



ILVO 

ANNUAL REPORT 2010

Publisher Erik Van Bockstaele

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This annual report describes the results of the two legal entities that join to form ILVO. These are:

The Internally Autonomous Agency (IAA) of the Flemish Government and ILVO Own Capital (ILVO-OC). These two 'legs' of ILVO support one body.

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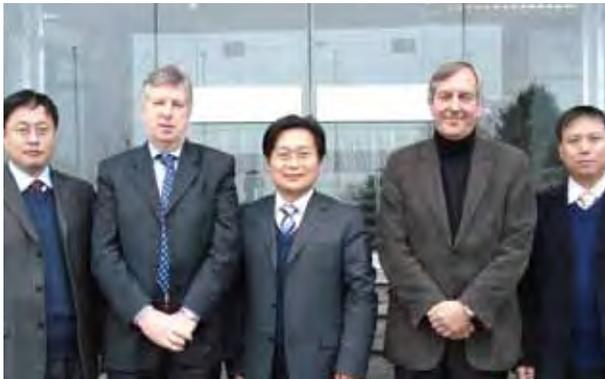
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Dear reader,

2010 was not an easy year, certainly not for the agricultural and fishing industries. It is therefore important that we, in our role as the Flemish Institute for Agricultural and Fisheries research, illustrate how our research, innovation and service provision has contributed to improving the sector's competitiveness and sustainability as well as deepened the understanding of food security and food safety.

This annual report is not an exhaustive summary of ILVO's efforts over the past year. We present only our most important results and accomplishments. They deserve to be put in the spotlight!

Research and service provision are about people. ILVO has proven once again that committed and open collaboration among co-workers leads to an increase in project research, a positive personnel survey and even better performance indicators. Our researchers and external partners are now working to put ILVO2020, the well-founded vision of ILVO's future, into practice. ILVO's communication also took to new heights in 2010. All of this has contributed to increase ILVO's maturity level as an organisation.

By streamlining our processes and optimising research projects, we were still able to maintain the high level of our research and even start new initiatives in a time of severe budget constraints.

Updating and improving ILVO's infrastructure will be one of our biggest challenges for the coming years. We now expect concrete progress and much greater efficiency on this front: as of 1 January 2011, the resources for infrastructure and maintenance of ILVO's building complex were transferred to ILVO's Own Capital. A realistic multi-year plan has been drawn up to remedy ILVO's pressing infrastructural problems, one step at a time.



It is my great pleasure to thank each and every one of our members of personnel for his or her support, effort, drive and enthusiasm. I hereby also include all those who directly and indirectly make our work possible.

Last but far from least, we hope that all of our stakeholders will not only support the notion of sustainability in theory, but will also (continue to) show practical and financial support.

Enjoy your reading,

Erik Van Bockstaele
Executive Director

ILVO's Mission

ILVO's mission is to perform and coordinate policy-supportive scientific research and to provide related services with an eye toward economically, ecologically and socially sustainable agriculture and fisheries.

Based on research in the various scientific disciplines, ILVO will acquire knowledge necessary for the improvement of products and production methods, for monitoring and safeguarding the quality and safety of end products, and for improving policy instruments as a basis for the development of the agricultural sector and policies relating to the countryside.

ILVO will regularly inform policy-makers, the agriculture, horticulture and fisheries sectors, and the public about its findings.



ILVO2020: Where to with Agricultural and Fisheries Research in Flanders?

For the third year in a row, ILVO has been working to form a solid vision for the future: which themes and research questions should be a priority for our researchers and how can we internally adjust the projects to meet these priorities? In other words, ILVO's mission - to strive for more profitable and more sustainable agriculture and fisheries – has been translated via a deep and long thinking process into a set of guiding arrows that point to the areas in which ILVO wishes to make its mark.

This thinking process is called ILVO2020. It proposes a broad foundation for a thorough discussion and methodological approach for all levels of ILVO and outside it (i.e., those outside ILVO who are involved in our research).

In the meanwhile, we have outlined the headlines: nine interdepartmental research clusters have been drawn up, each with a programme coordinator and related discussion group.

1. Sustainable Plant Production
2. Innovative Agriculture, Fisheries, and Product Processing
3. Quality Animal Husbandry
4. Sustainable Exploitation of Marine Resources
5. Agriculture and Fisheries in a Changing Climate
6. Agriculture and the Natural Environment
7. Agriculture and Fisheries for Safe and High-Quality Food
8. Dynamic Rural Areas
9. Competitive Agricultural Systems

We first shared ILVO2020 with our stakeholders and partners on 24 June 2008. They gave their opinion about the state of affairs of the initiative and formulated a first set of recommendations. On 15 January 2009, ILVO met with the administration of the Department of Agriculture and Fisheries to exchange ideas. On 16 March 2010, ILVO2020 was officially started by presenting the second version of the ILVO2020 document and discussing it at an event for 200 participants from within and outside of ILVO. Representatives from the academic world were present, as well as the Flemish administration for Agricultural and Fisheries and the agricultural sector. The plenary session on the European 'Foresight' process was held by professor G. Brunori. Tips gleaned from these sessions were taken up in the continuation of this ongoing visioning process.

Ever since, ILVO2020 is becoming more and more operational. The nine discussion groups have identified drivers (societal hot topics that undoubtedly will be investigated in the scientific world, such as climate change and food shortages, etc.). These were assigned to the specific agriculturally related research fields and expertise.

ILVO2020 has strengthened, among others, the insight that ILVO must work interdepartmentally and that extra points of attention are likely to be added.

The results of this thinking phase were discussed with the Flemish administration for Agricultural and Fisheries, representatives of the research stations and with the various working groups of ILVO's Advisory Committee. The series of consultations about the action points will be closed during the plenary session of the Advisory Committee in April 2011. A decision by ILVO's management is planned for June 2011.



of spray boom systems tested in Belgian greenhouses
 ... about 34% of total horticultural production output. For growers, finding ways to control production facilities is more difficult as the availability of authorized plant protection products is more limited. Ninety percent of Belgian growers still use high-pressure sprayers to apply plant protection products, but a recent survey of ornamental plant growers showed that present-day spray application techniques are unsatisfactory. As more equipment automated spray boom systems, many questions remain concerning the benefits for the equipment. New research is being conducted to evaluate the effectiveness of spray boom systems tested in Belgian greenhouses.



strategie zaai- en ploegbereiding na ploegen

... regine bij een goed zaai- en ploegbereiding, want de kwaliteit van het zaai- en ploegbereiding is van belang voor de plannen. In een goed zaai- en ploegbereiding krijgt het zaai- en ploegbereiding de nodige aandacht. Toch besteden landbouwers vaak te weinig aandacht aan de zaai- en ploegbereiding. Het is belangrijk om de zaai- en ploegbereiding te verbeteren, want dit kan tot een hogere opbrengst en een lagere kostenpost leiden. Het is belangrijk om de zaai- en ploegbereiding te verbeteren, want dit kan tot een hogere opbrengst en een lagere kostenpost leiden.



