, dead soil fauna and the like)
- Decomposed organic material (humus)

Organic matter is constantly being discharged and released in the soil. In order to keep the organic matter content of soil at the required level, it is important to provide a sufficient and regular supply of organic material.

Through a new, stricter manure legislation in Flanders (stricter phosphorus standards) the fertilization dose is now severely restricted, creating difficulties in supplying sufficient organic matter. Good crop rotation with use of the farm's own organic material for a good nutrient cycle are therefore important for maintaining healthy soil.

## Strawberry cultivation requires alternative techniques

In organic farms strawberry cultivation occurs in an extensive crop rotation. The way in which the crop is set up and cleaned up determines whether the release or discharge of organic matter takes place.

Traditionally, cultivation takes place on ridges that are covered with plastic film; the picking paths are covered with a weed-resistant cloth. At the start of flowering straw is laid to keep the fruits pure and free of disease. Afterwards, all of the material is removed from the field.

An alternative is to replace the plastic film with a bio-degradable one. On the picking paths, spontaneous vegetation, mowing material, straw or other organic material can be used. After harvesting, everything is simply worked into the soil. As a result, the soil is enriched with plenty of local organic material.





### **Different approach for cultivation of perennials**

Small fruits such as raspberry are perennials that demand a different strategy for fertilization and organic matter buildup than applied in annually cultivated crops. In perennial cultivation, planting is the only opportunity to add large amounts of organic matter to the soil. During cultivation, alternative methods must be used, such as woodcuttings, under-sowing of green manures or the application of cut green manures.

### **The organic sector has a plan!**

The organic sector is going to collaborate with Pamel Test Centre to examine practice-oriented solutions in order to influence the percentage of organic matter contained in the soil to the greatest possible extent – all within the limits of the Fertilizer Action Plan 5 (MAP5). Growers can put the research results and techniques into practice to cultivate high-quality fruit.

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**Funding:** Demonstration project "*Praktijkgerichte oplossingen voor organische stofopbouw in biologische landbouw onder MAP5*" (Practical solutions for organic matter buildup under MAP5)(Government of Flanders, European Agricultural Fund for Rural Development)  
(1/01/2016 – 3/12/2017)

# Characterizing nematode communities by DNA metabarcoding to determine soil health status

new

*Can a community of soil-borne nematodes serve as a bio-indicator for the health status of soils? Can we determine the composition of nematode communities accurately and routinely? Several studies confirm the role of nematodes as a bio-indicator. For easier and faster determination of nematodes in soil, ILVO has worked to replace the difficult and labor-intensive morphological characterization of nematodes with a more reliable and faster DNA-based technique.*

## **Nematode communities are ideal bio-indicators to monitor soil health**

Soil-borne nematodes are tiny and therefore unknown to most people. But they represent a large part of the soil fauna. Nematodes are usually present in the highest number of individuals and species diversity compared to other members of the soil fauna, except for bacteria. In 1 square meter of soil, between 2 to 20 million individuals and 30 to 60 different species can be found. Some nematodes feed on algae or plants. Others feed on bacteria or fungi, so they can renew their populations constantly. This activity maintains the mineralization of nutrients at an efficiently high level. Finally, some nematodes are predators or omnivores that feed on other nematodes and insect larvae. If their prey are plant pests, the predators and omnivorous nematodes play a role in biological control. Synthetic fertilizers and soil amendments such as compost, chemical herbicides or biocides all influence the biodiversity and abundance of nematodes. Activities that disturb the soil such as plowing, harvesting or application of green manures favor nematodes with a short life cycle and high reproductive rate. In short, nematodes contain a wealth of information to characterize and monitor the soil's condition. Recent research from ILVO demonstrated the positive effect of organic farming on nematode biodiversity and the survival of predators.

## **DNA metabarcoding for characterizing nematode communities**

DNA metabarcoding is a technically daunting procedure based on a simple concept. Similar to a barcode for products in a shop, each nematode species can be associated with a barcode. A database of barcodes for nematodes is now being constructed at ILVO. A large number of different



nematode species are collected from a range of soil samples and identified morphologically by ILVO's nematode expert. For each nematode specimen identified, the DNA is extracted and a piece of it is sequenced. This unique DNA sequence is called the "barcode". By sequencing the same piece of DNA from an unknown nematode and comparing its sequence with all the other nematode barcodes, the nematode can be identified. The DNA metabarcoding technique takes this even further: the entire nematode community present in a soil sample can be identified. This list of nematode species (or genera) provides information about the condition of the soil sample. Once the technique is sufficiently tested and validated, this DNA metabarcoding for nematode communities will be an important instrument to determine soil biodiversity, assess soil disease suppressiveness, and describe soil and plant health.

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# Occurrence and risk assessment of wireworms on agricultural fields in Flanders

new

Wireworms can cause economic damage in a variety of crops. Potatoes, corn and Belgian endive (*witloof chicory*) are among the most susceptible crops in Flanders. In spring 2015 a consortium of Flemish partners started the research project "Sector-wide integrated control of wireworms". By 2019, they aim to develop a decision support system and a practical IPM strategy to control wireworms in the three main susceptible crops listed above.

## A pest complex

Wireworms are the larvae of click beetles (Coleoptera: Elateridae). Several species and genera inhabit farmland and damage crops. To date, no information is available on the prevalence of harmful species on agricultural fields in Flanders. Defining which individual click beetle species forms the wireworm "pest complex" is nevertheless a prerequisite to develop integrated control strategies. Most of the main harmful species remain several years in the soil as larvae. This long development time in the soil differs for each species and, in addition, varies greatly depending on the field conditions. These features make the problem of wireworms even more complex.

## Flemish monitoring network 2015 - 2018

During a 4-year monitoring campaign, the National Research Centre for witloof chicory, Inagro and Hooibeekhoeve will collect field samples from at least 45 fields with a damage history or with risk factors for wireworms across Flanders. The larvae in the soil are sampled with bait traps and the adult beetles are caught with species-specific pheromone traps. In 2015 a total of 8200 beetles and 1922 wireworms were collected on 46 fields.

## Identification of wireworms

All wireworm and click beetle samples are identified at ILVO to species level, both morphologically and by molecular techniques. Preliminary results indicate that mainly *Agriotes* spp. are present. Seven species of the genus *Agriotes* have been identified of which *A. lineatus* and *A. obscurus* are important harmful species. Two other genera have been identified as well: *Adrastus* and *Hemicrepidius*. Further research is needed to clarify how much damage they may cause in Flemish agricultural fields.



### Predicting damage risk

Setting up a monitoring program to gather fundamental knowledge on the harmful species and the activity of wireworms in fields was the first step in the project. Next, the Flemish project will analyze the relative impact of the risk factors for crop damage. Therefore a damage assessment is made on all sampled fields with potatoes, witloof chicory or corn. This plant damage rates are analyzed in relation to the wireworm trap data and field site characteristics such as the crop history, soil type and cultivation techniques. With the use of new modeling techniques, an application that allows farmers to assess the damage risk by wireworms on a given field will be developed.

### Research on control methods

In case of a risk of damage by wireworms, farmers primarily want to know which control measures are effective to reduce the damage risk. Lab and (semi-)field experiments will address this question during the project (2016-2018). Control methods offering potential in organic agriculture will be tested and evaluated in the field by Inagro. Other partners will also focus on cultural and chemical control methods.

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**Funding:** VLAIO (Agency for Innovation and Entrepreneurship, Government of Flanders) (1/04/2015 - 31/03/2019)

**More info:** [www.inagro.be](http://www.inagro.be)

# Development of IPM tools for pest control in cereal farming



new

*Aphids and grain beetles are known pests in cereal production. Their occurrence is variable and is not a yearly risk of loss in production. Treatment is therefore not always necessary. In addition, many natural enemies exist to help to prevent or limit damage. To be able to estimate the risk of damage correctly, a four-year study is being done.*

## Known enemies in cereals

Aphids and grain beetles in high numbers can cause a significant loss in yield. Aphids (*Sibition avenae*, *Rhopalosiphum padi* and *Metopolophium dirhodum*) suck on either leaves or the grains in the ears. In addition, the aphids produce "honeydew" where fungi can develop. The larvae of the grain beetle (*Oulema melanopus* among others) are responsible for the typical rectilinear damage on the leaves. This damage is clearly visible in the crop.

As the farmer notices the damage, it is often already too late for intervention. But even for farmers who know and recognize both pest insects in the crop very well, it is not always easy to determine whether a treatment is needed. The extent of the final damage depends not only on the pest's density in the crop at a certain moment - other cultivation and environmental factors play a role. Therefore, a specific advisory system is needed to determine (1) the extent of the risk for economic damage which takes the different (field specific) factors into account and (2) the optimal timing of a treatment.

## ... and unknown friends

Previous research shows us that beneficial insects play an important role in this context. Natural enemies, including ladybugs, spiders, and parasitic wasps, can attack pest organisms and prevent damage. These beneficial insects occur in each crop but are insufficiently known in cereal production. Therefore farmers pay little or no attention to them.





### To a more integrated production

Early in 2015 Ghent University, together with Inagro and Soil Service of Belgium (*Bodemkundige Dienst van België*), started research toward better control of aphids and grain beetles in cereal production. "Better" control means more integrated control using different techniques and paying attention for the environment. As a result, the researchers aim to develop a web tool that will predict the damage by aphids and grain beetles and warns the farmer if treatment is needed.

For grain beetle, there is currently no warning system in Flanders. The monitoring of the different developmental stages in the field (eggs, larvae, and adults) as well as the determination of thresholds for damage are essential building blocks for efficient warning systems. Researchers are therefore monitoring more than 30 cereal fields spread over Flanders. During four years, counts and observations are being done on these fields. These results will contribute to more insights into the population dynamics of both pest insects and will allow determining damage thresholds. It will be the basis for a "guided" and economically justifiable pest management. An innovative aspect of the project is that the damage threshold will also account for the beneficial insects in the crop.

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# Root-knot nematodes in protected cultivation of fruit vegetables

new

*Despite many years of discussion about soil(less) cultivation in organic farming, it remains soil-bound. Soil health therefore remains essential, including implementation of a sufficiently large rotation. This represents a challenge in heated greenhouses. The most profitable crop scheme is a rotation of fruit vegetables, mainly tomato, pepper, cucumber, eggplant and zucchini. Because these crops only belong to two plant families, these crops are vulnerable to soil-borne pests and diseases. One of the main pests are root-knot nematodes (*Meloidogyne* spp.). These microscopic worms parasitize the roots, reduce plant growth and cause yield losses.*

## Current situation

There is no feasible and cost-effective solution for the control of root-knot nematodes. In practice growers work with grafted plants. Resistance against *Meloidogyne* spp. is present in certain rootstocks but the resistance is often either incomplete or limited to the tropical *Meloidogyne* spp. As such, population levels of some species of root-knot nematodes remain stable or even increase. When population levels are high, farmers can opt to steam the soil. This is a last resort, however, because it is expensive, kills beneficial soil organisms and does not result in complete eradication of the root-knot nematodes, so the population can rebuild.

## Natural products

Organic growers and their suppliers were consulted to determine which products that are already available on the market are believed to have an effect against *Meloidogyne*. Products were chosen that stimulate a healthy, vital soil and/or with an (in)direct effect on the plant-parasitic nematodes present. A test was conducted with the soil improvers biochar (Enriched biochar Soil Improver, Carbon Gold), ProFunda + Nematodemix (Nutugro) Maxstim for Salads (Maxstim Ltd.) and Nemater (Pireco). Woodchip compost from ILVO was also included in the test.

## Experimental design

In a *Meloidogyne javanica* infested greenhouse the five treatments were performed (4 replicates/treatment) prior to the cultivation of cucumber.



All treatments were compared with an untreated soil (control). After the cultivation the numbers of nematodes in the soil were determined. None of the treatments had a clear effect on the nematode population and there was no difference between the tested products. From these results, it appears that these products do not have any lethal effect on the nematodes. Whether they can slow down population build ups of *Meloidogyne* or prevent yield losses in the long term through increased plant defense should be tested in longer-term trials with successive crops and low initial numbers of *Meloidogyne*.

### Further research

We wish to continue this research and also look at the effect of antagonistic crops, cover crops, cut green manures and compost. Longer term experiments with more than one production run are advisable. Preliminary research is presently done with intermediate crops such as Sudan grass, rucola (arugula) and Tagetes (marigolds).

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(2015-2016 )

## Biopesticides: efficacy and utility for organic crops

new

*Plant protection products of natural origin are gaining popularity. They have the potential to contribute to a more sustainable crop protection, and are therefore also being studied in conventional research. Pesticides of natural origin need to go through the same registration procedure as synthetic chemical agents before they can be applied in crop protection. Research institutes therefore play an important role in this process. They perform efficacy trials in the field and explore which products show the best control potential for a certain pest or disease problem. PCG as well as Inagro implement this efficacy research specifically for organic culture.*

### **Prevention is still key in organic crops**

Despite the rising attention for biopesticides, prevention remains the basis for organic crop protection. Prevention starts at sowing or planting (use of healthy plant propagating material, selecting for resistant or tolerant varieties, etc.), and requires attention during the entire cropping period. Finally, the number of curative measures in organic fields are limited. In addition, some of these measures often have negative effects and are therefore not suitable for use in organic crops.

### **Authorized use of biopesticides**

Use of a plant protection product must be nationally approved for at least one specific application. A non-authorized commercial product cannot be used, even if the product is of natural origin and has approval in other countries. This legislation is the same for conventional and organic farming. Biopesticide use in organic crops is subject to European legislation concerning organic production. This legislation prescribes which active ingredients are allowed for organic plant protection. Hence, a (national) registered product may only be used if also the active ingredient complies with the European Directives regarding organic production.

### **Working group on "Authorization of biopesticides for organic vegetable production"**

Since 2010 there has been structural communication within the Belgian government concerning authorization of new plant protection products in the organic sector. In these meetings the problems and opportunities in



regard to the approval of biopesticides in Belgium are discussed. The main goal is to define which products the sector needs, to look at the feasibility for specific approvals and to formulate the tasks for the trial and registration of (new) potential biopesticides.

### Current research

At the moment the plant protection research on PCG and Inagro focuses on the control of mildew (*Oidium* spp.) in different crops as cucumber (*Cucumis sativus*), zucchini (*Cucurbita pepo*), and borage (*Borago officinalis*). In some crops the use of sulfur spray is allowed, but its use is often not recommended for several reasons: first, an application always harms all present natural enemies in the crop and second, frequent applications in plastic tunnels decrease the longevity of the plastic. Finally, some crops show an adverse response to the application of sulfur and thus lose fruits. Research into potential alternative crop protection products is thus of great interest. In 2017 PCG will test the most promising products against powdery mildew in tomato.

The extension research centers do not only focus on disease control; they also test biopesticides for organic pest control. Examples of ongoing trials are control of carrot fly in celeriac, flea beetles in turnip greens and *Meloidogyne* in fruiting vegetables in greenhouses.

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# The potential use of mycorrhiza in apple orchards

completed

*An important problem in the fruit growth in Flanders and the world is the lack of uncultivated soils, particularly soils where no fruit trees have been planted. The growers are obliged to reuse plots for new plantations. This situation can lead to soil fatigue or replant disease, which can negatively affect the growth of apple trees. Mycorrhizal fungi (particularly arbuscular mycorrhizal fungi (AMF)), fungi which live in symbiosis with the roots of plants can prove their usefulness. They facilitate the intake of soil phosphate, water and other essential elements by plants from the soil. In addition, there are important indications that the application of AMF can lead to the suppression of plant pathogenic soil fungi and nematodes. AMF therefore represent a possible solution to replant disease.*

## **Cause of replant disease**

Factors causing replant disease can be either abiotic (soil structure, drought and cold stress, mineral content of the 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. There are important indications that the application of arbuscular mycorrhizal fungi (AMF) can lead to the suppression of plant pathogenic soil fungi and nematodes.