Op 9 september organiseert het ILVO een conferentie met de titel 'De toekomst van de landbouw na ploegen'. De conferentie wordt georganiseerd door de Vlaamse Landbouwersbond (VLBO) in samenwerking met de Vlaamse Landbouwersbond (VLBO) en de Vlaamse Landbouwersbond (VLBO). De conferentie wordt georganiseerd door de Vlaamse Landbouwersbond (VLBO) in samenwerking met de Vlaamse Landbouwersbond (VLBO) en de Vlaamse Landbouwersbond (VLBO).

Trillandcultivator T16 (Kverneland - Kverneland Benelux)
 Deze machine is ontwikkeld voor zware, een- en tweewielers. Het is een trillandcultivator met een breedte van 4,50 meter en een maximumgewicht van 12.000 kg. Het is een trillandcultivator met een breedte van 4,50 meter en een maximumgewicht van 12.000 kg.

Samen met DARTMAN-project een ILVO
 ... project, waar gewerkt wordt aan de ontwikkeling van een innovatieve en duurzame landbouw. Het is een project, waar gewerkt wordt aan de ontwikkeling van een innovatieve en duurzame landbouw. Het is een project, waar gewerkt wordt aan de ontwikkeling van een innovatieve en duurzame landbouw.

Daarom: een afkorting van 'Very manager'
 ... is een innovatief project, dat toepassing vindt in een groot deel van de Nederlandse landbouw. Het is een innovatief project, dat toepassing vindt in een groot deel van de Nederlandse landbouw. Het is een innovatief project, dat toepassing vindt in een groot deel van de Nederlandse landbouw.

Meest belangrijke 120 melkveebedrijven in Noordwest-Europa
 ... worden geselecteerd op basis van hun productie en efficiëntie. Het is een lijst van de meest belangrijke 120 melkveebedrijven in Noordwest-Europa. Het is een lijst van de meest belangrijke 120 melkveebedrijven in Noordwest-Europa.

"Sociale psychologie weet boeren beter te overtuigen"
 ... in Carissa Wauters, het tijdschrift van de K.U. Leuven. Het tijdschrift van de K.U. Leuven. Het tijdschrift van de K.U. Leuven. Het tijdschrift van de K.U. Leuven.

Traditioneel tactisch landbouweconomisch
 ... in het kader van de economische crisis. Het is een artikel over de economische crisis in de landbouw. Het is een artikel over de economische crisis in de landbouw.

Op 9 september organiseert het ILVO een conferentie
 ... met de titel 'De toekomst van de landbouw na ploegen'. Het is een artikel over de toekomst van de landbouw na ploegen. Het is een artikel over de toekomst van de landbouw na ploegen.

Compostieren van beheerresten van
 ... met de titel 'Compostieren van beheerresten van'. Het is een artikel over het compostieren van beheerresten. Het is een artikel over het compostieren van beheerresten.

Compostieren is sterk gereguleerd
 ... in de landbouw. Het is een artikel over de regulering van het compostieren. Het is een artikel over de regulering van het compostieren.

Nieuwsbrief Geïntegreerde Bestrijding
 ... 'Verbeteren van de spuittechniek deel 1'. Het is een nieuwsbrief over geïntegreerde bestrijding. Het is een nieuwsbrief over geïntegreerde bestrijding.

Grote opbrengst voor Dive

BREDENE Zo'n 75 enthousiastelingen trotseerden de koude en dookten in de Noordzee in. Dit gebeurde onder de noemer Music for Life de Noordzee in.

Het initiatief kwam uit van het Instituut voor Landbouw- en Visserijonderzoek, de sectie Mariene Biologie van de UGent en het Instituut voor de Zee (VLIZ). Dankzij de lage temperatuur van de Noordzee en de strakke wind zakte de waterpeil van de Noordzee. Dit was de reden waarom de deelnemers zo'n 75 enthousiastelingen trotseerden de koude en dookten in de Noordzee in. Dit gebeurde onder de noemer Music for Life de Noordzee in.

Tot aan de knieën in zee voor Music for Life
 ... Een reeks vrijwilligers deed mee aan de actie. Het is een artikel over de actie Music for Life. Het is een artikel over de actie Music for Life.



Evoluties en toekomst in de p...
 ... is een artikel over evoluties en toekomst. Het is een artikel over evoluties en toekomst.

Optimalisatie van de zaadteelttechniek
 ... is een artikel over de optimalisatie van de zaadteelttechniek. Het is een artikel over de optimalisatie van de zaadteelttechniek.

Ilvo wil samenwerking verbeteren
 ... is een artikel over de verbetering van de samenwerking. Het is een artikel over de verbetering van de samenwerking.

Proefveldbezoek Italiaans traigras
 ... is een artikel over een proefveldbezoek aan Italiaans traigras. Het is een artikel over een proefveldbezoek aan Italiaans traigras.

Daarom: een afkorting van 'Very manager'
 ... is een innovatief project, dat toepassing vindt in een groot deel van de Nederlandse landbouw. Het is een innovatief project, dat toepassing vindt in een groot deel van de Nederlandse landbouw.

ILVO – Een Kennis Landbouw en verheldert maatschappelijke en een duurzame en competitieve sierteeltsector

De impact van de wereldwijde ILVO is het op internationaal niveau een belangrijke rol spelen in de landbouw en de sierteeltsector. Het is een artikel over de impact van ILVO. Het is een artikel over de impact van ILVO.



Biolandbouwonderzoek wordt beter afgestemd en verspreid
 ... is een artikel over biolandbouwonderzoek. Het is een artikel over biolandbouwonderzoek.

Evoluties en toekomst in de p...
 ... is een artikel over evoluties en toekomst. Het is een artikel over evoluties en toekomst.

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Maatschappij keuzen rond de Vlaamse

... economische middelen die de sector open-
... te integreren, en duurzame ontwikkeling te
... vanderregeringprocessen en systemen
... het effectief en kwaliteitsvol gebruik van
... wordt aangebracht. Zelfs met de Vlaamse
... samen. De wereld rukt op heel wat
... vreesenschap, bereikt voor duurzame land-
... en ontwikkelingsdoelstellingen. ... Bovendien
... onderzoekers en innovatieverrichters die
... de waarde van de sector. Meer in-
... dacht.



Fijn stof is een onzichtbaar gevaar

Sinds we jaarlijks wel enkele keren te maken krijgen met
smogalarm, beseffen we niet zo zeer dat fijn stof een impact
hebben op mens, dier en milieu. Het ILVO doet sinds vorig
onderzoek naar de effecten ervan in de varkenshouderij.

Bronafhankelijk
Fijn stof is een sterk zure stof met
die de efficiëntie die alle vissen en vliegt
... (water) ...

ILVO onderzoekt impact
In het toekomstige onderzoek wordt de impact
de landbouw, maar speciaal
Vlaamse landbouw in en om
... kennis ...

... decreet dat de
... gemodifi-
... vanden die de
... ILVO een

Luimveesector



... Vlaamse
... wordt hij ...



Hoe beter resultaat bekomen v...

... gederende varkens verblijven stroom-
... voren en gedurende de dag ...



Hoe beter resultaat bekomen v...