## **Diversity of AMF in apple orchards**

The positive effect of AMF on the host plant can be dependent on several factors such as the variety of the plant and the fungal species, type of soil and environmental conditions. Because the effect can depend on the specific AMF community for a specific plant species and region, research is needed to determine the best symbiotic combination. Moreover, a high diversity of AMF present is expected to lead to broad and stable functionality of the fungi. Therefore, the first phase of this research was to characterize the AMF communities naturally present in apple orchards. Although most of the mycorrhiza species identified in organic and conventional orchards belong to the same families and appear in almost the same proportions, organic orchards contain more unique species. The diversity of AMF in organic orchards is significantly higher than in conventional orchards.





### Effect of AMF on the growth of plants under stress conditions

AMF can support the growth of plants subjected to stress conditions. Different pot experiments were set up with apple trees to determine the effect of AMF on the growth of trees subjected to either drought stress or nematode infestation. Because the effect of AMF on trees can only be observed after a few years, experiments with apple seedlings were performed. Results indicate that AMF supports the growth of seedlings grown in the presence of nematodes. In addition, various mycorrhiza products (commercial products and a mix of AMF sampled from the apple orchards) are being investigated under field conditions in a new plantation of young apple trees.

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## Control of fire blight blossom infections with biological control organisms (BCOs) applied with bumble bees on apple and pear

new

*Belgian export of fruit (apple, pear) may be threatened by the presence of fire blight when exporting fruit to a fire blight free region. Fire blight blossom infections should therefore be avoided. Biological control organisms (BCOs) has shown potential for solving this problem but it is difficult to apply BCOs to the blossoms continuously throughout the blossoming period. Use of bumble bees as a vector for the application of BCO microorganisms has been shown to be more effective than spraying.*

### Protection in the blossoming stage

Apple and pear trees are most susceptible for infections of *Erwinia amylovora* (Ea) during the blossoming stage. Blossom protection is therefore an important part of the fire blight control strategy. The quarantine pathogen *Erwinia amylovora* can infect as well primary as secondary blossoms, resulting in important crop losses or even the loss of complete trees in a period of weeks.

Research indicates that biological control organisms (BCOs) have the potential to protect blossoms and that it is essential to select BCOs that colonize specific niches within the flowers. Many of the existing BCOs currently used for blossom protection have not been isolated from blossoms and are not well adapted to the blossom environment. In this project we will isolate dominant microorganisms from the blossoms and test their capacities as possible antagonists against *Erwinia amylovora*.

### Application of BCOs

BCOs work via either spatial or nutritional competition or through production of antimicrobial peptides. Therefore they must be delivered exactly onto the surface of the styles or onto the hypanthium. To ensure maximal competition with the Ea bacterium, the number of BCO units applied to the styles or the hypanthium and their survival on these places is of great importance. Standard application of BCOs is done via spraying but a better spread of the BCO can be obtained when bumble bees are used as vector. While visiting the flowers for nectar and pollen, they can deposit the BCO exactly where it is needed within the flower. While spray application of BCOs can only bring the antagonist into the blossoms that are open at the time of application, bumble bees remain active throughout the entire blossoming period.

### Preventive use of BCOs

One important consideration is that the bumble bee can also be a vector for the fire blight bacterium. When infection pressure is high, pollinating insects



like honey bees and bumble bees can spread fire blight in the blossoms. But these insect pollinators are also important for fruit set on apple and pear. The BCO must therefore be applied preventively on the flowers; this reduces the infection chances of the blossoms even when *Erwinia* bacteria infect the flowers in a later stage. Future trials will be done to test this hypothesis.

### BCOs in practice

Flowers are inoculated either by the bumble bees coming from the hive passing a dispenser with BCO or indirectly by picking up BCO from earlier-inoculated flowers. First the compatibility of the BCO with the bumble bees will be studied. Then the optimal way for to load the bumble bees with the BCO will be studied using different carrier compounds. The internal structure of the blossoms will be studied with special attention to the pollen- and nectar production within the flowers which can determine the attractiveness of the flowers for bumble bees and other pollinating insects. The number and type of flower visits by bumble bees will be monitored.

The type and degree of protection of the flowers based on BCO-loaded bumble bees will be tested first under controlled circumstances under greenhouse conditions in quarantine greenhouses, then later under orchard conditions both preventively in healthy orchards as curatively in infected orchards.

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## Rational and orchard specific management of scab on apple

*Scab, a disease caused by Venturia inaequalis, is one of the major fungal diseases in Belgian fruit production. Approximately 50% of the pesticides used in apple cultivation are applied to control this fungus. A good control of the primary infection moments, caused by ascospores originating out of the overwintering infected leaves of the previous season, reduces secondary infections risks (via conidia) in the summer. An accurate warning system in the spring is therefore an ideal strategy to reduce primary infections as well to regulate the number of treatments.*

### Current scab management strategy

The current scab warning system of the Extension Research Station fruit Fruit Cultivation (pcfruit vzw) is based on a worst case scenario in which ascospore releases from heavily infected scab leaves are evaluated during rainy periods. The warning system is additionally based on the climatological infection risks calculated by weather data gathered by the agrometeorological network in Flanders. The current warning system is considered to be very valuable as it allows fruit growers to control their applied treatments, products and dosages.

This system does have disadvantages, however. The use of a worst case scenario does not take the initial inoculum pressure of a specific orchard into account. Consequently, the warning system provides potentially biased information concerning the intensity of scab infections which leads to maximal treatment on each possible infection moment. Too many treatments (or treatment at the wrong times) is not only expensive and labor intensive, it also accelerates the development of resistant species.

### Optimizing scab management strategy

In this project, the initial inoculum pressure will be determined using qPCR. The protocol has already been tested thoroughly but needs to be validated in depth to obtain an accurate assessment of the initial inoculum pressure. In addition, the same technique will be used to monitor the real ascospore release during the season in individual orchards. Such information is critical to improve the advice to fruit growers in their use of pesticides to control



scab infections. Last, the same method will be used to study the latent presence of scab on both leaves and fruits. The presence of latent scab on leaves may have an influence on the initial pressure at the beginning of the following growing season, while the latent present on apple can lead to a prediction of the degree of scab infection during storage.

In the next two years, collaborative research at pcfruit vzw with ILVO and KU Leuven, funded by the Flemish VLAIO, will further lead to a more detailed management strategy. When the real primary inoculum pressure, the true ascospore release and the latent presence of scab on leaves is taken into account, a more rational and site specific warning shall become available for fruit growers. It will also result in advice for growers concerning the risk of scab development during storage.

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

# Investigation of alternative beneficial arthropods for the suppression of pear suckers

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 flower buds in the following season's.

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

Up to now, integrated pest management of pear psyllids has predominantly focused on predatory bugs (*Anthocoris* and *Orius* spp.). However, these key beneficial arthropods are not host-specific, and often they fly into the orchard too late to prevent damage from pear sucker populations that have already developed. Consequently, many growers are forced to wait and pray for the predatory bugs to come, and the conventional growers have no choice but to spray multiple times 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 like to eat pear psyllids?**

In this research project, we aim to develop a substantially improved integrated pest management strategy by maximizing 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 ( $\pm 25\%$  of the total population), whereas more velvet



mites were present in the organic orchards ( $\pm 25\%$  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 using 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 in 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](http://www.pcfruit.be)



## Parasitoids as a biological control agent against aphids in fruit tree crops

*The European Union and the general public are calling for higher-quality and more sustainable plant protection products. In the integrated approach to pest management (IPM) in agricultural crop systems, a biological, mechanical or non-chemical control is preferred to the use of chemical crop protection agents. 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 more efficient and sustainable control methods. Target pests and pathogens include aphids in pome and stone fruit crops and the fungus *Monilinia fructigena*.*

### Biological pest management of aphids

In a natural ecosystem, plants can survive aphid infestations because parasitoids or parasitic wasps are highly efficient at controlling them. During their short life span, the minuscule koinobiont parasitoids can inject their eggs into 50 to 200 aphids using their ovipositor. Their larvae develop inside the aphid, eventually causing the aphid to die and in turn giving birth to a new generation of parasitoids. Under field conditions, parasitoids can make 5-6 generations per year. In nature this controls the aphid populations but in many fruit tree crops, aphids like *Eriosoma lanigerum*, *Dysaphis plantaginea* and *Myzus cerasi* are either more numerous than parasitoids or they appear much earlier, causing important economic damage.

### Which parasitoid for which aphid?

This research project will concentrate on finding, screening and managing efficient parasitoids against aphids harmful for fruit tree crops. These aphid species are currently in the limelight: *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 the adjacent plant communities in the different EPPO zones. For Central Europe, pcfuit will screen orchards in Belgium. Parasitized specimens (mummies) will be collected and the host plant noted. Upon emergence, the parasitoids will be 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 pcfuit. All potentially valuable identified parasitoid species will be evaluated for life span and fecundity as well as their efficiency in parasitism and the possibility to produce them efficiently. If deemed successful under small-scale laboratory conditions, the production



process for mass rearing of promising species will be set up and tested. In parallel, 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. In the final phase of the project, a method will be developed to release the parasitoids under optimal conditions in the fruit tree orchard. The search for an adequate and cost efficient way to release these beneficial organisms is essential to this research program. This phase will take three years and will be applied in at least one fruit tree crop. The first year will be situated on 10 locations in Belgium, and the next two years will be done 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 because aphids are notorious front runners: if the parasitoids are released after the first aphids' development, it is too late to control them effectively.

### **Micro-organisms, good and bad**

An additional branch of this project is the testing of beneficial micro-organisms against *Monilinia fructigena* in field trials in cherry.

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**Funding:** BIOCOTES (EU FP7-KBBE-2013-7) (2014-2018)

**More info:** [www.pcffruit.be](http://www.pcffruit.be)

## Applied research on alternative crop protection agents for biological control of pests in organic pome fruit growing

new

*In organic growing as well as in conventional systems, spraying with crop protection agents is sometimes needed. The main difference is that the compounds used in organic fruit growing must be of biological origin.*

### **Prerequisites for crop protection agents for registered use in organic fruit growing**

Currently in Belgium, only a limited range of crop protection products compatible with organic fruit growing are available. Before a compound can be used in organic growing it must meet two prerequisites:

1. the compound has to fulfil the rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labeling of organic products with regard to organic production, labeling and control.
2. the crop protection product must be registered in Belgium for the control of pest(s) in the (fruit) culture (consultation via [www.fytoweb.be](http://www.fytoweb.be)).

One of the major obstacles is the lack of biological efficacy data for (organically compatible) crop protection compounds for controlling particular pest insects in fruit growing.

### **Natural pyrethrins as biological curative crop protection compound**

Natural pyrethrins are a class of organic compounds normally derived from *Chrysanthemum* flowers that have potent insecticidal activity by targeting the nervous systems of insects. It is often combined with the synergist piperonyl butoxide which is problematic for organic fruit growing.

### **Need for alternative biological control compounds**

The goal of this project is to determine the biological efficacy of a range of (organically compatible) plant protection products against problematic pest insects including sawflies, stink bugs and blossom weevils.



Therefore we are executing a number of GEP (Good Experimental Practices) field trials with biological crop protection products. We determine the optimal timing, optimal dose rate and spraying interval. Our aim is to support future registration dossiers to offer more control possibilities for organic fruit growers.

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**More info:** [www.pcfruit.be](http://www.pcfruit.be)

# Sustainable control of *Drosophila suzukii* in cherries, strawberries and ligneous small fruits

new

*The Asiatic fruit fly Drosophila suzukii* or "spotted wing *Drosophila* (SWD)" has quickly become the most damaging insect pest of cherries, strawberries and small fruits in Europe. In Belgium the first damage was noticed in 2011; during the last 5 years SWD has spread to all of the fruit growing regions in Belgium.

## **Incapacity of chemical crop protection products to control *D. suzukii***

Of the chemical crop protection products available, only broad active compounds (pyrethroids, spinosyns, organophosphates) work sufficiently quickly to control *D. suzukii*. The broad action and (multiple) applications of these pesticides are detrimental for integrated control of (other) pests, as all beneficial insects and mites are killed. Therefore we focus in this project on control measures compatible with biological control for sustainable control of *D. suzukii*.

## **Knowledge is power in the battle against *D. suzukii***

We begin with gathering knowledge about the key aspects of biology of *D. suzukii* in our fruit growing conditions. Where and how do they overwinter? What are the most important host plants? How are their population dynamics and development rates in different Flemish fruit cultures? Which natural enemies do they encounter in our environment? How can we stimulate these natural enemies?

## **Mass trapping and attract & kill**

The "attract and kill" and "mass trapping" strategies, in which pest insects are attracted to a trap and killed, are interesting control alternatives for organic fruit growing. They allow monitoring and control of *D. suzukii* without massive spraying of chemical insecticides. The development of these strategies as effective sustainable control measures are an important goal of this project.



### Sanitary control measures during and after harvest

Crop hygiene and fruit waste disposal are very important to prevent further multiplication and spreading of SWD in fruit farms. In this project we aim to develop a practical fruit waste container in which SWD is killed quickly and effectively. Furthermore, the fruit waste will be transformed to a valuable fertilizer for other (fruit) crops.

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## Soft fruit production in the presence of *Drosophila suzukii*: small fly, big problem

new

Since 2011 Europe has witnessed the fast-paced advance of the Asian fruit fly *Drosophila suzukii*. Unlike the common fruit fly, which can only lay its eggs in softer damaged or rotting fruit, the *suzukii* fruit fly is armed with a serrated ovipositor and can lay its eggs in healthy undamaged ripening fruit. Growers are faced with limited control strategies to combat the growing problem (including biological insecticides and the use of predatory insects). Therefore a project has been initiated that supports organic growers in the sustainable management of this problem.

### Necessary measures

After egg lay, the developing larvae feed on healthy ripening fruit, leading to enormous production losses. It is therefore important to identify the presence of the flies at an early stage. With the use of traps (with a lure solution such as apple cider vinegar) *D. Suzukii* populations in the field can be monitored. Regular immersion of harvestable fruit samples in a saline solution (100 g kitchen salt and 1 L water) can also be used to determine if marketable fruit is infected. Currently the only curative measure for controlling *D. Suzukii* is the broad application of insecticides. Possibilities for biologically less aggressive control methods are currently extremely limited. It is also extremely important that growers adhere to strict hygiene rules. In short, growers need to maintain an excellent cool chain and all of the ripe or rotting fruit should be removed from the field and destroyed either by burying, burning or anaerobic fermentation.

### Netting does work

One new control measure being used in Flemish horticulture is the "Preventive or exclusion netting" of a crop to protect against *D. Suzukii*. As part of this project, two sites demonstrate the use of netting: "Frambiosa y besos" by Wim Vandenberghe in Veurne and Francis Kestemont in Lennik.

Traps are placed both within the netted area and outside it. Many fewer (80% fewer) flies are trapped inside the nets; salt tests of fruit grown under the nets also suggest that infection is reduced. In contrast, the resulting climate under nets is less favorable for fruit production. Tunnel constructions in particular gave rise to a very humid environment. Fruits harvested in such environments were constantly wet and the leaves continued to stick to the fruit. Larger, higher constructions provided a drier climate that was more conducive to better fruit quality (especially rain covers). In a second





attempt (2016) plastic on the sides of tunnels was lifted and replaced with net to increase the ventilation in the smaller constructions. This system appeared equally effective as the original tunnel construction against *D. suzukii*.

### Important to remember...

If you wish to net a field as a means to prevent infection by *D. suzukii* then keep the following in mind:

- The optimal mesh size should be (in one direction) narrower than 0.8mm. The chosen mesh should allow for sufficient light and ventilation. In this instance Ornata net (Howitec, 0.77 x 1.02 mm) was used. This net allowed 70% photosynthetically active light to penetrate and the rectangular mesh shape ensured adequate ventilation and thus an optimized climate.
- Construct nets over as much area as possible and try to provide enough ventilation in the sides of the constructions.
- Netting the crop before the fruit ripens will ensure that no early populations of *D. suzukii* become trapped inside the nets and begin to cause problems. In this way you can start the season plague-free.

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**More info:** [www.pcfruit.be](http://www.pcfruit.be)

# Biological control of aphids in ligneous small fruits

new

*Also in conventional production of ligneous small fruits, possibilities for chemical control of pest insects are diminishing and the search for alternatives becomes important. Release of natural enemies can provide an alternative solution. They offer an alternative biological control approach and decrease the likelihood of pesticide resistance development also suitable for organic production. In this project we test and validate several biological control programs in protected cultures of raspberries and strawberries.*

## **Aphids: difficult to control severe pest insects**

Aphids are one of the most destructive pest insects. They are responsible for considerable crop losses in small fruits year after year. Their sucking activity weakens the plant (with smaller fruits as a result) and the secreted honeydew results in quality problems within the harvested fruits. Aphids can also be vectors for disease. They have a complicated life cycle. During spring and summer they can reproduce asexually. Offsprings are identical to their mother. In addition the females are viviparous and the development of new offsprings start immediately after the aphid is born. One female aphid can reproduce 100 offsprings. This means that their populations can increase exponentially in very short time periods.

## **A biological army against aphids**

Within this applied/demonstration research project, we develop biological control strategies with the release of preventive as well as curative beneficial insects. At several times during the growing season (before blossoming, during blossoming, after blossoming) beneficial insects like parasitic wasps, Adalia ladybirds, lacewings (*Chrysopa carnea*) and predatory midges (*Aphydoletes*) are released and their impact is analyzed. An important focus is to find out which biological control organism on what time moment is most efficient in controlling the aphids. Also a cost-benefit analysis for the growers will be conducted.



### Preventive versus curative

Larvae of parasitic wasps develop inside the body of the parasitized aphid and eventually kill them. Consequently, the next generation of parasitic wasps appears always later than the next generation of aphids. This type of beneficial insect must therefore be active against the very first aphid stem mothers (fundatrices) as a preventive control.

Other beneficial insects such as predators can also be applied curatively. The advantage in this case is that when introduced after the first pest/damage presence they will find some prey to build their population on. Optimal release strategies are being tested in this project.

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# Weed control in the organic small fruit sector

new

*Good weed control is an ongoing problem in organic small fruit production. This two-year study was commissioned by the organic small fruit-sector to find practice-oriented solutions.*

## Weed control is a complex problem

Weed control within organic small fruit production is a complex issue, in large part because of the different types of fruit cultivated. Small fruit can be divided into three main groups:

- The **genus Ribes**, (e.g., currant, gooseberry, and blackcurrant), cultivated in bush or hedge. On the strip below the plants there is hardly any need to care for ground shoots.
- The **genus Rubus**, (e.g., raspberries and blackberries) has a very shallow root system. New ground shoots must be cultivated each year.
- The **genus Vaccinium** (e.g. blueberries).

The fruit farms themselves also differ greatly, for example in terms of surface area or cultivation system. Intensive mechanization is not financially viable for a smaller company, while a larger company can expect a fast return on investment. Ligneous small fruit is grown both in the open air and under protection; not all protective constructions are equally accessible by machines. These different cultivation systems thus require different approaches. Every company also has its own specific weed flora which is linked to the physical and chemical composition of the soil, but which can also be linked to the fruit grower-specific approach to cultivation techniques.

## Complex problems require creative solutions

We visit small fruit growers and interview them to get better insight into their current weed problems. In addition, we thoroughly examine their



approach to weed control. Finally, tests take place at growers' locations and at the research center, where new and innovative technologies are examined, such as the use of poultry as weed controller in the small fruit plantation. Direct input from the producers is very important for the fast translation of research results into practical application.

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**Funding:** CCBT-project "*Onkruidbeheersing in de biologische kleinfruitsector*" (Weed control in the organic small fruit sector) (Government of Flanders, Department of Agriculture and Fisheries) (2016 - 2017), supported by the European Agricultural Fund for Rural Development

**More info:** [www.vlaamsbrabant.be/ppkpamel](http://www.vlaamsbrabant.be/ppkpamel)

# BioRoots: tackling vine weevil in organic small fruit production

new

*The aim of the "BIORROOTS" project is to provide participatory support for a more well-reasoned approach to various priority problem pests/diseases in several organic subdivisions. As part of this project, Proefcentrum Pamel focused on the vine weevil (Otiorynchus sulcatus).*

## Well-considered control of the vine weevil

In recent years the indigenous vine weevil has been expanding explosively. It is becoming less choosy about its diet and has recently also been damaging small fruit crops. But growers of (organic) small fruit crops are not yet alert to the vine weevil, and consequently an unnoticed infestation sometimes causes severe damage, especially in the form of plant failure due to larval damage to the roots. BIORROOTS aims to bring the monitoring of vine weevil to a sufficiently high level within the sector so that infestations are observed and controlled in a timely manner. The project also aims to demonstrate the possible organic control techniques, with special attention given to the correct conditions in which the applications should take place.

## An ounce of prevention is worth a pound of cure

Checking (monitoring) at the right times for the possible presence of larvae, pupae and/or adult vine weevils can prevent a great deal of distress. Monitoring the adult vine weevils can be performed simply and cheaply by using wooden floorboards or sticky traps under which the vine weevils hide during daylight. Other types of traps were observed to be less effective. Monitoring of the hibernating adult vine weevils should start in the period April/ May, up to and including September. Control of larvae is best done in spring or early autumn. For that purpose, a plant is chosen at regular intervals in the small fruit rows, the root system is partly freed and the growers pay close attention to the presence of the larvae. As part of the BIORROOTS project, monitoring took place at Proefcentrum Pamel as well as at 5 practice-oriented companies to determine the presence of adult vine weevils and vine weevil larvae. At 2 of the 5 companies, adult vine weevils (under the sticky traps) as well as larvae were observed. At the 3 other companies neither vine weevils nor larvae were observed.



*Soil plates for monitoring the adult vine weevil*

### **Organic pest control**

The larvae of the vine weevil can be effectively controlled with organic pest control techniques. For this, growers use naturally occurring soil organisms such as parasitic worms (nematodes) and fungi (*Metarhizium* fungus). However, these organisms only work optimally at sufficiently high soil temperature and humidity. The application of biological products for the control of vine weevil larvae were and are demonstrated as part of the BIOROOTS project. The adult vine weevil cannot be controlled yet in organic cultivation due to lack of an authorized product.

### **Things to do and not do**

- Do buy (certified) larvae- and weevil-free stock (container plants) or if not possible: check purchased plant material
- Do monitor traps and use signal plants (i.e. plants selected for observation at regular distances within the rows) and apply pest control where necessary.

With the gathered knowledge in the project, we want to support strawberry growers in their integrated pest management on farm level.

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**Funding:** Government of Flanders, Department of Agriculture and Fisheries, supported by the European Agricultural Fund for Rural Development (2015 - 2016)

**More info:** [www.vlaamsbrabant.be/ppkpamel](http://www.vlaamsbrabant.be/ppkpamel)



## Learning monitoring techniques: the key to successful organic strawberry protection

new

*Today, strawberry cultivation is possible in various ways and during a long cultivation period. Short and long cultivation periods, from heavy forcing under glass to normal open ground cultivation outdoors are possible. Finding the correct approach to crop protection is therefore very important. In the past, chemicals were often used to control pests and diseases but with the advent of IPM, natural methods of pest and disease control have become a necessity.*

### **Working towards Integrated Pest Management (IPM) through monitoring**

The potential of natural enemies as crop protection strategy is already known in various crops but the power of using them has been difficult to estimate. This demonstration project is used to make the growers aware of how to deal with aphids, thrips and glasshouse red spider mite when consumers are present. The Asian fruit fly *Drosophila suzukii* also often shows up in strawberry cultivation. It is important to detect this new infestation in a timely manner. Test center research is used to seek the most effective strategy for getting this infestation under control.

### **Keys to success**

The project partners have proposed various pest keys based on scientific research that can be easily used by strawberry growers, including a key to identify the presence of consumers and to develop a crop protection strategy based on this information. These keys are used for monitoring of the current situation. However, the power of monitoring lies in performing a weekly check at the same places to observe the evolution of the pest infestation. As a result of this, a corrective treatment can often be delayed, or it may become evident that the introduction of additional consumers is necessary. It also helps to be able to choose from the wide range of essentially preventive consumers or truly curative consumers.

### **Knowledge as the motor for monitoring**

Monitoring a crop only becomes valuable when the grower actually knows what he or she is observing. Workshops are organized during the project period to make the technology accessible to growers. Besides presenting



the pests and their enemies, attention is given mainly to practicing the monitoring technique. Groups of growers will monitor the crop under the guidance of researchers and advisors. During this process, particular attention is paid to the identification of both the harmful and the consumer insects and correct counting. Towards the end of the workshop the monitoring results are examined and a decision is made on whether steps should be taken to ensure optimal crop protection. Zero tolerance is not required to successfully complete the cultivation of a strawberry crop. Sometimes patience is all that is required to achieve a natural balance.

### Deciding on the basis of knowledge and experience

Growers who have learned the monitoring techniques can make independent decisions on crop protection. This does not exclude the role of advisors and suppliers, it rather ensures that growers are better able to interpret advice. This unique collaboration between advisor, research center and grower results in cleaner cultivation.

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**Samenwerking:** Proefcentrum Hoogstraten, pcfruit, Inagro, proefcentrum Pamel and suppliers & growers

**Funding:** Demonstration project "Aanleren van monitoringstechnieken: de sleutel tot succes van biologische gewasbescherming in aardbei" (Learning monitoring techniques: the key to the success of organic crop protection with strawberries) (Department of Agriculture and Fisheries, Government of Flanders) supported by the European Agricultural Fund for Rural Development (03/2015 - 02/2017)

**More info:** [www.vlaamsbrabant.be/ppkpamel](http://www.vlaamsbrabant.be/ppkpamel)

## Optimal biological control strategies for sustainable protection of strawberries against thrips

*Anthophilous thrips are a severe pest in strawberry, causing a decrease in production (by injuries of leaves, heads or flowers) and damage to the fruit like bronzing, deformation and a seedy appearance. For a fruit with very high quality standards like strawberry, such imperfections have great economic consequences. By feeding on plant cells and inserting their piercing-sucking mouth- parts into plant tissue as well as by laying eggs in the plant tissue, thrips cause serious damage in the strawberry cultivation. Reinfestation due to their high mobility and wide variety of host plants, a quick build-up of resistance due to their short life cycle and a low reachability due to thigmotactic behavior all make thrips hard to suppress with chemicals. Other incentives for seeking alternative control measures are legal limitations in the use of chemical control and the rising demand for (extra-legal) residue minimization on fruit.*

### **Biological control by predatory mites is the key**

Biological control by means of predatory mites is one control option. The great advantage of mites is their short life cycle, which implies a population build-up fast enough to control thrips, even in crops with a relatively short cropping season like strawberry. Although potentially natural predatory mite species are present, their augmentation in strawberry is not feasible due to production in greenhouses, production in a mono-cropping system and yearly replanting. For these reasons introduction of predatory mites is favored and many generalist species are commercially available and advised for the control of thrips. At this time, however, these commercial predatory mites are recommended and chosen based on their geographic origin and the few known temperature dependent life history parameters. Climatic conditions of strawberry production vary greatly, driven by the constant aim of producing when supply is low and prices are therefore high. In this project we attempt to match the commercial thrips predating phytoseids with the highly diversified climatic conditions of different strawberry production systems. Therefore all (Belgian) production systems and time spans are categorized into three climate types.



### Other biological control compounds

In this project we also investigate the potential impact of entomopathogenic fungi. Together with the predatory mites we try to develop different biological control schedules for control of thrips in the different strawberry cultivation systems.

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## Combatting thrips with flower strips in strawberry

new

*Thrips, also known as thunderflies, are winged insects that cause severe damage to plants. Some thrips species are capable of piercing flowers and fruits of strawberry, resulting in a loss of yield and fruit quality. Thrips are particularly hard to control in field-grown strawberry.*

### Natural pest control: sow wild flowers

Natural enemies play a key role in the natural control of pests by attacking plant damaging pest species. In some crops (e.g., lime-trees, cereals, potatoes, etc) it has been shown that flower strips and/or hedgerows can stimulate these natural enemies. We wondered if this is also true for field-grown strawberry by monitoring the occurrence of thrips and their natural enemies in a strawberry field bordered by a flower strip or a grass strip during two growing seasons (2015 and 2016).

### Say it with flowers

Despite the differing thrips pressure during both test years (fewer thrips in 2016), a couple of wild flowers species were highlighted for their value in the control of thrips. By far, predatory bugs were the most important natural enemies of thrips and they were more frequently observed in the strawberry parcel adjacent to the flower strip. A strong population build-up of predatory bugs in the neighbouring strawberry field was mainly caused by common vetch (*Vicia sativa*) and buckwheat (*Fagopyrum esculentum*). Moreover, common vetch and corn flower (*Centaurea cyanus*) seemed to be more attractive to thrips compared to strawberry flowers, without being a source of thrips infection. This may have caused the flower strip attracting thrips from the adjacent strawberries. In order to keep thrips away from the strawberries during the full growing season, it is important that the flower strip blossoms before, during and after strawberry bloom.

### Not all thrips are the same

Besides the number of thrips, we also considered the species of thrips occurring in the cultivation of strawberry. Indeed, not all thrips species are equally harmful to strawberries. Strikingly, the most damaging thrips species,



*Frankliniella occidentalis* and *Frankliniella intonsa*, only presented a small portion of the total thrips population observed during our field experiments. Thrips major and *Thrips fuscipennis* were most abundant (each >35%) and are known as species causing “moderate damage” to strawberry fruits. Although the interest of the *tobacco thrips*, *Thrips tabaci*, to strawberries is low, their proportion in our tests was about 15%. Identification of thrips species can only be done by experts, thus this knowledge has little applicability in the field.

### What to remember

Applying a flower strip may have a positive effect on the control of pests in open field cultivation of strawberry. An important condition is that the flower strip has to blossom before, during and after strawberry bloom. The species composition of the flower strip is also an important aspect: the wildflowers need to be more attractive to thrips than the flowers of strawberry and/or have to be suitable to support the population build-up of predatory bugs. Based on our experiments, we considered common vetch, buckwheat and cornflower as best suited for this purpose. Last, besides the number of thrips, the thrips species itself affects the impact of thrips damage to strawberries.

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**More info:** <http://pure.hogent.be/>, –“Projecten”, –“trips beheersing”

# Potential of grass/clover, clover and lucerne in cattle husbandry

completed

*Grass/clover and to a lesser extent lucerne are essential in organic farming as protein rich forage for cattle and as excellent pre-crop in the rotation. Conventional farmers are starting to discover the potential of these crops in the framework of ecological focus area and third crop in the cultivation plan or because they are stimulated by subsidies from PDPOIII.*

## **Forage production with grass/clover: which combination?**

In an experiment (2011-2015) several grass species (perennial ryegrass, tall fescue, *Festulolium*) are combined with a mixture of red and white clover with a moderate N fertilization (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, persistence and nitrate residue. This experiment demonstrates that grass/clover in combination with a moderate N fertilization is also very favorable on intensive – organic or conventional – farms because of the yield capacity, a high protein content, a good forage quality and a low nitrate residue in the soil.