... een positieve impact hebben op de agrobiocen
In het rapport maken het resultaat voor Natuur en
voor Landbouw en Visserijonderzoek (ILVO) om t
bestaande paketten agrobiociden te vergelijken. Dit
begeleiden de participatie van landbouwers en de
maatregelen zijn. De sector specifieke agrobiociden
is weg naar markt en in de bedrijfsvoering inzet

Tot de potentieel nieuwe agrobiocidenpakketten beho
vrij het biobestrijdbaar van de bodem. Bovendien
personeel, het ontwerpen van overwinterende gar
de best van resistente en afwezigheids gewassen, agro
(watergeleidelijke ecosystemen) en het vermind
landbouwproducten (soorten, stoffen, houdbaar).

Maatregelen die de impact van de landbouw op agrobioc
betrekkend op het verkrijgen van een kleine milieuwaa
van de bodem, waterlopen en nutriëntenconcentraties, op
voedsel en voedselketen en voortplantingshabitat voor di
van het gebruik van bestrijdingsmiddelen en diergeneesk
n op het gebruik van de algemene structu

NIUWSFLASH KAMERPLANTEN

De snelle e-mailservice van het PCS 8 augustus 2010 - nr. 30

Proeven kamerplanten op het PCS: momenteel te zien

Vergelijking (bio)fungiciden ter preventie van wortelknipdiphtherie



Momenteel wordt de werking van
Trichoderma-preparaten vergeleken
met deze van klassieke fungiciden voor
potgrondbehandeling zoals Fenominal
(prof. i.s.m. ILVO en Certis).

Spruittechniek tegen bladvlies
In het project
'Spuittechniek' (i.s.m. ILVO)
werden toepassingen met
de lansspuit vergeleken met
verticale bomen met en
zonder luchtondersteuning
(foto: laurier in
insectengasheers)

VRAGEN OVER DEZE PROEVEN ?

Mail marc.vandenberghe@ilvo.be
DRINGENDE VRAGEN of IDEEËN ?
Heb je dringende vragen i.v.m.
proefwerk of onderwerpen voor
studiedagen: GEEF ZE DOOR !!

Testen met nieuwe middelen tegen wolluis

Sinds deze maand zijn er weer diverse nieuwe pro
opgezet voor de bestrijding van wolluis (Planococcus
Volgende zaken worden getest:

- Spuitproef met nieuwe middelen tegen wolluis
- Effect van voorbehandeling
- Menging met diverse typen uitvoelers
- Test met opzuigen van middelen

De proeven gebeuren op Ficus benjamina en Fuch
laatste bevat ook witte vliegen (Trialeurodes vaporariorum)



Het beëindigde proeven

Fytofocuste proeven fungiciden (juni 2010)
Dorsproef met woutrijmiddelen (juni 2010)
Proefwit op komst:
Fytotoxici

Vlaams kennisnetwerk voor biologische landbouw

Met de oprichting van het CCBT, NOBL en de biobedrijfsnetwerken, krijgt het
Vlaams biokennisnetwerk voor landbouw stilaan vorm. Centraal in deze netwer-
ken staat het uitwisselen van informatie en ervaring, en het opbouwen van nieu-
we kennis voor de biolandbouw. Door een goede samenwerking tussen deze
laten doorstromen, wat toepassing van nieuwe kennis zal stimuleren.



Kostprijs braadkippen berekenen wordt makkelijker

De meeste kippenhouders kunnen nu makkelijker berekenen wat de
kostprijs van een kilogram kippenvlees is. Het Instituut voor Landbouw
en Visserijonderzoek (ILVO) in Melle heeft een model uit om deze berekening eenvoudiger te maken. Het
model is ontwikkeld door de Vlaamse Landbouwersbond (Vlaamse Bond) en de Vlaamse
Landbouwersbond (Vlaamse Bond) en de Vlaamse Landbouwersbond (Vlaamse Bond).

Het gebruik van een horizon spuitboom

Een goede indringing in het gewas en een uniforme verdeling over het gewas worden beschouwd als de
voornaamste factoren voor een efficiënte toepassing van gewasbeschermingsmiddelen. Echter het bekamen van
een uniforme verdeling is niet eenvoudig zeker in bepaalde dichte gewasstypes. Het gebruik
van een horizon spuitboom kan hier een oplossing bieden en bovendien de arbeidskosten en de bloot-
stelling van de gebruiker verminderen. In volgende samenvatting worden de proef en de resultaten beschreven.



Vissers zien 2010 hoopvol tegemoet

De visprijzen gingen sinds de
beginning van het jaar de hoogte
in. De prijzen zijn gedaald en
kan ondanks scherpe wor-
visquota op peil blijven. "W
nieuwe jaar hoopvol tegem-
reder Urbain Wintin van
Het Laatste Nieuws. "O

Plantenregeling



... de Belgische biologische sector
... van de landbouw in
... de Vlaamse
... de Vlaamse
... de Vlaamse
... de Vlaamse

Plantenregeling

... de Belgische biologische sector
... van de landbouw in
... de Vlaamse
... de Vlaamse
... de Vlaamse
... de Vlaamse

Azalea's marktgericht veredelen



... veredelen werd Azalea
... met ingenieur Johan
... van het ILVO, een
... de applicatievervalding

... de marktgericht veredelen
... met ingenieur Johan
... van het ILVO, een
... de applicatievervalding

A New Leaf

The Plant Sciences Unit

Four Research Areas and a Business Unit

Plant Sciences Unit comprises four research areas: 'Applied Genetics and Breeding', 'Crop Husbandry', 'Crop Protection', and 'Growth and Development'. In addition, a separate Business Unit coordinates the activities related to the creation and marketing of high-end breeding material and cultivars (seeds and cuttings), the Diagnostic Centre for Plants, the lab for chemical analysis of feeds, soils and substrates, and the national reference lab for detection and control of quarantine organisms.

The scientists of the Crop Protection research area study and identify the bacteria, fungi, viruses, insects, mites and nematodes that can damage plants. They search for appropriate techniques to detect and control plant pathogens. These researchers also find strategies to reduce the use of chemical crop protectants and test alternatives for them. This research area is also appointed as the National Reference Laboratory for Plant Health.

One of the activities of the Applied Genetics and Breeding research area is to use technologically advanced DNA-based techniques to create ornamental plants with novel and esthetically pleasing characteristics. They also aim to produce improved cultivars of feed crops, vegetables and industrial chicory. This group's researchers also archive the genetic heritage of crops such as azalea and ryegrass in gene banks.

The team from the Growth and Development research area deciphers the fundamental processes of growth and development of a crop. This team researches the following question: what biochemical and genetic factors in a plant determine its architecture, growth, quality of biomass and tolerance to stress?

The Crop Husbandry research area compares the effect of different growing systems on the crop and the environment. They aim to develop cropping techniques that guarantee the long term physical, chemical and biological health of soils. These researchers also conduct the official government-mandated tests for (new) cultivar registration of feed crops, flax and chicory.

Agriculture and science: a game of supply and demand

During 2010 Plant Sciences succeeded in registering nine new ILVO cultivars on the official cultivar lists: four ryegrasses ('Meracoli', 'Meltador', 'Mekim' and 'Melprius'), red clover ('Avanti'), chicory ('Dolce'), black salsify ('Melina'), leek ('Wendy') and celeriac ('Claire'). ILVO's research on genetics and breeding of crops helps satisfy the agricultural sector's need to deliver food, energy and starting material for various sectors, all with a minimal impact on the environment. ILVO strives to improve the yield, persistence, disease resistance, internal and external quality and trouble-free seed production of agricultural and horticultural crops.