## **Grass/clover in practice**

A parcel of grass/clover (max. 150kg N<sub>available</sub>/ ha) is compared with grass (max. 150kg N<sub>available</sub>/ 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 and of the pre wilted forage before and after ensiling is determined. These results, in combination with the farmers' experiences about management and valorization in the ration, will be communicated to the sector. These measurements in practice 2014-2015 confirm the small plot results. Continuation in 2016 (and 2017) is needed to evaluate the persistence of grass/clover and clover in the 3<sup>rd</sup> (and 4<sup>th</sup>) year of management.





### Spring seeding of clover and lucerne under peas as a cover crop

Seeding in autumn is often impossible on specialized dairy farms or it is done very late. As a result the risk of failure is high and spring seeding is the only option. Peas can be seeded as a cover crop and harvested as silage to compensate lower dry matter yield of the forage. What is the yield potential from peas as silage and is there any effect on the development of the (grass/)clover or lucerne in the first and second year? In an experiment, 7 mixtures of (grass)/clover and (grass) lucerne were sown with and without peas in 2015. The preliminary results from 2015 indicate that the total dry matter yield with peas is 18% higher (1.65 ton DM ha<sup>-1</sup> versus 9.88 ton DM ha<sup>-1</sup>). The crude protein yield was 7% higher (1932 kg CP ha<sup>-1</sup> versus 1799 kg CP ha<sup>-1</sup>). The experiment was sown again in 2016.

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## Organic cultivation of quinoa is possible in Belgium

new

*The reputation of quinoa as a food has increased significantly in recent years. It is a pseudo cereal with high nutritional value and is popular with "foodies". Some advantages of the small seed prove that quinoa is more than hype. It contains a lot of protein, about 15%, in which all the essential amino acids are present in the amounts that the human body uses them. This makes quinoa interesting for those looking for meat alternatives. Because it contains no gluten, quinoa can be used by people with celiac disease as a substitute for rice and pasta.*

*The nutritional value of quinoa has long been recognized by NASA and the United Nations, who proclaimed 2013 as International Year of Quinoa. In terms of preparation, the possibilities are endless. It can be easily cooked as a side dish, but also mixed into all sorts of dishes and pastries. In specialized shops you can find puffed quinoa flakes or even quinoa flour for baking.*

### **New product, new crop**

The quinoa now on our shelves originates mostly from South America. For centuries, the crop has been grown in the highlands of the Andes. Each year about 10 000 tons of quinoa from Bolivia, Peru and Ecuador is imported in Europe. That import has been called in question because the increasing global demand has caused the homeland prices to rise immensely. Until recently, quinoa was a staple food for the poorest in these countries. Despite increased production, quinoa is now reserved for export markets and the local, wealthier middle class.

A solution might be closer than we think. In The Netherlands, a number of quinoa varieties were developed that are suitable for cultivation in Western Europe. In Belgium too, cultivation of quinoa is underway with currently a cultivated area of 110 hectares, including 20 hectares in Flanders. Inagro assists farmers who are interested in quinoa. At Inagro's experimental organic farm, the available varieties and mechanical weeding were tested.



### Improving cultivation

Organic cultivation of quinoa is an opportunity for a limited number of producers. In our trial in the dry spring of 2015, repeated harrowing was sufficient for good weed control. Field trials in Wallonia indicate positive experiences with the rotary harrow. Hoing might be necessary in a wet spring. An early sowing in (beginning of) April was necessary for a good yield. In addition, proper planning of harvesting is a critical point of quinoa cultivation.

Jessie is an early variety that, despite its sensitivity to downy mildew, achieved a good yield, regardless of sowing in April or May. The opportunity to thresh on stem was a plus for this variety. For the later varieties Atlas and Pasto, mowing and subsequently threshing from the swath was required. Based on our experience, harvesting is best done early and certainly before mid-September in order to obtain a dry product. Pasto had, in early sowing in the begin of April, a higher yield potential than Jessie. In the case of a late sowing in May, Jessie seems to be the best choice. Atlas and Riobamba so far showed little added value.

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# OK-Net Arable: european knowledge exchange between farmers, advisors and researchers for more productive organic arable production

new

*The complexity of organic farming requires farmers to have a very high level of knowledge and skills. But exchange on organic farming techniques remains limited. Coordinated by IFOAM EU, the OK-Net Arable project promotes exchange of knowledge among farmers, farm advisers and scientists with the aim to increase productivity and quality in organic arable cropping all over Europe. OK-Net Arable involves 17 partners from countries all over Europe and is funded by Horizon 2020, the EU's framework program for Research and Innovation.*

## **Scientific analysis of constraints in organic arable cropping**

Based on most recent scientific literature, OK-Net Arable identified the barriers for increasing productivity in organic arable cropping and made recommendations in the areas of soil fertility and nutrient management, weed control and pest and disease control. Flanders and Denmark belong to the countries with top production levels.

## **Knowledge exchange for better farming**

OK Net Arable brings together 14 farmers' innovation groups located in 10 countries across Europe. These are groups of organic farmers who cooperate in research and innovation. OK Net Arable gathered the common challenges cited by these groups into a report. The main challenges are weed control, soil fertility and control of pests and diseases. The data from the farmers' innovation groups clearly show a wide range of crop yields. This indicates certain needs as well as an opportunity to improve the yields. The report gives a good overview of the challenges for organic farmers in Europe and gives a clear view of already working solutions in practice.

## **Best methods for learning and knowledge exchange**

OK-Net Arable has analyzed how farmers and farm advisers access information. The findings show that the use of printed media is still widespread and that physical meetings (e.g. field days) are preferred to anonymous online courses. Nevertheless, it was also found that social media is changing the way information is spread and highlights the importance of online videos in the exchange of knowledge across borders.



## Farmers Knowledge platform

OK-Net Arable has launched a knowledge platform aimed at filling the gap in the exchange of information between farmers, farm advisors and scientists across Europe. The platform can be used to find practical organic solutions, and at the same time discuss how it works on the field, in our geographical and climatic conditions. Farmer's needs were taken into account at every stage of development in order to make it easy to use. The platform is available in 10 languages (English, Bulgarian, Danish, Dutch, Estonian, French, German, Hungarian, Italian, Latvian) and the solutions are divided according to the most relevant topics in organic arable farming: soil quality and fertility, nutrient management, pest and disease control, weed management and solutions for specific crops.

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**Funding:** H2020 - EU Thematic Network (03/2015 - 02/2018)

**More info:** OK-Net Arable web platform: <http://farmknowledge.org/>  
OK-Net Arable project website: <http://www.ok-net-arable.eu/>

## SOILVEG: optimizing the use of cover crops

new

*Soil is the central production factor in organic agriculture. Good soil management implies a sophisticated crop rotation, reduced soil tillage and smart fertilization.*

*In the European SOILVEG project, ILVO, Inagro and Ghent University (UGent) test a new mode of termination of cover crops using a roller-crimper. Cover crops play an important role in sustaining and enhancing soil quality. The project aims to optimize the use of cover crops and therefore enhance their positive impact on the agro-ecosystem.*

### **“Roller-crimper” technique tested in organic vegetable cropping systems**

The central theme of this project is the termination of cover crops by the “roller-crimper”. This agricultural machine simultaneously flattens and cracks the stem of the cover crop, where after the main crop can be sown or planted throughout the flattened cover crop. To avoid regrowth of the cover crop, it is important that the roller-crimper is used at the right cover crop growing stage (florescence). The use of the roller-crimper technique in vegetable cropping systems is still in an experimental phase. In field trials at ILVO and Inagro, main crop development, soil quality, nutrient dynamics, weed pressure, biodiversity, disease suppressiveness and energy use are investigated in plots where the roller-crimper technique is applied compared to plots where the cover crop is terminated in the traditional way (mulching and incorporation). Different cover crop species (winter rye, winter pea and winter vetch) are sown separately or in combination in autumn. In the treatments with the roller-crimper, no (ILVO) or a minimal tillage (Inagro) was executed in the plant row before planting. In the other treatments, non-inversion tillage was executed. Headed cabbage was the test crop in the first research year 2016.

### **First experiences with the roller-crimper technique**

The relatively mild winter worsened the weed pressure in the young cover crops. In a flattened cover crop, mechanical weed control is omitted to conserve the mulch layer. At flattening the dry matter biomass yield of the rye-pea mixture at ILVO was 5 Mg ha<sup>-1</sup>, which allowed a certain weed





pressure (grasses and common chickweed). This weeds did not prevail over the cabbages and almost no additional weed species appeared. In the field experiment at Inagro, tillage with a tooth in the plant row for enabling planting caused additional weed emergence in the row. The main crop started better in the plots where the roller-crimper technique was applied. However, its development gradually lagged behind compared to the plots where the cover crop was terminated in the traditional way, which certainly will suppress the yield. The minor development in the plots where the roller-crimper technique was applied is probably related to a poor rooting ability in a more compacted soil. Soil compaction is caused by rainfall excess during winter and tractor wheels in spring. Soil compaction was not relieved in case of the “roller-crimper” technique, which probably resulted in a larger oxygen shortage in the flooded soil due to the excessively wet weather circumstances short after planting and during the whole month of June. Prevention of compaction and amelioration of planting technique are the two most important issues to deal with in next season’s experiments.

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**More info:** <http://coreorganicplus.org/research-projects/soilveg/>



# Andean tubers: potential of yacón and yam in our region?



new

## Yacón

For over 5 years PCG has been researching the cultivation of yacón, a sweet-tasting tuber grown in the Andes with reported health-promoting properties. Planting in open field happens in April or May when the risk of frost has passed. During the first six to eight weeks the growth is very slow. Weed control is very important in this period. Yacón needs a maximally long cultivation period for best tuber yield. Depending on the length of the season the yield is estimated between 30 and 50 tons of tubers/ha.

Previous research had established that it was possible to cultivate yacón in a Western European climate. Nevertheless, some questions are yet unanswered. There may be a great interest in this new culture, but there are still challenges to tackle before scaling up. Culture methods and mechanization of the culture can still be optimised.

## Yam

In the last couple of years the interest in the cultivation of yam, sweet potato, in Belgium has increased. Although in Flanders this culture is virtually non-existent, the tubers can easily be found in local supermarkets. The success of sweet potato is becoming more and more visible. Famous tv chefs use them frequently in their cooking programmes and newspapers write with great appreciation about the diversity of these tubers.

Flemish farmers would like a share in this success. Optimization of the culture and the product is a crucial step in this process. First, economically interesting, qualitative plants and cultivars suited for cultivation in Flemish climate and soil are needed. Second, a detailed description of the characteristics of the different cultivars will help to decide which ones are suited for fresh market and which for the industrial production and processing industry.



## Research in 2016

Years of research on yacón continue to build knowledge about the cultivation of this tuber. In 2016 we focused on cultivar selection and mechanisation. In a randomized “variety” trial we compared eleven different “varieties”. A demo trial was planted to test different ways to mechanize the harvest of the yacón tubers. The impact of the mechanical harvest on storage of the tubers will also be evaluated. To get more people acquainted with the culture of yacón in Flanders, three demo trials were set up at different locations in West Flanders, East Flanders and Limburg.

In 2016 PCG started with research on sweet potato. Variety trials in open field as well as in two plastic tunnels were performed. Different cultivars were planted to be able to make an estimation of their potential yield in our climate. At the end of May, 5 varieties of the seed company “Graines Voltz” arrived in trays. These cultivars were Evangeline, Bonita, Murasaki 29, Orléans and Beauregard. On the 31<sup>st</sup> of August an early harvest was carried out in one of the plastic tunnels. Bruto yield results were already between 10 and 25 tons/ha. The plants were planted rather wide and can grow further until at least mid-October in the other plastic tunnel. This means that obtaining a larger yield is definitely feasible. The open field trial will also be harvested mid-October.

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## Organic cultivation of strawberries: cultivation testing for "Joly"

*Cultivar "Joly" seems to be the upcoming reference in the organic cultivation of strawberries. To optimize organic cultivation of Joly, we studied three technical aspects of the cultivations: planting distance, planting date and fertilization.*

### **Planting distance**

Too-close planting produces a lower yield and more small strawberries. A closed foliage layer also provides protection, however. Four planting distances (40 cm, 33 cm, 25 cm and 20 cm; 4 repetitions each) were tested starting on 14 August 2015.

### **Planting date**

A later planting date leads to earlier production and more Class 1 produce, but fewer strawberries per plant. Planting at the beginning of August means the plants may develop more heavily and require more space - at 33 cm they may be too close together. Planting towards the end of August means a less heavily developed plant. At a planting distance of 33 cm, 4 planting dates (4 repetitions each) were tested, i.e. 7 July, 14 August, 21 August and 28 August.

### **Fertilization and nutrient balance**

What is the effect of fertilization on the organic cultivation of Joly? To answer this, we planted 4 sets of plants (4 repetitions each). Each object received a different actual percentage of the recommended fertilizer



dosage. In addition to a control with 0% fertilizer, 50%, 100% and 150% of the recommended dosage for NPK were administered. We are gathering information about the nutrient balance on the basis of a soil sample in spring, fruit analysis around mid-picking (= 50% picked), a leaf analysis, the weight of crop residues during uprooting and a soil sample at the end of cultivation. The yield and fruit quality are obviously also determined, to know how the organic cultivation of Joly reacts to the different fertilization levels.

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## Silvoarable agroforestry: yield, soil characteristics and functional biodiversity

*Agroforestry is an agricultural system whereby a woody component (e.g. trees, shrubs) is grown simultaneously with an agricultural crop on the same field. A frequently occurring type of agroforestry is alley cropping, where the agricultural crop is grown in between tree rows. In several foreign countries, agroforestry is frequently implemented but occurrence in Flanders remains limited. This might at least partly be due to lack of knowledge about this system.*

### **Which effects of tree row presence are to be expected?**

The presence of tree rows in an agricultural field can greatly influence on field management, the agricultural crop and the environment. The farmer must therefore begin by asking several questions.

- What will be the effect on yield and quality of the agricultural crop?
- Will there be a change in the occurring functional biodiversity?
- How much wood will be produced?
- How will trees influence the soil nutrient status? And more...

### **Answers are on their way**

A research project has been set up to investigate the effect of tree rows in arable agroforestry fields. Various measurements are being done in fields with tree rows of varying age. Locations of the measuring points vary between nearby the tree row up to 30m into the field.

### **Results communicated via website**

Preliminary results already indicate that trees have a strong influence on several soil characteristics. For example, strongly elevated soil organic carbon and concentrations of basic cations were found in the plough layer



nearby the tree rows. The main explanatory factor for these increases is probably the input of tree leaf litter.

Similarly, depending on the specific crop grown, trees can greatly influence crop yield. For example, the effect on winter wheat and barley was far smaller than on maize. As expected, the extent of the noted effects is strongly related to the age of the present trees.

Further results of this research will be continuously communicated via [www.agroforestryvlaanderen.be](http://www.agroforestryvlaanderen.be) to support interested farmers in their decision-making.

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**Funding:** VLAIO (Agency for Innovation and Entrepreneurship, Government of Flanders) (1/09/14 - 31/08/19)

**More info:** [www.agroforestryvlaanderen.be](http://www.agroforestryvlaanderen.be)

# More nature for seedy fruits through pollination by wild bees

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. Wild or solitary bees can help the honey bees to pollinate fruit trees, as they have proven to be efficient pollinators.*

## **Nesting possibilities for bees**

The goal of this project is to stimulate the presence of (wild) bees in fruit orchards. Therefore we investigated which bees occur in the orchard during the blossom period, which species inhabit the nest boxes, if the bees actually do visit the apple flowers and whether their visits result in increased fruit set and pollination level. We placed nest boxes in many orchards in Belgium (and The Netherlands) in order to offer wild bees nesting possibilities. In addition, a detailed analysis of the environment will be provided which might reveal important obstacles or opportunities for the wild bees.

## **Food for bees**

Sufficient food availability is extremely important for a bee's survival. To provide pollen and nectar during the whole growing season, we investigate the influence of flowering plants/trees in and at the borders of fruit orchards. The impact of the increased biodiversity and pollen/nectar supply is monitored. These mitigation measures are also applied at a larger scale in the surrounding environment.

## **What about fruit set and pollination level?**

In each orchard, the trees and especially the flower clusters are marked and followed up during the season in order to get an idea of fruit set (number of fruits/number of flowers per cluster). Fruits are counted and weighted, seeds are counted as indicator of the pollination level, and the quality is determined.





### Other beneficial predators against pest insects and (water) voles in fruit orchards?

The mitigation measures for increased biodiversity also offer opportunities to other beneficial organisms in fruit orchards like natural enemies of pest insects and (water) voles (e.g., mustelids).

#### 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 2017, information will be available on the impact of their presence on fruit set and pollination level.

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**Funding:** Interreg V, Province Limburg, Province of Flemish Brabant (2016 - 2018)

**More info:** [www.pcfruit.be](http://www.pcfruit.be)

# Homegrown baking spelt in Belgium



new

*The use of spelt has increased rapidly since 2010. Because international demand is greater than supply, prices are high. In the last years, prices of 600 to 800 euro/tons and more were paid for hulled organic spelt. Although the Flemish food industry is usually served by international grain trade, demand is growing for locally grown cereals.*

## **A guide to get started**

Inagro developed a “Practical guide for organic spelt” commissioned by “*Bio zoekt boer – Bio zoekt keten*”. The aim is to help farmers get familiar with the cultivation of spelt and provide them the tools to overcome logistical bottlenecks. “*Bio zoekt keten*” will continue this work by effectively developing this trade chain and guiding the actors through it. Inagro is as a partner in this project.

## **Not all spelt is equal**

People sometimes talk about the “purity” of spelt, meaning that it originates from varieties that are minimally crossed with wheat. Some German processors request these pure or “real” spelt varieties because they are closest to the original spelt species. The good baking and quality characteristics of spelt are attributed to pure spelt varieties. A share of wheat genes in the variety is said to reduce these properties. Because of this, a classification of spelt is made of “old types” or pure spelt varieties and “new types” or spelt varieties with a certain share of wheat genetics



## Variety selection

Because choice of variety is an important factor in cultivation and marketing, Inagro also sowed a comparative variety trial for organic spelt. The growing conditions in the 2014-2015 season were quite favorable for the cultivation of cereals. Good yields were achieved in the trial, with a gross average of 5.8 tons / ha. The supply of varieties is very diverse and the trial largely confirms the division into "old" and "new" types of varieties. Older types like Oberkulmer Rotkorn and Ebners Rotkorn are susceptible or very susceptible to yellow rust and were limited in yield (4 to 5 tonnes/ha hulled). Titan was a positive outlier. Frankenkorn, Cosmos, Epanis and Zollernspelz combined lower disease susceptibility with high yield potential (6 to 7 tons/ha hulled). The analysis of baking quality is still running.

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## “COBRA” project strengthens organic breeding

completed

*In 2016 the European research project “COBRA” ended, in which a total of 41 research partners from 18 countries worked on the subject of organic breeding and seed production of cereals and protein crops. In Flanders, Inagro and the University College Ghent participated in the project.*

### **Project goals**

“COBRA” stands for “Coordinating Organic Plant Breeding Activities for Diversity”. This European partnership aimed to assemble and strengthen the ongoing research activities on organic plant breeding in cereals and legumes throughout Europe via more concerted action. Breeding “for and through diversity” summarizes the research content. The importance for organic production is clear: a high genetic diversity has the potential to make crops more resilient, more robust and better adapted to varying climatic conditions.

### **Composite cross populations of winter wheat are promising**

One of the project goals was to determine whether exposure of genetically diverse populations to different environmental conditions makes them, through natural selection, more resistant to climate change or not. A synthesis of those results is being written. In addition, the coalition studied to what extent composite cross populations (CCPs) differ from local standard varieties of winter wheat in terms of yield potential and disease resistance. For two years, CCPs of Germany and the United Kingdom were compared to some reference varieties of organic winter wheat for northern France.

The results confirm that these winter wheat CCPs produce resilient crops that keep up with standard varieties, both in terms of yield, (baking) quality and disease resistance. Although two years of trials is too little to draw solid conclusions, our results have been confirmed by project partners also working with these CCPs. The trials show that these CCPs are suitable for the practice. In a follow-up to this project, Inagro organizes a joint order for organic farmers wanting to test the CCP “ORC Wakelyns Population” of the UK.

### **Breeding of protein crops in Europe**

One of the project objectives was to determine whether essential oils can be used to control certain fungal diseases in field peas and beans. A



screening of different oils was set up at Ghent University and their impact on *Botrytis cinerea*, *Colletotrichum acutatum* and *Pleiochaeta setosa* was assessed. Another objective was to determine whether protein crops bred in other regions are adapted as well or better than varieties bred in our environment. A screening with peas and field beans imported from Latvia and from our regions was set up for 2 years. This showed that the material from our regions is better adapted, and that it also performed better under Latvian conditions.

In addition, Inagro and University Ghent set up trials with locally available varieties of forage pea and field bean. These protein crops, both winter and summer types, were cultivated in a mix with wheat, barley and triticale for harvest of grain in the seasons 2013 to 2015. Special attention was paid to the weed suppression and yield stability of the available varieties.

### More than field tests

COBRA activities were field days and presentations at events for the general public such as the exhibition "BioXpo" (2015) and the seminar "TAM: Agroecology in Action" (2015). Finally, the COBRA project allowed us to meet new European partners, which delivered us continued contact and collaboration.

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## Robust organic varieties

new

*Organic farming systems have less nitrogen available than in conventional systems. In the coming years the fertilizer legislation will strengthen this restriction even more. In addition, through climate change more extreme weather conditions over a longer period (e.g., heat, drought, etc.) are expected in our regions. This may result in increased impact of pests and diseases. Breeding should be part of the answer to these challenges. Robust varieties have good tolerance to pests and diseases, achieve a good nutrient efficiency and are resistant to various stress factors. In a CCBT-project started in 2016, PCG and Inagro wish to test four concrete cases in Flemish practice.*

### CCPs in cereals

Composite cross populations (CCPs) are obtained by mutually crossing a range of varieties of a self-pollinating crop such as cereals. The result is high genetic diversity in the future generations. By sowing a part of the harvest every year, the population adapts to the local and changing environment. 2015 was the third year Inagro seeded CCPs of winter wheat. Meanwhile, a European pilot project is trying to register populations on the international "list of varieties". The British research institution ORC registered the population that has been sown in several European countries under the name "ORC Wakelyns Population" and developed commercial seed that became available for sowing in 2016. As part of this CCBT-project Inagro brings CCPs to Flemish practice.

### Mixing varieties of potatoes

In recent years, a number of new high-performance potato varieties are developed with good pest resistance such as Connect, Carolus, and Alouette, among others. These varieties proved their worth in the field trials of Inagro and are used in practice. Nevertheless, they do not cover the entire culinary spectrum and thus most potato growers keep on growing certain (more sensitive) varieties. In years with high pest pressure this results in disappointing yields with a rather moderate quality. By growing these sensitive varieties mixed with more resistant varieties, the spreading of the potato pest in these sensitive varieties can be slowed down. Inagro will test different mixing forms in field trials at some organic farms.

### Nutrient efficiency in broccoli

Broccoli and cauliflower need sufficient nitrogen and water to achieve a good yield. If one or both fails, yield and quality will be insufficient. Increasingly



strict fertilizer legislation and global warming may lead to an increase in these unfavorable circumstances. Not all farmers are able to correct these problems. In 2016 and 2017 Inagro is performing a comparative variety trial in which approximately 5 varieties are tested under normal vs. rather poor N regime on the other hand. In times of drought the entire trial will not be irrigated.

### Open field cultivation of tomatoes

Also within this CCBT-project, the cultivation of tomatoes in open field is tested as a possible option for farms with pick-your-own or short chain selling. If cultivation of robust varieties in combination with the expected warmer summers appears to be a success, then the additional investment of protecting the plants will no longer be needed on those farms. During the growing season 2016 some preliminary tests were set up by organic growers with short-chain activities. From this experience the best varieties will be selected. Then, these cultivars will be tested by PCG in a variety trial in open field in 2017. The same cultivars will be grown during the same season in a polytunnel. As well the available open-pollinated varieties as the hybrids will be taken into account. Disease resistance is very important for selecting the varieties. During the trials, yield and quality of the fruits will be observed, but as taste of tomatoes is highly important when selling directly to consumers, a sensory study will be done by PCG.

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**Funding:** CCBT-project "*R<sup>2</sup> - Robuuste rassen*" (Robust varieties) (Government of Flanders, Department of Agriculture and Fisheries) (2016-2017)

**More info:** [www.ccbt.be](http://www.ccbt.be)



## Late blight resistant potato varieties catch on

*The experimental organic farm of Inagro tests about 20 potato varieties per year. The circumstances in 2016 were (like in 2014) ideal for an explosive growth of *Phytophthora infestans* in potatoes. The available late blight resistant varieties not only prove their worth in the field, they are also catching on in the market. Their range continues to expand.*

### Organic potato cultivation

Some 200 hectares of organic potatoes are cultivated in Flanders. This area is growing, but remains small compared to the total Flemish acreage of potatoes and the acreage of organic potatoes in for example the Netherlands and Germany.

No chemical fungicides are used in organic potato production. To control late blight, organic growers have to rely on other cultivation measures. The aim is to achieve reasonable production before the crop is adversely affected. Early planting, pre-germination of tubers and moderate fertilization are important measures. The use of formulations based on copper is limited by law and is also subject to debate.

The choice of variety is a very important tool in the fight against potato late blight. Earliness and late blight resistance in leaves and tubers are important criteria, which are clearly gain importance in the selection work of potato breeders.

### Variety testing

Every year, Inagro tests 20 to 30 potato varieties under organic growing conditions and without any treatment against *Phytophthora infestans*. Variety selection is based on the supply of commercial seed companies at home and abroad. In accordance with the regulations for organic agriculture, these varieties are the product of only natural breeding techniques. Besides some standard varieties, new varieties are tested that are almost ready for introduction.

### Supply of resistant varieties grows

Some of the late blight resistant varieties in the trial have been in in trials for at least 3 years. Carolus is late ripening and has a white-yellow skin with



pink-red eyes. It is very suitable for French fries and an with appropriate cultivation measures it can be used as a floury table potato. Connect is late ripening and has a white skin. Its taste and fitness for fries barely meets requirements. Alouette is a qualitative, semi-late table potato with red skin. It is firm cooking with yellow flesh and its taste is rated very well. Some 10 more new varieties were able to withstand the late blight in the trial of 2016. In the future, their late blight resistance in tubers and their level of quality and yield will be further examined.

### **Expansion in the market**

The seed acreage of the first group of late blight resistant varieties is expanding considerably. In the near future, organic seed of varieties like Carolus and Connect will be easily available. At the same time, we see a positive change in the attitude of potato buyers to these new varieties. Gradually, all chain actors are realizing that the introduction of resistant varieties and the development of their range, benefits cultivation and in the end the supply of organic potatoes. Finally, the fact that this late blight resistance is obtained in a natural way appeals to the end consumer too and can accelerate the development of the organic potato sector.

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## Organic sheltered crops: cultivar and rootstock research

*The PCG (Practical Research Centre for Vegetable Cultivation) started its research on organic greenhouse crops in 2001. Every year, in consultation with the technical subcommittee for organic farmers, the research program and trial planning are made. The organic sector is thus very closely involved in the research and the trials are guaranteed to be of practical use. During the years, a wide diversity of cultivars and rootstock trials have been carried out.*

### Importance of resistant varieties and rootstocks

Resistant crops are essential to organic cultivation as organic farmers only have a limited amount of plant protection products available to act against diseases and pests. Because control of pests and diseases in organic farming is based on prevention, choice of the right cultivar is key.

In heated greenhouses, organic farmers have a very close crop rotation as the investment in the greenhouse itself and heating needs to pay off. The crops most suited to cultivation in heated greenhouses are fruiting vegetables such as tomato, bell pepper, cucumber, eggplant and zucchini. Unfortunately, all these crops belong to only two different families. In the long term soilborne pathogens as *Verticilium* and *Fusarium* and also root-knot nematodes (*Meloidogyne*) are inevitable. Use of grafted plants on resistant rootstocks therefore represent an important strategy.

### Approach

The choice of the cultivars and rootstocks used in trials are mainly decided by the farmers. In a next step the seed companies are contacted for interesting new cultivars. Preferably organic seeds are used but if these are not available, non-organic, non-disinfected seeds are used.

All trials are carried out in the organic certified parts of the greenhouse and tunnels at PCG. All trials took place on the same soil type with the same specific soil challenges. Especially for rootstock research, trials are repeated on farm to generate representative results for the sector.

### Short overview

List of the trials in greenhouses or tunnels carried out in 2014-2015



Culture	Most suitable cultivar/Rootstock
<b>Heated greenhouse</b>	
Cucumber, early	Carambole (Rijk Zwaan)
	E23L.2216 (Vitalis)
	Proloog (Rijk Zwaan)
Eggplant rootstock	Mao (Nieuw) (Grow Group)
Eggplant cultivars	Bartok (Vitalis)
	Taurus (De Ruiter)
Tomato rootstock	Brigeor (Gauthier)
	Multifort (De Ruiter)
Tomato cultivars	Tovit 1411, Nr2 en Nr3 (Enza) mainly Cladosporium resistance
Bell pepper cultivars	E20B.4541 (Enza)
	Sapporo (Rijk Zwaan)
Bell pepper rootstock	Scarface (Vitalis)
<b>Tunnel</b>	
Coeur de boeuf	EXP 868 (Clause)
	Gourmandia (Clause)
Radish, spring	Famox (Hild)
	Rockstar (Syngenta)
	Celesta (Vitalis)
	Rudolf (Bejo)
Chinese cabbage, spring	Orient Surprise (Takii)
	Manoko (Bejo)

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## Search for resistant and/or less susceptible apple varieties

*Variety testing is and remains an important issue for organic fruit growers. Jonagold remains the most grown variety in organic and IPM-based cultivations. Disease-resistant varieties are therefore very important to both types of growers.*

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

At the Extension Research Center for Fruit (*Proefcentrum Fruitteelt vzw – unit Proeftuin pit- en steenfruit*) all new apple varieties are tested for their susceptibility to scab, powdery mildew, nectria canker and storage diseases. To do so, 4 trees per variety are planted in a separate parcel which is not sprayed against powdery mildew, nectria canker and storage diseases. Spraying against scab is only done under conditions of very heavy infections. This yields information about the susceptibility of the new varieties and their opportunities for organic fruit growing.

### **New apple varieties for organic fruit growing**

Since 2009 interesting new apple varieties for organic fruit growing are also planted in a separate parcel with an organic spraying scheme. Currently 20 new apple varieties are planted in this parcel. Here we focus on the influence of copper and sulphur sprays on the quality of the skin.

In the organic parcel (only organic sprays and fertilization) the 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. Only copper and sulphur-based products are used against scab and powdery mildew.

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 susceptibility to powdery mildew, storage dis-eases and susceptibility



*Isaaq®/CIV 323*



*Natyra®/SQ159*

to pests such as woolly aphids and spider mites will also play a future role in variety selection.