A significant number of new research projects started in 2010. The Crop Protection group's research includes a survey of economically important harmful organisms for plants in terms of their status in Belgium and risk of spread; a study of the biology and control of root knot nematodes; and the use of nematodes to control insect pests. Growth and Development is working to discover the genomic secrets of grass and translate the knowledge about Arabidopsis to oilseed rape. The Crop Husbandry group is addressing soil quality and the use of fungicides in the seed production of Italian ryegrass. Researchers in the Applied Genetics and Breeding research area investigate biodiversity of the Flemish vegetables, chicory breeding and the construction of a detailed genetic map of azalea. ILVO's scientific research also has direct social relevance. One example of this Crop Protection's work on a number of exotic organisms (pests and diseases). These

organisms are often given quarantine status from the European Union because of their potential to cause significant damage to our primary plant production. Crop Protection's fundamental research, which includes the development of diagnostic tools, status determinations and pest risk assessments, has played a crucial role in creating a successful phytosanitary policy, preventing trade barriers, and averting the undesired introduction of exotic biological control organisms.

Green thumbs up: ornamental crop production

For several years, ILVO has produced scientific innovations in ornamental crops that have easily found their way to the horticultural sector. BEST-select, which celebrated its tenth anniversary in 2010, is a perfect example of this: 20 Belgian tree nurseries work together to commercialise high-end ILVO innovations. During the past 10 years, BEST-select has commercialised 15 valuable new ILVO cultivars. The most recent creation, a compact-growing paniculate hydrangea called 'Bobo', was introduced to the public in September 2010 at the Green Expo in Ghent.

ILVO's Plant Sciences Unit also has a long-standing tradition in azalea breeding. Since 2008, 21 leading azalea growing companies have united their forces in the Azanova cooperative. This year, Azanova introduced three new ILVO-bred azaleas during the 2010 Floralties of Ghent - the pink, white and red Aiko®.

Building ILVO's future: infrastructure improvements

About 15 years ago, ILVO drew up plans to construct a new glasshouse. In 2010, the necessary funds finally became available and construction began. This new complex offers ILVO a surface area of 3200 m² and is fully equipped for the current and future demands of scientific research. A connected building of industrial size will house ecophysiological research, seed analysis, and postharvest

cleaning of vegetables and chicory. Appropriate cooling and freezing spaces for the storage of the seed-based gene banks will also be provided.

The glasshouse will be equipped with separately-regulated compartments, which will enable the required environmental conditions for each of the crops under study. Part of the glasshouse will fulfill the requirements for conducting experiments with genetically modified organisms. Yet another part will have the necessary facilities to safely conduct experiments with plant pathogens.

The new glasshouse also got an extra 1000 m² extension based on the joint investment of Ghent University and Ghent University College. Besides sharing costs, the physical proximity of the infrastructure will enhance the already-existing project-based collaborations between our institutes and create new opportunities for collaboration. This joint investment is the first concrete accomplishment of the new Technology Pool for Ornamentals, a collaboration of several research institutes for research on ornamental plants. The Technology Pool, which arose from the European 'Ghent: Flower Region' project, unites ILVO, Ghent University College, Ghent University, and the Research Centre for Ornamental Plants (PCS). The Technology Pool serves the entire ornamentals sector, from cut flower growers to tree nurseries. Its guiding principle is that knowledge leads to innovation, which in turn leads to a more profitable market position.

The Crop Husbandry site installed a new lab to integrate the activities of the former 'Agrolab' with the former 'chemical lab'. This reorganisation increases the efficiency of all analyses of feeds, soils and substrates. Several of their analyses are conducted under ISO17025 accreditation, including chemical and NIRS analyses of feeds and energy crops for dry matter, total ash, nitrogen, total protein, total fiber and NDF, ADF and ADL cell wall components. The accredited scope also includes specific analyses of mineral soils such as those for total organic matter content, pH-KCl, and nitrogen content (nitrate- as well as ammonium).

Know Thine Enemy

Research on Crop Protection

Bacteria damage the reputation of Flemish seed potatoes

The seed potato sector in Flanders has faced serious problems from wilting and blackleg symptoms on plants and maceration of tubers. These problems are caused by the bacteria commonly known as pectinolytic *Erwinia*, which have recently been renamed as *Pectobacterium* and *Dickeya*. A new and highly aggressive variant of *Dickeya*, tentatively named *Dickeya solani*, is causing alarming plant health issues in the form of macerative blackleg. This pathogen has damaged the good reputation of seed potatoes from Flanders and has become a major block to export.

The objective of the *Dickeya*@ILVO project is to get a grip on the pathogen through studying its diagnosis, identification and epidemiology. The research is connected with European initiatives and is partly financed by the Flemish Fund for Agriculture and Fisheries.

Analysis of wilting and maceration symptoms reveals that about 50% of these disorders are caused by phyto-bacteria, with an almost equal distribution of *Dickeya* and *Pectobacterium*. The *Dickeya* isolates are analysed by molecular tests and in plant assays. Identification of *Dickeya* is done via PCR on the pelADE gene cluster. Six *Dickeya* species are known worldwide, and differentiation of the species is not straightforward. Species are determined via sequence analysis of a PCR amplicon of a core gene such as *recA* or *dnaX*. We target genes that are associated with virulence, such as the gene that encodes the flagellin protein which assembles the flagellar tail. That gene possesses specific antigenic properties which differ according to the *Dickeya* variant. The *Dickeya* isolates from Flanders' seed potatoes have been explicitly identified as *Dickeya dianthicola* and *Dickeya solani*. Both types may be present in a seed potato field but have never been found together on one potato plant. *Dickeya solani* is the dominant variant since 2005 and has outcompeted the less aggressive *Pectobacterium atrosepticum*. Field tests have demonstrated that *Dickeya solani* is far better at colonising the potato plant than the initial variant, which has been assigned to *Dickeya dianthicola*.



wilting and blackleg symptoms on plants
and maceration of tubers

Differences in virulence of *Dickeya* variants have been explored in a test panel of 20 plant species. A virulence profile is established using a binary result code. The resulting bar code of pathogenicity allows the assessment of the infection probability of crops and culture plants. Many host plants increase the potential for spread and survival.

Dickeya may be present as latent infection in the vascular tissue at the stolon end and as contamination on the tuber peel. Seed potato lots at risk can be identified by targeted detection. A sample of 200 tubers is being analysed from each seed potato lot destined for multiplication. *Dickeya* and *Pectobacterium* are still detected by individual conventional PCR tests pending the application of a validated multiplex real-time PCR. The result of the tuber test is evaluated using the observations of bacterial blackleg on the post control field of Flanders' seed potatoes. We have demonstrated that contamination at the apical end is important in the development of *Dickeya* contaminated seed potato fields. Physically removing the apical sprouts to break top sprout dominance resulted in three to five times more infected plants.