## Results

If promising varieties are found in the first screening for the organic fruit grower, we plant more trees to find solutions for the specific problems of the new variety (especially concerning cultivation techniques). At this moment we have 3 varieties in the second screening, namely Sweetango®, Isaaq®/CIV 323 and Natyra®/SQ159.

In 2009 the first promising new resistant apple varieties were planted in an organic parcel. Most of the varieties are still too young to be able to decide whether they are suitable for organic fruit growing. Sweetango®, Isaaq®/CIV 323 and especially Natyra are possible candidates but Sweetango® is not scab resistant.

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**More info:** Pcfuit vzw - unit Proeftuin pit- en steenfruit, [www.pcfruit.be](http://www.pcfruit.be)

## Organic cultivation of strawberries: variety tests with available organic plant material

*Correct variety selection contributes significantly to the profitability of strawberry cultivation. Variety tests conducted under conventional cultivation do not show how a variety will behave when grown under organic cultivation. Organic cultivation relies on the use of disease-resistant varieties or varieties less susceptible to disease. The variety tests at Proefcentrum Pamel evaluate new varieties according to the organic cultivation method. These tests mainly concern the plant varieties for which organic plant material is available. The study also includes promising varieties that do well in organic experiments but for which organic plant material is usually not (yet) available.*

### Research conducted on June-bearing varieties

During the cultivation of 1-year June-bearing varieties in 2015, three promising varieties were compared, the: Joly, Darselect and Sonata. Of the three varieties studied, Sonata had the highest level of production, resulting primarily from a higher percentage of Class 2-production.

Strawberry varieties listed in harvest year 2016 are: Candiss, Capriss, Cireine, CIV 251, CIV 260, Darselect, Dely, Donna, Elegance, Elsanta, Honeoye, Joly, Korona, Magnum, Malling Centenary, Matis, Rubis des Jardins, Rumba , Salsa and Sibilla.

### What about with a 2-year cultivation of June-bearing varieties?

In 2015 a two-year cultivation of June-bearing varieties was evaluated and covered 16 varieties: Gariguette Cigaline, Ciflorette, Clery, Primy, Donna, Dely, Cireine, Elsanta (Martailac), Joly, FF 1004, Elsanta (Mazzoni), Candiss, Asia, Laetitia and Elegance. On the one hand, arguments that led to the interest in a 2-year organic cultivation period of June-bearing varieties included the practical experience that certain June-bearing varieties did not do badly at all as a 2-year-old and on the other hand the estimation that in practice only 50% of the plantings will be renewed annually. Moreover, the use of agro-biodiversity probably has more chance in a system of multi-annuality.





The test showed that keeping June-bearing varieties in a second year of production generally means more picking. On average, the fruit weight was lower and for most varieties there was a higher percentage of failure.

### **Taste**

A final important parameter is taste. Taste is a subjective detail and, as such, is therefore difficult to register. Objective tests with taste panels do exist but they are expensive. Each year, Proefcentrum Pamel gives growers the opportunity to taste the varieties that are in production.

The extensive results recorded in 2015 can be found in the Annual Report 2015 issued by Proefcentrum Pamel. The results recorded in 2016 will be published in the 2016 edition.

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## Top varieties from the variety trials of June bearers in full soil

*Trials at pcfuit repeatedly confirm the potential of Elegance and Malling Centenary. Both varieties have a formidable presentation and great shelf life which make them very marketable. Although neither variety is perfect in cultivation, the future looks bright.*

### Elegance

Elegance was first selected at East Malling Research station by David Simpson in 2001 and has featured continuously in variety trials at pcfuit since 2010. Elegance receives consistently high scores for presentation, both fresh and after storage (7 days at 4°C). It is easy to recognise by its typical round shape, orange-red colour and extraordinary gloss. Fruits also have excellent firmness, a pleasant mild flavor and juicy texture.

Elegance is a highly productive mid to late season variety. Typical yields are 38% more than Elsanta. Fruit development is well spread across fruits on a truss giving rise to a well spread production over a period of five weeks. Typically the mid harvest date falls one week later than reference mid-season varieties. Fruit of Elegance have a large average fruit weight (28.4 g) compared to standard variety Elsanta (22 g) and typically a low percentage of class 2 fruit.

Elegance is an excellent choice for outdoor production in the soil. Fruit can withstand heavy intermittent rain and does not readily show bruising after harvest. Fruit set is excellent and the variety does not have any physiological disorders. Consequently the percentage of marketable fruit is much higher for Elegance than most other short-day varieties. Some of its less positive attributes include shorter trusses, mass dense vegetation and its sensitivity to root diseases caused by *Phytophthora* and *Verticillium*.

Previous plant density trials have indicated that per plant yields of Elegance are only marginally affected when the plant density is increased to 6 pl/m<sup>2</sup> as compared to 4 pl/m<sup>2</sup>. From a practical perspective, however, Elegance should not be planted at such high rates due to the increased difficulty in picking and increased rates of Botrytis. A marginal plant density of 4 pl/m<sup>2</sup> therefore gives the easiest harvest, lower incidence of botrytis and also delivers the highest per plant yields.

Planting Elegance early gives the best per plant yields. When planted early, Elegance produced a greater percentage of class 2 fruit but not at the expense of class 1 fruit.



## Malling Centenary

Since its first introduction in 2012 at the research center, Malling Centenary has proven to be a consistently promising variety particularly in tunneled or covered soil production. Variety trials at pcf fruit have highlighted its outstanding characteristics especially regarding its healthy open canopy, large average fruit size, pleasant flavor, good storage ability, gloss, firmness and ease of picking. The average fruit weight is about 25% higher than reference variety Elsanta and there is a significant lower percentage of small fruits due to a more uniform fruit size. Malling Centenary has single

trusses with 5 to 7 fruits per truss. The long trusses display the fruits well on the plants and ensure a high pick return. Malling Centenary, however is sensitive to Pestalotiopsis and Pytophthora. At high infection pressure odium can become a problem.

Malling Centenary has a less favorable crop what lends itself to higher plant densities. This has especially its advantage for tunnel cultivations

In 2015/16 a commercial planting of Malling of approximately 5 ha was seen. Extremely early planting dates in 2015 for Malling have indicated a way forward to improve yield in the future. Growers should be aware that by bringing the planting date forward, fruit firmness is somewhat compromised but still remains better than reference variety Elsanta. Earlier planting dates lead to larger plant canopies, which negatively affects fruit and results in more difficult harvest. Despite some of these minor points, Malling Centenary has a strong future.

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## Arrival of alternative day-neutral strawberries?

*Variety trials of everbearing strawberries in full soil focus on fruit quality, productivity and disease susceptibility.*

### Harmony

Harmony, the new Variety from Vissers, has a highly attractive fruit with short wedge shaped to round conical fruits with broad shoulders and at times a slight neck. Occasionally the variety can give odd fan or wedged shapes and on some occasions white tips and ridging, especially on primary fruits, although this did not detract from its percentage of class 1 fruit (With 55.15%, this was the highest scoring of all varieties in trial). Harmony gave excellent yields that were 25% higher than reference variety Portola.

Fruits of Harmony have an outstanding presentation especially when harvested in the trays. Its skin is a vibrant red with outstanding gloss that holds during storage. Its seeds are well placed in the skin and have an attractive red colour ensuring that the fruits never appear seedy. Fruits of this number also have a fresh and very showy pale green calyx which makes it highly attractive. Similar to Portola, it does not easily show harvest damage or bruising.

Harmony seems to be more resistant to root diseases compared with Portola, although an infection with *Verticillium* is detected once in a while.

### Malga

Malga is a newly named variety by Italian based breeding program New Fruits. The variety produces an abundance of large long conical fruits and is one of the top three yielding varieties in this trial (1.5 kg/pl). The fruits have an angular pointy shape with the occasional wedge shape. The berries color uniformly and have an excellent presentation in the punnets. The berries are well displayed on the plants, expediting harvest. At times the fruits appeared somewhat seedy. Furthermore the fruits did not color very quickly, both on the plant and also after harvest, giving growers good flexibility when planning harvests. One notable disadvantage of Malga is its apparent susceptibility to rain damage and bronzing.

### Furore

Furore has attractive long elliptical shaped fruits with a vibrant orange red color and outstanding gloss that holds during storage. The seeds are always



well placed in the skin and fruits have outstanding presentation especially when harvested in the punnets. Fruits of Furore have a delicate skin which can be problematic in warmer temperatures. While bruising does not show as discoloration, bruises can leave wet watery marks due to skin weakness. Generally the flavor of Furore is outstanding. Perhaps the most interesting part about Furore is its production profile. Furore has a mid-harvest date that falls at least 10 days earlier than any other variety tested in this variety trial. It is a variety that gives many trusses early on and then experiences a long delay in production that can come too late for a continued harvest. The future of this variety depends upon a suitable management strategy to improve skin weakness.

### **Florentina**

Florentina produces complex trusses with short round conical fruits with big round shoulders and an attractive well positioned fresh looking calyx. The fruits are glossy and orange, typically with darker coloured seeds which can be raised or at least sometimes give the impression of being seedy. Florentina has an attractive orange color that does not darken both on the plant and after storage. The average fruit size for Florentina was similar as for Portola. Florentina was in our trials 14% higher yielding than Portola. The variety is sensitive to botrytis.

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## Controlled traffic farming (CTF) at large track gauge has added value for Flemish organic agriculture

*After exploring the subject of "controlled traffic farming at large track gauge" with an innovation group of organic farmers in 2015, Inagro started a unique pilot project in spring 2016 on its experimental organic farm. The aim is to introduce, design and validate the concept of controlled traffic farming in Flemish organic farming.*

### Added value of controlled farming is scientifically based

Controlled Traffic Farming (CTF) is the practice of using RTK-GPS to use exclusively one set of tracks year after year. CTF is being increasingly implemented in arable farming systems with reduced tillage. Dutch organic farmers have developed their own concept with fitted tractors at track gauges of 3.2 m. Science as well as practice have proved the benefits of CTF:

- Optimal soil structure in the seedbed is guaranteed as any negative impact of the tracks (compaction) is prevented. This results in more intensive and homogeneous root development of the crops in the soil profile, in turn leading to better nutrient use and water balance.
- Depending on the crop and growing conditions, a yield increase from 0 to 10% in arable crops was measured.
- The seedbed remains flat with no tracks, resulting in more accurate mechanical weed control.
- Different row distances under the tractor are possible, regardless of the track gauge of the tractor.
- Because the soil in the seed bed carries almost no load bearing wheels, deeper tillage is less necessary. Practical experience indicates that CTF goes well with non-inversion tillage.

### Inagro sets the plow aside

The pilot project at Inagro's experimental farm is used to introduce, design and validate the concept of controlled traffic farming in Flemish organic farming. Specific challenges in Flemish organic agriculture are the small scale and fragmented field structure. In addition to confirming foreign





experiences and research, farmers question the feasibility in practice on their small sized fields. In June 2015, the innovation group of Flemish organic farmers discussed the approach to be explored at Inagro's organic experimental farm. A new tractor would be adapted to large track gauge and for the rest, existing material should be used as much as possible. Most crops and fieldwork are done at a row distance of 70 cm, thus we decided to use a track gauge of 3 m. At the same time, Inagro is striving to convert to a reduced tillage system. We therefore look for inspiration from some pioneers who have been working on reduced tillage in organic farming for many years already. Experiences from abroad indicate that controlled traffic farming and reduced tillage fit and reinforce each other. Furthermore, the combination of CTF with reduced tillage leads to more effective work in field trials.

### **Immediate application in practice**

In the meanwhile, several members of the farmers' innovation group have formed an operational group. Four farmers, accompanied by Inagro, ILVO and Ghent University are looking how they can implement CTF on their own farm and what possible bottlenecks are.

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

completed

*Management of storage diseases with biological control organisms (BCOs) is a safer and more environmentally friendly alternative that can be applied 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 selected for the control of storage diseases. Their mode of action is based on a competition for food and space. Until now, only a preharvest treatment with one specific BCO (BoniProtect) is registered for pome fruit in Belgium. More research is necessary to know more about how to implement BCO's in postharvest disease control.*

## **Nebulization of BCOs in cold storage to control postharvest diseases**

Research concerning the application of fungicides in cold storage rooms by thermos-nebulization has been performed (funded by Flanders Innovation & Entrepreneurship (VLAIO)). One disadvantage of this application technique was non-homogeneous distribution of the fungicides in the cold storage room. Some residue levels were thus above the legal standards, which may result in strong restrictions in the retail or export industry. This residue problem does not occur when BCO's are used. Based on the findings and the limitations of using this technique in practice, the idea arose to use nebulization in combination with BCOs. In this project we examined the feasibility of spraying BCOs in a cold storage room to combat storage diseases. The results reveal a fairly uniform distribution of the BCOs when they are applied with the Swingtec Fontan 'Starlet' device. Nevertheless, there is still room for optimization: the shape of the cold room, ventilation, BCO concentration, etc. remain factors to consider. The goal is to increase uniformity of distribution.



### **Efficacy of different BCOs against postharvest diseases**

In this project some (new) BCOs are tested for their efficacy against postharvest diseases. The first results indicate that some of the BCOs tested are effective against postharvest diseases. Some additives have, in certain combinations with the BCOs, a synergistic effect on the efficacy of BCOs against storage rots. Other challenges include the specific formulation type of the product and the development/optimization of an appropriate technique for an efficient application and correct deposition of the product. The application technique certainly shows potential for the future.

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Government of Flanders) (1/1/13 - 31/12/16)





# **Robust organic production systems – Animal production**

Animal welfare and health

Animal feed

Production systems



# Native plants as antihelmintics in organic goat farming

completed

*Gastrointestinal parasites affect animal health and lead to production losses in ruminants. Parasitism results in several symptoms: diarrhea, weakness, slower growth, anemia and even death. Infection leads to both direct (reduced milk production) and indirect losses. Animals get infected by ingesting infectious larvae living on the grass. Non-organic farms avoid infections by applying zero grazing or by the preventive use of anthelmintics when grazing is applied. However, in organic farming, the legally bound access to pasture as well as the curative-only use of anthelmintics has led to the intensive search for alternatives.*

## **Gastrointestinal parasitism limited in Flanders**

Between February and September 2015, monthly fecal samples were taken on ten organic dairy goat farms and analyzed for presence of nematode eggs. Positive samples were subjected to larval culture; the worm species were identified to genus level.

Sixty percent of the farms did not have any infection or had a negligible infection level. The Flemish goat farmers appear to manage their worm burden quite well due to appropriate pasture and feed management systems. Only two farms had an egg count exceeding 400 EPG (eggs per gram feces) and this only between June and September.

Several students from University College Ghent (Dept. of Agro- and Biotechnology) were involved in taking the fecal samples on the dairy goat farms. They also contributed to preparing the samples in the laboratory. This practical lab training was evaluated as an added value in their education program.

## **Native plants to the rescue?**

We developed a quick test to determine the nematicidal activity of a product in the laboratory. The test was performed on *C. elegans*, a model organism frequently used in biomedical research and often used to evaluate the effect of anthelmintics. We collected various native plants claimed to have anthelmintic activity and made extracts of them, which were then evaluated by the test.



This test revealed sainfoin, a species from the Leguminosae, as one of the most promising plants. A feed trial with a group of 20 non-lactating goats was started. Ten of them were fed daily with sainfoin for 70 days. The animals that consumed a sufficient quantity of sainfoin over a 40-day period excreted fewer worm eggs than the other group. Sainfoin does appear to show great promise as an anthelmintic forage.

### Further research needed

Researchers are trying to optimize the cultivation of sainfoin, which is not as easy as initially thought. More knowledge and hands-on experience are required to improve the growth of this forage. Additional feed trials on the other promising plants that could link our test with real life practices are also desirable.

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**Funding:** University College Ghent PWO-project (Practical oriented scientific research) (22/09/14 - 21/09/16)

**More info:** <http://pure.hogent.be> → "Projecten" → "GINGEIT"

## Pharmaceutical use on organic dairy goat and cattle herds: casus of pasteurellosis in goats and gastrointestinal nematodes in cattle

new

*Pharmaceutical use on organic herds should be restricted to a minimum and may only be used in a curative manner when no alternatives are available and only under supervision by a veterinarian. Until now, it was unclear what amount of pharmaceuticals are actually being used in commercial organic livestock husbandry in Flanders. We have collected data about the use of medicine in the dairy goat and cattle sector. A farmer survey indicated that most medicines were used to treat Pasteurella in goat kids and gastrointestinal nematodes in cattle.*

### Our calculation method to survey pharmaceutical use

During a farm visit, the farmer was asked to provide us a copy of the official document written by the veterinarian that lists information about medicine delivery, administration and indications ("Toedienings-en Verschaffingsdocumenten" or TVD) from 2012, 2013 and 2014. We received the TVD of 3 dairy goat herds and 4 cattle herds (2 dairy and 2 meat cattle herds). The "defined daily dose" per year, DDD/y, was calculated based on the medication use derived from the TVD, the number of present target animals and their average weight. The DDD/y is the average of the administered doses of antibiotics per animal per year and is developed to give insight into the general antibiotic use on a herd. During our study, we also used this formula to calculate the anthelmintic use. The persistence of an antibiotic and the remnant effect of an anthelmintic were included in the DDD/y calculations.

### Dairy goats

Two goat farms, Herds A and C, needed a great deal of treatment during 1 of the 3 investigated years. The calculated DDD/y was 10.89 and 17.99, respectively. In the other years, either no medication or a very short treatment (DDD/y = 0.56) was needed. The third herd B was treated every year, with a DDD/y between 7.86 and 11.36.

### Cattle

The treatment frequency and the DDD/y varied greatly between herds. The annual number of deworming for the entire herd is presented in Table 1. While calculating the DDD/y, we did include the remnant effect of the anthelmintic used. Herds A, B, C and D used a product with a remnant effect of 35, 35, 14 and 21 days, respectively.





Table 1. Overview of the anthelmintic use on 4 cattle herds

	2012	2013	2014
Herd A			
Number dewormings/y	0,82	1,05	1,77
DDD/y	28,80	36,64	61,78
Herd B			
Number dewormings/y	0,33	0,91	0,79
DDD/y	11,40	31,86	27,72
Herd C			
Number dewormings/y	1,06	2,77	2,02
DDD/y	14,89	38,72	28,30
Herd D			
Number dewormings/y	-	0,85	1,32
DDD/y	-	17,87	27,70

### Room for improvement

Pharmaceuticals are applied frequently in both the organic dairy goat and cattle herds. The calculated treatment frequency and the DDD/y reveals a clear need for herd-based preventive management practices to reduce the DDD/y over time. Further research in this subject is very much desired!

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**More info:** [www.ccbt.be/projecten](http://www.ccbt.be/projecten)

## Animal welfare protocol for dairy goats: the most eye catching results

*To evaluate the welfare of dairy goats on professional herds in Belgium and The Netherlands, we developed an animal welfare protocol. During the months November and December 2014 and January 2015, the protocol was practiced on 8 Belgian and 8 Dutch goat herds, mainly organic. It took us on average 10 hours per herd to work out the entire protocol. The housing and climate conditions were measured. These results can be read in an article for V-focus (April 2016). Subsequently we focused on the goats by observing their behaviour in group and by randomly selecting 30 individual animals which were scored for the presence of lesions, tumours, body condition score, among others. And last but not least we asked the farmer to answer the questions of a questionnaire which gathered information about management and the farmer's well-being on the herd. Via statistical analyses; we sought for correlations between the different variables.*

### **If the herd enlarges, ...**

- ... the available laying surface per dairy goat declines ( $R^2 = 0,65$ ). The minimal legal requirement of  $1.5\text{m}^2$  is full-filled in the majority of the herds included in this study. The larger the herd, the closer it approaches the minimum requirement which makes them able to fully utilize the available housing equipment.
- ... the heart girth in cm /  $\text{m}^2$  laying surface increases ( $R^2 = 0,652$ ). This is an indication of an increased animal density per  $\text{m}^2$ . In additional research we were able to demonstrate a very strong correlation between heart girth and body weight of adult Saanen goats. So in herds with larger animals and consequently a wider heart girth, there is more kg body weight per  $\text{m}^2$ .
- ... the dairy goats demonstrate more negative behaviour ( $R^2 = 0,522$ ). Both aggression against neighbouring goats and browsing on iron were included as negative behaviour in this study. Negative behaviour also increases if more animals per  $\text{m}^2$  are housed ( $R^2 = 0,544$ ).

### **Horned goats ...**

- ... have more laying area per animal (expressed as  $\text{m}^2/\text{cm}$  heart girth) ( $R^2 = -0,727$ ).
- ... do not result in a decreased welfare of the herd, even not in mixed herds (hornless and horned animals together), if there is a proper



adaptation of the management for these horned animals. This became clear by applying the shorted version of the protocol and analysing the results of the Qualitative Behaviour Assessment (QBA) by proximate analysis. All herds with a large percentage of horned animals clustered in the positive emotion area.

### Goats expressing positive behaviour or positive emotions ...

- ... make the farmer has more fun in his job (or is it vice versa?) ( $R^2 = 0,57$ )
- ... approximate the farmer quicker and closer while he enters their pen ( $R^2 = 0,71$ )
- ... are more productive ( $R^2 = 0,65$ )

### Is there something else?

The welfare protocol gives a lot more information than we are able to conclude from the significant correlations. Discussing the data with the individual farmers or in group, seems the most interesting and valuable merit of the protocol. It gives extra information and insight in the own herd or the herd of others.

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**Funding:** PWO (project based scientific research), research funding of the University College Odisee (1/11/2013 – 31/12/2016)

# Enhanced protein quality in the diet of organic livestock

new

*Rations based on grass-clover in organic farming generally have a high level of rumen degradable protein from roughage. This excess of rumen degradable protein causes increased concentrations of ammonia in the rumen. This is converted to urea, which is excreted in urine and milk. In order to improve the nitrogen use efficiency, the ratio of rumen undegradable relative to rumen degradable proteins has to be increased in the ration. A series of measures can increase the quality of the proteins in the diet. Within the CCBT-project "More PDI (protein truly digestible in small intestine) for organic livestock" practical applicability and impact of some of these measures will be examined.*

## Sainfoin

Tannin-rich leguminous plants may reduce the degradability of the protein in the rumen. Condensed tannins have the property to bind protein and thus protect against degradation in the rumen. This increases the proportion of intestinal digestible protein and total protein supply. During this project in vitro analysis will be used to determine whether addition of sainfoin in the diet increases the proportion of rumen undegradable proteins. Sainfoin is not easy to grow, however; DM yield and persistence after two years of sainfoin was very low on some Flemish organic fields. If the in vitro analyses are positive, cultivation technique and useful varieties of sainfoin need to be further explored to achieve a profitable crop in Flanders.

## Grass/clover

In autumn 2015 a trial with grass/clover was set up at an organic dairy farm. Four types of grass (*Festulolium*, hybrid ryegrass, perennial ryegrass and a mixture of tall fescue and timothy) in combination with two varieties of red clover (Larus and Lemmon) are compared. During the first year some clear differences are measured. *Festulolium* and hybrid ryegrass achieved a higher DM yield for the first three cuts but with a significantly lower crude protein content compared to perennial ryegrass or the mixture of tall fescue and timothy. The higher protein content of perennial ryegrass and the mixture of tall fescue and timothy also gives a higher total DVE yield per ha. No obvious differences were observed between the two types of red



clover. However, a clear influence of the type of grass on the development of the red clover was observed. Due to the strong grass growth in spring of hybrid ryegrass and *Festulolium*, the amount of clover is strongly reduced.

### Heat treatment of concentrate

In a third section of the project, the effect of a heat treatment of concentrates (e.g. field beans) will be tested. Heat treatment reduces the degradation of the protein in the rumen by denaturing the proteins and forming compounds between the proteins and carbohydrates and between the proteins themselves. However, this process must be done carefully: if not heated enough there is little effect, if heated too much, the protein is partially indigestible. We partner with Borlix to develop the heat treatment of field beans, lupins, peas, and full-fat soybeans.

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**Funding:** CCBT-project "*Meer bestendig eiwit in biologisch melkvee rantsoen*" (More PDI (protein truly digestible in small intestine) for organic livestock) (Government of Flanders, Department of Agriculture and Fisheries) (2015 – 2016 )

**More info:** [www.inagro.be](http://www.inagro.be), [www.biopraktijk.be](http://www.biopraktijk.be)

## Grazing winter rye to resolve clover fatigue in pastures

new

*In Flanders as well as in neighboring countries, clover fatigue has been observed in pastures with a long period of grass/clover, in particular in pastures around the stable. Clover fatigue is not often a problem in meadows used for mowing as these parcels are part of a crop rotation with cereals. In most of the cases pastures could not be turned into arable land because of a lack of grazing surface on organic farms. Therefore all available pastures should be producing grass/clover as much as possible.*

### Grazing winter rye

In some organic dairy farms in Denmark a mixture of winter rye with Italian ryegrass was sown in spring in pastures around the stable. If winter rye doesn't pass a certain cold period it stays in a vegetative stage and it can be grazed. Winter rye grows very quickly in spring and can be grazed already 4 weeks after sowing. This makes it possible to install a short crop rotation in long term grass clover without loss of dry matter yield on these pastures.

### Does this strategy work in Flanders?

The research investigated the feasibility of "grazing winter rye" under Flemish conditions. Growth, dry matter yield and feed value of grazed winter rye and Italian ryegrass are being determined on a pasture of an organic dairy farm in Flanders during 2 years.

The experiment was set up on a field with partly heavy sandy loam and partly sandy soil. Sowing was done late because of the wet spring. From July on there was drought, which rapidly slowed crop growth. Crop yields in general were lower than expected. From the trial it appears that rye together with Italian ryegrass is a good combination. The rye provides sufficient foliage 4 weeks after sowing so that the non-grazing period remains short. Italian ryegrass follows quickly and it stays productive also under grazing in the summer and autumn.



The test will be repeated next year so that the potential of this cultivation practice will be evaluated under Flemish conditions. Animal productivity will also be monitored during the grazing period. Here, the milk production and concentrate feed consumption will be checked and compared with the original conditions of the year before.

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**More info:** [www.inagro.be](http://www.inagro.be), [www.biopraktijk.be](http://www.biopraktijk.be)



# Locally sourced organic feed in poultry nutrition

completed

*Organic agriculture strives to close cycles at the regional and farm level. In poultry, 20% of the feed substances must be produced on farm or in the region (region is defined by each country). This regional feed for poultry may be processed first by feed processors. Flemish organic layer farmers often lack extra land to produce feeding crops, apart from the required free range. To meet the local feed demand, these farmers need to look for partnerships with arable farmers and feed mills to close cycles. Farmers who are interested and capable of producing, blending or supplying raw materials ought to be aware of the bottlenecks: sufficient production volumes, adjusted machinery and knowhow. For food producers, each delivery has to fulfill specific requirements.*

## Locally sourced feed

In this project, the EPC, INAGRO and ILVO looked at the theoretical potential of producing crops locally. First we described the layer nutritional requirements and what influence the rations. Secondly, we designed different rations in theory including local feed materials. In a third part, we created technical sheets for different crops (cereals and grain legumes) to cultivate in the region of Flanders. For oilseeds, we collected only technical advice on how to process these materials on farm, since the lack of experience of cultivation in Flanders. These advises were mainly based on the recommendations of a feed expert meeting held in 2015 at the EPC.

## Protein crops

We focus on grain legumes to produce locally. These crops contain a relative high amount of protein and a high quality amino acid pattern. However, a nutritional disadvantage is the presence of anti-nutritional factors (ANF's) which can differ between type and races of grain legumes. Grain legumes in monocultivation is difficult in organic production as weed grows strongly in the beginning and at the end of the season. A combined cultivation of



*Layers need an optimal ration comprised of high-quality raw materials  
(Source: experimental Farm for Poultry)*

cereals and grain legumes can counteract these problems. To incorporate a mixed crop in poultry feed, experts advise to flatten the materials. Chickens can process a whole grain but not a whole legume. Grinding the feed through use of a hammer mill would make the feed particles too small. Flattening the products gives the best quality feed yet the flattening process is strongly influenced by the dry matter percentage of the raw materials. According the current study a simple 2- role flattening machine is not sufficient and a 3 role flattening, but more expensive, machines are recommended. Similar advises are summarized for cereals and oilseeds.

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**More info:** [www.provincieantwerpen.be](http://www.provincieantwerpen.be), [www.ccbt.be](http://www.ccbt.be)

## Increasing free-range use of broiler chickens housed in mobile stables, in combination with production of short rotation coppice

*What is the effect of short rotation coppice in the free-range area on behavior and production of slow-growing broiler chickens, and how does this combination affect the growth of the short rotation coppice? In practice, free-range chickens make limited use of the outdoor area: only part of the flock goes outside, and those that do tend to stay close to the chicken house. This is probably because they feel unprotected against predators and adverse weather conditions. Previous research indicates that shelter plays an important role in free-range use, but which type is most suitable remains unknown. More free-range use and a better distribution of the flock over the available space would benefit both the birds and the environment.*

### Experimental design

At ILVO's poultry facility a 1-ha plot was planted with 50% short rotation coppice (willows) while the other 50% consisted of grassland with artificial shelter (wooden A-frames). Four groups of slow-growing broiler chickens were housed (during multiple production rounds) on the plots in mobile houses. The chickens had access to both the grassland with the artificial shelter and the willows. Observational studies were made to determine whether the chickens preferred either the grassland or the willows, and whether their behavior was related to the shelter type. It was also studied whether a dark brooder (a wooden box with plastic flaps on the sides, which contains heat panels that do not produce light) during the first 3.5 weeks of the chickens' lives (before they get outdoor access) caused the animals to be less fearful and make more use of the free-range area at a later age. Additionally, it was tested if extra overhangs adjacent to the pop holes (which the chickens use to go outside) caused more free-range use by providing a more gradual transition from inside to outside. We also tested which weather conditions affect the number of chickens that go outside, and if the presence of the chickens affects the growth of the willows and the nutrient balance in the soil.

### Preference for willows

The first results show that the chickens prefer the willows over grassland; on average 23% of the chickens was found in the area with the willows



compared to 3.1% on grassland. Free-range use increases with age, especially in areas further than 5 m than the house. Weather conditions also influenced free-range use: more chickens went outside with an increasing temperature, while the opposite was true for increasing wind speed.

### Relevance

If the chickens make more use of the outdoor area and distribute themselves better, there is more space per animal, and more opportunities to perform natural behaviours such as dust bathing and foraging. A better distribution of the flock over the area also reduces the occurrence of point pollution. If the short rotation coppice can contribute to a better free-range use, it can also be an extra income for the farmer because it can be harvested every three years; the wood chips can be sold or used for heat production. It could also be possible for short rotation coppice producers to keep broiler chickens on their plots as an extra source of income.

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**Funding:** VLAIO (Agency for Innovation and Entrepreneurship, Government of Flanders) (1/01/14 - 31/12/17)

# What makes a free range more attractive?

completed

*Organic layers should spend 30% of their time outside. To prevent point pollution the hens should spread out in the free range. A well designed free range is both a financial and time investment for a farmer and should be adjusted to the hens' behavior.*

## Recommendations in practice

We assessed the use of the free range during three consecutive days in the winter and summer season on two organic layer farms. For each farm, the free range was divided into different areas and the movement of the hens was described. Based on this, recommendations were formulated to improve the design of the free ranges on the farms. Both farms invested yet in a variation of crops and zones to meet the hen's specific behavior.