The most important issue in epidemiology is to gain knowledge about how clean seed becomes contaminated. *Dickeya* and *Pectobacterium* are found in surface water during the growing season. They can be introduced in a seed crop via water used for irrigation or for preparation of pesticide applications. Check points have now been set up at all seed potato growers to avoid the use of contaminated water. The identity of the *Dickeya* variant in the water sample is yet unknown. However, we anticipate that this will be derived from the PCR amplicon.

Smearing of bacteria from macerated tuber tissue is generally considered to be the most important pathway of dissemination of *Dickeya* in a seed lot and between seed lots. Dissemination patterns from single locus infections were established for both *Dickeya* variants. The experiments were performed under

intensive or occasional irrigation and under the naturally prevailing weather conditions. The degree of dissemination to nearby plants was related to soil moisture. *Dickeya solani* showed a stronger dissemination potential than *Dickeya dianthicola*.

The fate of *Dickeya* contamination was also investigated in various stages of crop development of three potato varieties ('Bintje', 'Spunta' and 'Désirée'), twinning race and crop susceptibility. 'Bintje' and 'Spunta' showed stronger reactions than 'Désirée'. *Dickeya solani* outperformed *Dickeya dianthicola* in plants and tubers. The strongest infections occurred from the contaminated mother tuber. Infected progeny tubers were still detected when inoculation was performed 10 weeks after planting. A late introduction in a seed crop still implies a risk for contaminated seed tubers.

The proliferation of *Dickeya* has focused attention on bacterial effect on seed potato quality. The recommended therapy is an integrated approach of intensive inspection with diagnostic analysis, an accurate identification and a better knowledge of the bacterial environment.

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Co-financing: Fund for Agriculture and Fisheries

Collaboration: Microbiology Lab (Ghent University), Research Centre for Potatoes (Beitem), ILVO

Know Thine Enemy

Research on Crop Protection



Barcodes for bacteria: DNA sequence-based species identification

Recent advances in DNA sequencing technology are revolutionising the study of microbial diversity and refining diagnostics in phytobacteriology. Bacterial plant pathogens are responsible for major harvest losses worldwide and have a significant economic impact. The increased number of plants being traded worldwide also enhances the chance of harmful organisms spreading. The development of accurate identification tools for plant pathogens and pests is essential to support the European Plant Health Policy. For this reason, ILVO is

working on the QBOL project (Quarantine organism Barcode Of Life). The aim of QBOL is to develop new diagnostic tools using DNA barcoding in order to identify quarantine organisms harmful to plants. ILVO's role in the project is to coordinate the barcoding of plant quarantine bacteria.

DNA barcoding is based on the observation that species can be distinguished and identified using a short gene sequence. Although the DNA sequences of related species are generally very similar, there are differences to be found. Each organism has a specific difference in its DNA, which forms a unique and specific molecular DNA barcode. A key feature of the use of DNA barcodes for the identification of quarantine bacteria is the possibility to integrate them into a universally accessible system. Therefore, an internet-based database will be built that contains all relevant DNA barcodes. The database will be made freely available for national plant protection organisations so they may correctly identify quarantine bacteria on plant products crossing the borders.

Such a large barcode reference library will require maintenance and updating. This is the mission of B-Net, a consortium that joins the expertise of ILVO's National Reference Lab for Plant Diseases with the BCCM/LMG Bacteria Collection and StrainInfo at UGent. Through B-Net, the DNA barcode sequences will be linked to all relevant taxonomic, geographic, and host data of the quarantine bacteria. Fundamental questions in phytobacteriology can best be addressed using the most complete genomic source of information - the entire bacterial genome. Therefore, ILVO recently started to compare genome sequences of six closely related quarantine bacteria. Promising genomic studies are expected to shed light on interesting aspects of plant pathogenesis, including host specificity, infection mechanisms, and virulence factors. The increasing accessibility of genome sequencing and the constantly decreasing costs of sequencing indicate that genomics will set the standard in the near future.

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 Financing QBOL: 7th Framework Program of the European Union
 Collaboration QBOL: Microbiology Lab (Ghent University), Agroscope Changins-Wadenswil Research Station (ACW, Switzerland), ILVO



Barcodes for bacteria

A new enemy: the South American tomato moth *Tuta absoluta*

The South American tomato moth *Tuta absoluta*, responsible for massive yield losses in South American tomato production for several decades already, was first detected in Europe in the area of Valencia (Spain) at the end of 2006. This harmful insect was probably imported via infected tomatoes. Migration and international trade led to the moth being found shortly afterward in several countries of the Mediterranean region, the Middle East, the Netherlands, the United Kingdom and Switzerland.

Tomato is the preferred host of *T. absoluta*, but the insect has also been known to damage aubergine, paprika, peppers and potato crops. Although the larvae of this moth principally mine the tomato leaves, stems, crowns and tomato fruits can also be infected. Infested tomato fruits become commercially worthless. Infestation of the vegetative plant parts leads to loss of quality and lower income. When the larvae enter the tomato fruit under the crown, their presence is not visible at harvest and the insect can thus enter the trade chain. This has dramatic consequences for growers and auction organisations, and could also stain the excellent international reputation of the Flandria label. The presence of *T. absoluta* in Belgian nurseries has already negatively influenced their export position. The United States and Canada, where *T. absoluta* is considered a quarantine organism, has enacted import restrictions for tomatoes of European origin.

T. absoluta was detected for the first time in Belgium in an organic tomato nursery in 2009. The moth likely entered Belgium via imported organic tomatoes from Italy. After that finding, the Federal Agency for the Safety of the Food Chain (FASFC) started monitoring import companies. Pheromone traps were placed to attract the male adults, and *T. absoluta* was detected in almost all locations. Tomato nurseries were also monitored in summer and autumn 2010. The results show that the moth occurs in the main production areas of tomatoes in most areas of Flanders. The only exceptions were East and West Flanders, which had only a limited number of discoveries.



ILVO's Diagnostic Centre for Plants checks the pheromone traps for the presence of moths. Any suspicious moths are confirmed morphologically by taking a microscopic slide of the male genitalia. Starting in early 2011, the ILVO-coordinated QUARANSTAT project will map the occurrence and spread of *T. absoluta*. The damage is expected to increase in 2011, because the moth is now living in the glasshouses and it is difficult or impossible to eradicate during crop rotation. Moreover, international trade fosters re-infection of the production areas each year.

Contact: Sebastien Morio & Hans Casteels
Financing QUARANSTAT: Federal Public Service Health, Food Chain Safety and Environment
Collaboration: Research Station for Vegetable Production (Sint-Katelijne-Waver), Research Centre Hoogstraten (Meerle), ILVO

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Anthracnose: a threat to strawberry production

In the last ten years, Belgian strawberry production fields have suffered serious losses from the anthracnose disease caused by the *Colletotrichum* fungus. Little is known about the spread and epidemiology of this fungus, and current strategies do not sufficiently control the disease. A research project conducted by ILVO and the Fruit Research Centre (pcfruit) during 2006-2010 aimed to find a more efficient and sustainable control strategy for this strawberry disease. The specific objectives were to study: (1) the presence and spread of *Colletotrichum* sp. in Belgian strawberry fields, (2) the symptomless (latent) life phase and the epidemiology of *Colletotrichum* on strawberry, and (3) the efficiency of (non)-chemical products to control *Colletotrichum* on strawberry.

We began by conducting a survey to study the spread of *Colletotrichum* in Belgian strawberry fields. *Colletotrichum* was found to be widespread in Belgium, despite its classification as a quarantine organism on strawberries in the EU at the beginning of the project. Given the widespread occurrence of *Colletotrichum* in Europe, the fungus was removed from the quarantine list in 2008.

Morphological and molecular analysis of more than 200 *Colletotrichum* isolates indicated that an unusually diverse *Colletotrichum* population is present in Belgian strawberry fields[1]: the species *Colletotrichum acutatum* was found most frequently (97%), followed by *C. gloeosporioides* (2%) and *C. coccodes* (1%). In addition, the *C. acutatum* isolates were assigned to five intraspecific groups. The high diversity observed within Belgian *C. acutatum* isolates contrasts with previous reports on the limited diversity of *C. acutatum* on strawberry within a geographic region. One possible explanation is that *C. acutatum* was introduced into Belgian production fields along with planting material from several different geographic origins. Finally, the traditional differentiation between *C. acutatum* and *C. gloeosporioides* as causal agents of fruit and crown rot, respectively, proved not to be valid in Belgian strawberry fields. Our experiments showed that both species can cause both fruit and crown rot.

Analysis using a real-time PCR technique developed for this project[2] showed that *C. acutatum* can be latently present on strawberry transplants and weeds. This showed that weeds and transplants are important inoculum sources in the

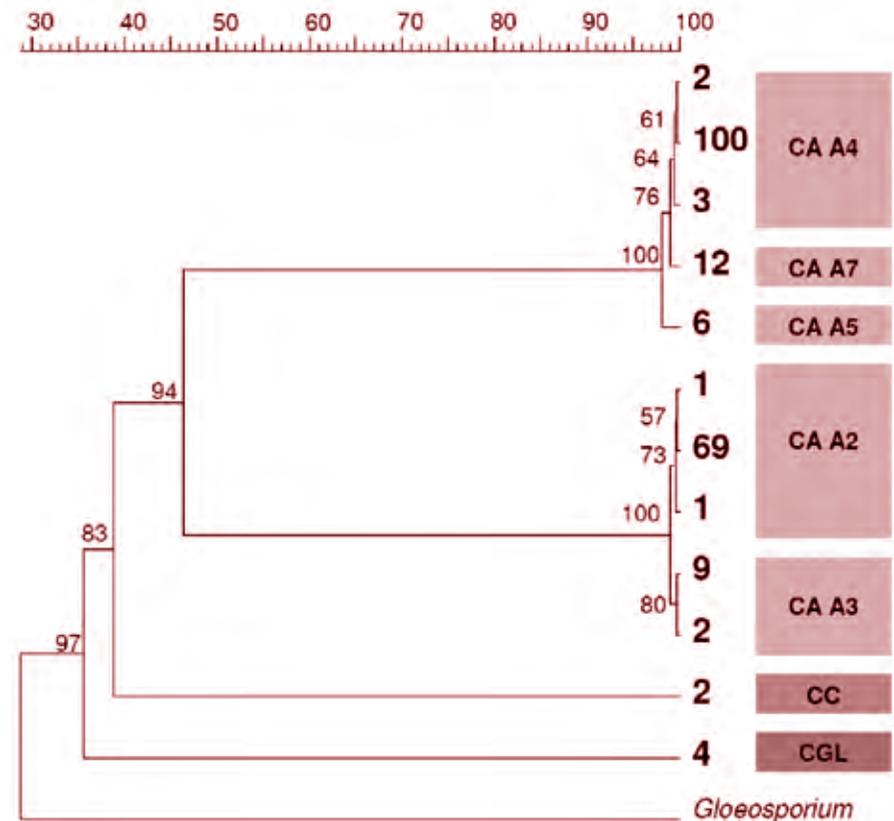


figure: UPGMA consensus tree constructed from an alignment of rDNA ITS sequences of 211 Belgian *Colletotrichum* isolates, showing the inter- and intra-species diversity. Numbers in bold are the number of isolates in each group. Numbers on nodes are bootstrap values. Tree was rooted with *Gloeosporium* sp. strain DAOM 233252 (accession number EF672242). CA = *C. acutatum*; CC = *C. coccodes*; CGL = *C. gloeosporioides*. CA group designations according to Sreenivasaprasad & Talhinhas (2005)

strawberry field. Disease management should focus on treating planting material and efficient weed control in the field. In addition other plants such as apple, pear and cherry can host *Colletotrichum* and can serve as an inoculum source in a strawberry field. *C. acutatum* from a strawberry field can in turn form a threat to other crops such as apple, pear and cherry.

Once *C. acutatum* is introduced in the field, the fungus can spread in the field via dew or rain splash. Experiments conducted during this project showed that the fungus is able to spread in a 1.5 m radius of the introduced point source after a few moderately intense rain showers. The in-field spread of the fungus was more severe within rows than between rows, and straw ground cover had only a minor effect on the spread between the rows. In addition, our results showed that the symptomless presence of the fungus on the plant was related to the amount of symptomatic fruit during or after harvest.

Last, we studied control strategies for *Colletotrichum* in the strawberry field. In vitro and in vivo experiments showed that the fungicides Switch and Signum are the most successful against *C. acutatum* on strawberry. In addition, an early treatment with fungicides (targeting the latent phase of the fungus) proved to be successful in controlling *Colletotrichum* in the field. Besides chemical products, we also tested alternative methods including hot water and UV-c treatment. Both methods showed to have potential, but further research is necessary to optimise the timing and doses. Finally, we monitored the epiphytic yeasts on the strawberry plants. This research may lead to the selection of yeasts as biological control agents (BCA). Experiments showed that *Pichia*, *Cryptococcus*, *Candida* and *Rhodosporidium* are the yeast species typically present in the phyllosphere of strawberry leaves and fruit. Applications of Switch or Signum had little impact on the composition and quantity of the yeast cells present in the phyllosphere of the strawberry plant. This indicated that these yeasts are good candidates for BCA. The timing of application and plant parts that need to be treated are two important factors to take into account in further research on the use of yeast as BCA for *Colletotrichum*.

Contact: Jane Debode

Financing: Agency for Innovation by Science and Technology

Collaboration: pcfruit mycology (Hasselt/Tongeren), ILVO

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strawberry with *Colletotrichum* symptoms

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Research on Crop Protection



symptoms of
Cylindrocladium buxicola

New threats to Boxwood

Boxwood, a slow-growing evergreen plant, is popular in modern garden landscaping. The plant is perfectly usable as a pot plant and in hedges and as a base for topiary. It is also durable, given that it had no important phytosanitary problems in the past. In recent years however, *Buxus* spp. suffer from a new fungal disease, *Cylindrocladium buxicola*. The box growers and marketers also fear increasing damage by the voracious caterpillar of the box tree moth *Cydalima perspectalis* (Lepidoptera: Crambidae). This invasive pest was detected for the first time in Belgium in 2010.

The fungus *C. buxicola* causes leaf and twig blight on *Buxus* spp. First detected in nurseries in the United Kingdom and New Zealand in the mid-1990s, the disease has spread throughout Western Europe. In addition, an increase in incidence and intensity of outbreaks was observed, with peaks in 2006 and 2007, which caused substantial economical losses for the first time. During the warm and humid autumn of 2010, numerous outbreaks of *C. buxicola* were observed. Consumers found the disease particularly aggravating, as they often lack the necessary knowledge, experience and fungicides to combat it.