A striking result was the lack of movement in bright sunlight. Hens are then less likely to cross a large area or they move faster to find an area with sufficient shelter. On a cloudy day or in areas with more shelter, hens spread out and take their time to forage.

Layers need straight lines, offering permanent shelter (if possible) along which they move in group to explore the free range (both in summer and winter). These lines can be formed by hedges, bushes or artificial fences. Straight lines help to bridge the passage between zones easier. In a free range existing of a meadow and an orchard, the hens will not spread out properly if there is no route or line to follow.

A second recommendation is to place "wind catchers". Windy zones are visited less frequently by the hens. A line of trees can break high wind speeds and soften the climate in the free range.

Third, offering a large variation of crops, natural materials, shapes and forms attracts the hens to explore the free range: examples are large branches, tree lines differing in height, fields and meadows. A sandy hill can lure the hens to practice their dust bathing behavior.



*In bright sunlight, hens are less likely to cross to another zone*

*(Source: experimental Farm for Poultry)*



*Straight-edged structures in a free-range area ensure that hens can stay in a group while navigating the area*

*(Source: experimental Farm for Poultry)*

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# **Flexible organic chain systems**

# Organic and "low-input" dairy farms in Europe: how different are they?

completed

*Organic and "low-input" agriculture are often lumped together, as both agricultural systems differ greatly from the conventional high-input farming system. They are often raised as alternatives to the current intensive dairy farming systems. But to what extent are "low-input" and organic farms actually comparable, or is their similarity only based on their alternative status?*

## What is low-input?

In contrast to organic agriculture, there is no generally accepted or legal definition to identify "low-input" (LI) dairy farming systems. There are no benchmarks available that indicate to what extent the use of external inputs should be limited just as there is no indication of what should be the ecological impact resulting from reducing the use of external inputs. In this pan-European study, LI farms were differentiated from "high input" (HI) ones by use of a pragmatic chosen indicator, taking into account the availability of data from the Farm Accountancy Data Network (FADN). This indicator was calculated as the sum of the cost of purchased feed, fertilizers, plant protection products and energy, divided by the number of grazing livestock units on the farm. In every European country, the 25% of farms with the lowest value for this indicator were categorized as LI, whereas the 25% farms with the highest value were categorized as HI.

## How comparable are LI and organic dairy farms?

In 14 European countries, characteristics of LI farms were compared with those of organic farms by use of 18 indicators. Structural indicators enabled us to reveal differences in farm size and in organization of production factors. In addition to these structural indicators, other indicators were used to analyze intensity and productivity characteristics of both farming systems. As many as 12 of the 18 indicators were significantly different at European level, which suggests that LI and organic farms differ considerably from each other. The number of grazing livestock units per ha is higher on LI farms in 12 countries. In most countries, the proportion of grassland on total area for roughage production is higher on organic farms. In several countries, there



is a clear substitution between area for maize production and grassland between conventional LI farms and organic farms. Productivity per hectare is generally lower on organic farms, but milk production per cow, however, is not significantly different.

### **Are differences country-specific?**

Dairy farms in the EU are very diverse and highly influenced by the socio-economic, legal and institutional context of the region. Climatic conditions and the agronomic potential of the region also play a role. This diversity is at the origin of variation between countries considering differences between HI and organic farms. For example in Germany, as many as 15 of the 18 indicators are significantly different between LI and organic farms, while in Italy, LI and organic farms differ only on 2 indicators. The differences between organic and LI farms in Italy deviate strongly from the European trend, while for other countries, including Denmark, the European trend strongly resembles observed differences at the country level.

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# Competitiveness of organic and "low-input" dairy farming across Europe

completed

*From the perspective of ecological sustainability, organic and "low-input" agriculture are often raised as alternatives to current intensive dairy farming systems. In contrast to organic farming, conventional "low-input" systems do not receive price premiums, as there is no legal or generally accepted definition of "low-input" to permit the use of "low input" as a marketing feature. This might raise the question to what extent "low-input" systems can compete with conventional more intensive production systems and organic farming systems across Europe.*

## Higher costs offset higher yields

In a pan-European study (2004-2012) "low input" (LI) and "high input" (HI) farming systems were differentiated using a pragmatic chosen indicator, taking into account the availability of data within the European Farm Accountancy Data Network (FADN) (see also Organic and "low-input" dairy farming in Europe: how different are they?). HI farms are bigger than their LI counterparts and they have a higher productivity per hectare and per cow, resulting in a total output which is more than twice as large. The output on organic farms is somewhere in between, and is partly explained by higher prices for organic milk. The comparative advantage of HI farms, however, is almost entirely offset by higher costs. Although the family income still benefits the HI (€25,191 per farm) and organic farms (€26,766) (compared to €20,727 on LI farms), net economic profit is negative for HI (-€10,969), LI (-€3,740) and organic farms (-€12,801). Net economic profit is what remains after the opportunity cost for owned land, capital and labor are paid. High opportunity costs for capital and labor presumably explain the strong negative values of net economic profit on HI and organic farms, respectively.

## LI is less prone to volatile milk prices

As LI farms are less dependent on external inputs and production factors, they are more resilient and less prone to fluctuating prices of both inputs and outputs. In years with high milk prices (2007), HI farms have higher values for net economic profit than LI farms, due to economies of scale and



higher productivity on HI farms. On the other hand, during the depression in 2009, economic losses were most pronounced on HI farms. Throughout the years, net economic profit is the most negative on organic farms, with the only exception in 2009, when the losses were highest on HI farms.

### **Zooming in from Europe to Belgium**

The above-mentioned results illustrate a pan-European trend. Obviously, this European trend is not equally pronounced in every country for HI, LI and organic farming systems due to the diversity of dairy farming systems in Europe. In Belgium, farms with an input use in between that of LI and HI farms are most competitive. This indicates that many farms are beyond the optimum (overuse of inputs) or not yet up to the optimum (too little input use). In contrast to the results at European level, organic farms in Belgium are more competitive compared to their conventional counterparts. Averaged over the years, organic farms manage to obtain positive values for net economic profit, which is not equally true for conventional farms.

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## More flowers on our plate?

*Eating flowers is not new, but the use of edible flowers is increasing in restaurants and drinks. In July 2015 PCG started the PDPO project "Edible flowers: elegant and tasty!". This project wants to exploit the potential of edible floriculture and make it a more professional, sustainable and environmentally friendly cultivation that can serve as differentiation and innovation for a horticulture and/or floriculture company.*

### **Cultivation of edible flowers**

The wide variety of edible flower species led us to request input from the sector to focus this research. The growers asked PCG (the Vegetable Research Center in Kruishoutem) to test different organic products and products of natural origin to control powdery mildew in borage. To inspire farmers, a demonstration field was planted with different edible flower species.

At PCS a growth inhibition trial was carried out with the aim of finding alternatives for chemical growth inhibitors. An artificial lighting test was performed to evaluate the influence of LED illumination on the length of the harvest period and flower color.

Attention is also being given to creating a legal framework for the culture of edible flowers and raising awareness about the use of chemical products.

### **Online consumer survey**

To estimate the potential market for edible flowers in Belgium, an online consumer survey was carried out. In total, 668 consumers and 51 professional cooks responded. The aim of the consumer survey was to gain insight into the potential buyer of edible flowers. The cooks provided information about the current market for edible flowers and the possibilities for expanding sales.

Creative consumers that experiment in their kitchen seemed to be much more interested in buying edible flowers compared to more conservative consumers. The main reason why consumers buy edible flowers is esthetic. The preferences of the professional cooks seemed to be very similar to those of the consumers in relation to types of dish and seasonal use. Besides yellow, the professional cooks also preferred darker shades such as red and purple. The top three flowers used in the kitchen are *Tropaeolum* species, courgette flower and pansies but interest was also shown in the broccoli flower, *Impatiens* species and the basil flower.



### Sensory analysis and consumer research

A taste trial was carried out with 56 consumers in the sensory lab at PCG to test the influence of cultivation method and species on consumer acceptance of edible flowers. Smell, taste, taste preference, texture, appearance and willingness to buy based on taste and appearance were scored. Two kinds of edible flowers were evaluated: a Tropaeolum variety and borage. Both flowers were cultivated in the open field as well as in the greenhouse, in plastic pots on tables and in soil.

Generally consumers like the appearance of both tested flowers and they have an interest in the taste of the flowers. The texture and smell of Tropaeolum are more appreciated than those of borage. The smell of Tropaeolum flowers is more intense and their texture is better. The Tropaeolum taste is nice but a little strong. The taste of borage is acceptable and not strong enough. For both flowers, the effect of cultivation method on taste and appearance did not give a clear result.

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## Back to basics: circular economy and agriculture

new

*The resource circle is complete in nature but not in our production systems. The central element of a circular economy is to close cycles in the economic system instead of linearly extracting raw materials. Closing cycles has a positive impact on sustainability. This study has identified some glowing examples of circular thinking and acting in agriculture and horticulture.*

### The theory: three models for circular agriculture

The first model for agriculture is the recycling business model. It closes the loops as much as possible at farm-level (or together with neighbors/farmers), but the focus remains on food production. The second model is the valorization model: food production remains a priority, but the farm also becomes a link in the chain as a supplier of raw materials. A third model is the multi-actor and multi-functional agricultural model, in which the farmer becomes a link in a circular (urban) environment and fulfils various functions in addition to food production, in collaboration with various stakeholders (citizens, NGOs, local authorities, etc.).

### Back to basics: seeds for a circular economy in agriculture?

In the three models, the farmer returns to the basics: the mixed farm, supplying raw materials to other sectors (formerly textiles and construction), bringing agriculture closer to the consumer, and so on. New elements are the strong innovative and technological character of the circular economy: complex chains and cooperation with various sectors and actors. We have found that the current logic in agriculture is built on efficiency and low costs. Some seeds of the circular economy are emerging in agriculture and horticulture, however: an agro-ecological organic farm, valorization of residues from tomato and pepper cultivation in packaging, a bustling city full of urban agriculture initiatives, etc. Most examples were still patchy (i.e. they only focus on one aspect of the circular economy), small-scale, local, or in pilot or draft form. Technical and economic bottlenecks are also common.

### More than one possible path

Each company must choose how it can and wants to participate in the circular economy. Each choice brings represents advantages, disadvantages and challenges: e.g., moving to a more land-based, mixed or agro-ecological business model, optimally matching supply and demand flows, providing a multifunctional range of products, services and activities, gaining knowledge

## OUTLINE OF A CIRCULAR ECONOMY

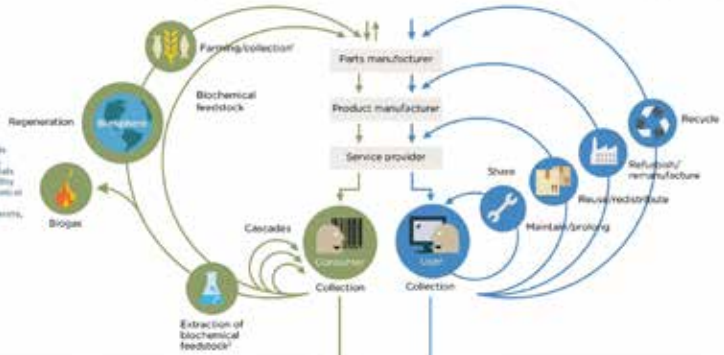
### PRINCIPLE 1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows  
 RESOLVE levels: regenerate, optimize, exchange



### PRINCIPLE 2

Optimize resource grids by stimulating products, components and materials to use at the highest utility at all times in both technical and biological cycles  
 RESOLVE levels: regenerate, reuse, optimize, lease



### PRINCIPLE 3

Focus system effectiveness by revealing and designing out negative externalities  
 All RESOLVE levels



1. Huisman and Filling  
 2. Capri-Huisman Foundation, NLR and Huisman Center for Research and Innovation (drawing from European & Huisman, 2016) (drawing from Capri-Huisman, 2016)

and expertise, implementing new technologies, investing and cooperating. Despite the many opportunities and examples of some pioneers, there is still a long way to go. This is to be expected in transitions such as moving toward a circular economy. Such transitions require a structural change in business models, structures, production and consumption. The path is rugged and involves successful and unsuccessful experiments, technological development and social innovation. The government's role in stimulating this transition is to provide the right conditions. These are:

- adequate legislation, a coherent policy approach and a level playing field for all models and applications
- setting a good example, e.g. through public procurement
- stimulating innovation and knowledge exchange
- facilitating collaboration
- smart spatial planning and connecting the cities with the surrounding (rural) area
- raising consumer awareness

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# **High quality food**

## Tomatoes in all shapes and colors: what does the consumer want?

*One of the reasons why consumers buy organically cultivated vegetables and fruit is their belief that organic produce tastes better. But what influences the taste of tomatoes? In 2015 sensory analysis was carried out to evaluate the influence of cultivar on the flavor of tomatoes.*

### Sensory analysis at PCG

PCG (the Vegetable Research Center in Kruishoutem) started sensory analysis on vegetables and fruits in 1998. For this sensory analysis, a tasting room with a food preparation area was installed in PCG according to international standards (ISO 8589). In this room with 14 booths, equipped with color filters on the lighting to optionally eliminate color differences on the samples, the panel members taste and evaluate the vegetables and fruits. This evaluation follows accepted sensory practice and is done blind, i.e., the panel members do not know (for example) which breed or cultivation type the evaluated products are.

The PCG uses various panels. The consumer panel includes about 300 people (men and women of varying ages) and is used to determine which fruits are deemed to be most tasty and which properties are found to be superior or inferior. The panels focus not only on taste but also on mouth-feel, juiciness, smell, texture, and visual aspects of the food. The trained panel members possess an optimal sense of taste and smell. They are trained to recognize and review the different sensory components of each vegetable or fruit. This panel quantifies appearance, taste, texture, aroma and smell of a particular fruit or vegetable by using their human senses in a systematic way, as if they were machines. By linking the results of lab measurements as well as the taste panel, we gain insight into the characteristics that most determine the appreciation of vegetables or fruit by consumers.

### Cherry tomatoes in different colors

On June 15 2015, during "the organic week" 60 visitors evaluated 4 cultivars of cherry tomatoes at PCG: red (Capr ese), yellow (Summer Sun), orange (Bambello) and brown (Zebrina). The consumers scored general acceptance before and after tasting, color, taste, sweetness, sourness, firmness, juiciness and purchase intent. All cultivars were attractive. The taste of all the cherry tomatoes was rated "good", except for the brown ones



which were rated “moderately acceptable”. The brown tomatoes were also a little too sweet and too firm. Most of the consumers preferred the red ones (Caprésé).

### **Coeur de boeuf**

At the event “BioXpo” on September 27 and 28 2015 at Brussels, 120 visitors each evaluated 4 of the 8 cultivars of Coeur de boeuf tomatoes. Each object was tasted 62 to 74 times. The consumers evaluated the same parameters as mentioned above in the taste session of the cherry tomatoes. The tomatoes of the cultivar Cauralina (Gautier) was evaluated the best on all parameters in this taste session.

### **Communication of the results**

Through publication in agriculture magazines, the PCG newsletter or the PCG website, the results of our sensory analysis on fruits and vegetables is communicated to help growers make more informed choices regarding variety and cultivation.

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**Funding:** PCG, CCBT

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- **BBN**

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- **PcFruit**

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- o Experimental garden for pome and stone fruits T 011/69 70 88
- o Experimental garden for strawberries and woody small fruits  
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- **PCG**

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- **PIBO Campus vzw**

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- **Proefbedrijf Pluimveehouderij vzw**

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