Typical symptoms of this disease are black leaf spots that sometimes have a pale center. Young twigs show very characteristic black stripes oriented lengthwise. In time, the disease causes severe defoliation and dieback, which can rapidly spread throughout the plant in the right weather conditions.

The Flemish box growers are suffering from the rapid spread and financial impact of this disease. The arboriculture and garden landscaping sector has urgently requested more knowledge about this pathogen. A four-year research was started in September 2009, in the form of a partnership between the Research Centre for Ornamental Plants (PCS) and the Institute for Agricultural and Fisheries Research (ILVO). During this project, extensive practical and applied scientific research will be done on the diversity, epidemics and detection of the fungus, as well as host plant resistance.

Another threat is the box tree caterpillar. This insect originates in East Asia and was discovered for the first time in Europe in Germany in 2007. In the meanwhile, this pest has also been reported in several other European countries,

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moths were captured in a light trap in Nieuwrode (Vlaams-Brabant) in September. Intensive field observations and monitoring with pheromone- and light traps in the surroundings of the different findings were without result. At this moment the occurrence and distribution of this harmful insect is limited. Despite the chemical control measures it is expected that this moth will migrate in all directions and that the defoliation caused by the larvae will increase.

Contact for box tree moth: Shana Vandierendonck & Hans Casteels
Contact for integrated control of *Cylindrocladium buxicola* in *Buxus*: Bjorn Gehesquière
Financing *Cylindrocladium buxicola*: Agency for Innovation by Science and Technology
Financing FYQUARSTAT: Federal Public Service Health, Food Chain Safety and Environment
Collaboration: Research Centre for Ornamental Plants (Destelbergen), ILVO



adults of the box tree moth

always on box. Because of the severe defoliation caused by the caterpillars and problems with a satisfactory chemical control, the establishment of this insect could represent a threat to public green spaces, nurseries and private gardens. ILVO responded by starting the FYQUARSTAT project in the fall of 2009. In this project, several important box nurseries, including some in the risk region along the border of the Netherlands and Germany, were monitored. The box plants were investigated regularly for the presence of egg clusters, caterpillars and pupae. In addition, the presence of the adults was investigated using pheromone traps. Growers, gardening contractors, public green services and others (phytosanitary companies, the ministry and garden centers) were sensitised via the 'Observation and Warning System for Nursery Stock and Landscape Gardening' of the Research Centre for Ornamental Plants (Destelbergen). There was also a collaboration with the 'Werkgroep Vlinderfaunistiek' of the Flemish Entomological Society, which carries out thousands of observations per year over the whole country using light traps. The first caterpillars of this exotic insect were detected in a private garden in Kapellen in May 2010. The first adult was captured the beginning of July in an amateur light trap in the community Stokkem (Maas valley), close to the German and Dutch border. In August, new caterpillars were detected in several private gardens in Lochristi. Finally, two



larvae of the box tree moth



Knowledge translated from *Arabidopsis* to oilseed rape

Oilseed rape offers a number of advantages for Flemish agriculture in terms of crop rotation, feed production, erosion control and biodiesel production. Oilseed rape belongs to the Brassicaceae family, and not to the more common families of cereals, beets or potatoes. This makes it valuable for crop rotations. After pressing the seeds or oil extraction, the remaining protein-rich cake can partially replace soy in feed production. Winter oilseed rape covers the soil during the winter months and can thus significantly reduce erosion. Last but not least, oilseed rape oil has numerous industrial applications, including the production of biodiesel. Biodiesel derived from oilseed rape complies with the European norm EN14214 and can be readily used in mixtures with fossil fuels. But the low seed yield of oilseed rape limits its biodiesel production per hectare. Therefore, the seed yield must increase before Flemish farmers will want to cultivate oilseed rape. Seed yield is a complex trait, and breeding efforts depend on increased knowledge of the genetic factors influencing seed yield in this crop. The combination of research on a model plant such as *Arabidopsis thaliana* with research on oilseed rape will help to solve the mysteries of seed yield.

This combination of model plant and oilseed rape has been the basis of four years of research financed by the government agency for Innovation by Science and Technology (IWT). Our objective was to identify genes with a positive influence on seed yield in oilseed rape. In a first step we identified genes that promote the growth and/or the seed production in *Arabidopsis*. This was based on a detailed study of the effects of 49 genes in *Arabidopsis*. The growth and seed yield of transgenic lines with either a higher or a lower expression of each of the target genes were thoroughly evaluated. The results were used to identify nine genes with a highly significant positive effect on seed yield in *Arabidopsis*. The effects were in some cases mediated by a higher number of seeds, and by the seed size in other cases.

In a second step we translated these results to oilseed rape. Transgenic oilseed rape lines with altered expression for each of the nine genes mentioned above were generated. We evaluated the growth and the seed yield of these lines in growth chambers and in the greenhouse. Only some of the effects observed in *Arabidopsis* were confirmed in oilseed rape, but we demonstrated positive effects of certain genes on the number of seeds and the seed size in the crop. These promising results need to be validated under field conditions before

definitive conclusions can be drawn. The knowledge generated in the context of this project regarding the genetic control of seed yield in *Arabidopsis* and oilseed rape can be used in the future when designing breeding applications in crops of the Brassicaceae family.

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Collaboration: VIB-Plant Systems Biology, ILVO

In pursuit of sustainable biomass production: evaluating fast growing grasses as energy crops

The current energy and climate policy is promoting measures at several levels for increasing the use of bioenergy. The European Commission has chosen for an integrated climate and energy policy that aims to combat climate change and increase the EU's energy security by transforming itself into a highly energy efficient, low carbon economy. ILVO is investigating the potential of a sustainable biomass production for energy purposes in Flanders.

One aim of this research project was to evaluate several biomass crops for the production of second generation bio-ethanol in Flanders. This study began in 2007 by installing a field trial to compare six species: *Miscanthus x giganteus*, *Miscanthus sinensis*, *Panicum virgatum* (switchgrass), *Phalaris arundinacea* (reed canary grass), *Phragmites australis* (giant reed) and *Salix fragilis* (willow; included in the study as reference crop). We estimated the productivity of the different crops under low input conditions, as well as the biochemical composition and quality of the biomass harvested. In February 2010, the trial was harvested for the third time. Willow, which is managed according to a short rotation coppice scheme, was harvested in 2010 for the first time. One important issue when growing these perennial crops is the requirement of a settling period that takes 2 to 3 years before the maximum dry matter yield is achieved. The first harvest in 2008 resulted in a dry matter yield of only 5.6 ton.ha⁻¹ obtained from reed canary grass. In 2010, the yield increased up to 25.7 ton.ha⁻¹ produced by *Miscanthus x giganteus*. *Miscanthus x giganteus* was clearly the most productive of the crops compared in this study.

Yield is not the only aspect that is important to bio-ethanol production; composition of the biomass is also important. The harvested biomass should ideally contain a large cellulose fraction (linear glucose chain) and little lignin, as it limits the



Deciphering and Translating Research on Growth and Development

conversion process. As expected, willow, which was used here as a native woody reference species, contained the largest amount of lignin (13.4%) and consequently displayed the lowest glucose release by saccharification (60 mg glucose per gram biomass). *Miscanthus x giganteus* had also a relatively low saccharification efficiency (79 mg glucose per gram biomass) but was able to compensate for this low conversion efficiency by its very high dry matter yield. For comparison, we chose the parameter of glucose production per hectare. This was calculated for each crop. One hectare of *Miscanthus x giganteus* resulted in 2.2 ton glucose.year¹, closely followed by the 1.8 ton glucose produced by switchgrass. Reed canary grass cultivars rendered only around 110 - 120 kg of glucose.ha⁻¹. These results demonstrate that *Miscanthus* and switchgrass are probably the most promising crops for biomass production in Flanders. Considering the limited breeding efforts invested in these two crops up to now, we can anticipate an enormous potential for improvement of both yield and quality traits relevant to bio-ethanol production.

Contact: Steven Van Hulle & Hilde Muylle
Collaboration: PhD research: ILVO, Applied Genetics and Breeding and ILVO, Crop Husbandry and Environment, University College of Ghent. Also part of EFRO project 'Energiebewust Boeren' and Ghent University's 'Biotechnology for a sustainable economy' project.

Perennial ryegrass: genomic secrets revealed

In 2000, the first full genome sequence of the model plant species *Arabidopsis* became available. At the time, that was ground-breaking, but now, new plant genomes are released almost every month. This has provoked a paradigm shift – not only in fundamental plant research, but in applied research on agriculturally important crops as well. This acceleration in genomics is mainly due to the development of so-called Next Generation Sequencing technologies. ILVO has also seized the opportunity to use this genomics research and technology in applied research and particularly in the research and breeding of perennial ryegrass (*Lolium perenne*).

In the past year, ILVO has determined the DNA sequence of more than 15,000 genes of perennial ryegrass using Next Generation Sequencing. Because fourteen different genotypes were sequenced at the same time, we not only have access to the DNA sequence of each gene, but also to the natural genetic variation of

each gene within and among individuals (alleles). These data provide a wealth of information. First analyses show that we have identified the DNA sequence for about 60% of all ryegrass genes. Using direct sequence comparison with other plant species, we can assign a putative function to each gene. This database can now be used to identify specific candidate genes with a key role in a physiological process or agronomic trait of interest in ryegrass. This valorises the currently available fundamental knowledge generated in model species.

We can also now directly study the effect of the presence of a specific variant form of a gene (allele) on a trait in the crop. For instance, one allele could stimulate a trait such as tillering, whereas another allele can suppress tillering. By analyzing the allelic variation of a gene in a diverse population phenotyped for branching characteristics, we can couple specific alleles to their effect on that trait. As a result, one can start to select favorable alleles for further selection and breeding.

This databank of gene sequences is an important milestone and will enable researchers and breeders to effectively translate fundamental knowledge on gene functions in model species to applications in crops. Over time, this information will lead to innovation in breeding strategies and application of new selection methods.



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Aarhus University (Denmark), ILVO

Soil quality: the basis of agricultural practice

Just below a harvested crop lies the basis of sustainable and healthy agricultural practice: the soil. Soil is a complex, mutable living resource. Soil quality and soil resistance are vital aspects of this resource. Current Flemish and Dutch policy often considers soil characteristics to be isolated entities. Integrated, sustainable soil management is insufficiently understood and therefore unsatisfactorily applied in practice. The interreg project 'BodemBreed' (www.bodembreed.eu) aims to increase sustainability of agricultural soil practice through increasing knowledge and sharpening insight about the soil as a coherent whole. The project's main goal is implementation of practical interventions that improve the quality of agricultural soils.

One of the project's core activities was an extensive literature review on soil quality and agriculture. The literature study, performed by ILVO, has three main aspects:

1. Soil quality, soil characteristics and processes

This theoretical introduction gives practical insight into soil quality and forms the basis for further project activities. Soil characteristics and soil processes (e.g. mineralisation, compaction, erosion, and wash out) are defined and their importance elucidated. Mutual relationships are identified between the soil and agricultural suitability, the latter defined in terms of cultivation potential, efficient use of nutrients and water, suppressiveness, and yield security and amount.

2. Evaluation of soil quality and agricultural suitability

Measurement instruments and indicators are needed to monitor soil quality and agricultural suitability. This section presents and evaluates a set of regularly used soil indicators and measurement methods. Specific attention goes to the demarcation of predefined indicator thresholds and reference values. In addition, the present situation and trends in the research area are presented as they relate to organic matter, soil compaction and erosion.

3. Effects of farming practices on the soil and its agricultural suitability

The third and most extensive part of this study describes how the following farming practices interact with soil quality and agricultural suitability: soil tillage, crop rotation (including green manure crops), fertilisation regime and crop protection. Starting from a set of frequently asked questions and common statements, these



non-inversion tillage

Soil and Crop Yield

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are then critically evaluated based on scientific literature, experimental results and expert knowledge. Particular attention goes to experiments relevant to agricultural practice, soil and climate conditions within the project area.

Besides the written report, a user-friendly guide, mainly oriented to farmers, makes it possible to view the main results and findings. The core of this tool is a matrix that visually summarises the effects of farming practices on different aspects of soil and water quality.

Contact: Bert Reubens & Karoline D'Haene

Collaboration: Province of Vlaams Brabant, Province of Belgisch-Limburg, Province of Nederlands-Limburg, Flemish Government (Albon), Waterschap Roer en Overmaas, Boerenbond (Leuven), Iltb (Roermond, The Netherlands), Arvalis (Roermond, The Netherlands), PIBO campus (Tongeren), PPO Swageningen, The Netherlands), Hooibeekhoeve (Geel), ILVO

Both the report and the user-friendly guide are available at www.bodembreed.eu/kennisloket

The use of fungicides in seed crops of Italian ryegrass

The incidence of fungal diseases like powdery mildew, crown rust, black rust and leaf spot disease is much lower in seed crops of Italian ryegrass than crops of perennial ryegrass in our temperate climate. This difference is mainly due to the cleaning effect of the preceding forage cut and the faster growth rate of Italian ryegrass. However, in some mild and warm seasons, the above diseases can detrimentally affect the seed yield of Italian ryegrass. For this reason, ILVO recommends a preventive fungicide treatment to ensure higher and more stable seed yields over several years.

ILVO research, based on one year trial on Italian ryegrass, led to the extension of authorisation (FAVV, 2002) of 'cereal'-fungicides for general use in grass seed crops:

Allegro (epoxyconazole + kresoxim-methyl): 1 l/ha

Amistar (azoxystrobin): 1 l/ha

Sphere (cyproconazole + trifloxystrobin): 1 l/ha

Horizon (tebuconazole): 1 l/ha

Tilt (propiconazole): 0,5 l/ha.

In order to determine the impact of a disease treatment on the profitability of grass seed crops, the fungicide research continued in 2006, 2007 and 2008 on two tetraploid cultivars of Italian ryegrass, 'Meroa' and 'Salome' (more rust tolerant). Six different fungicides were used as preventive treatment in the early ear emergence (spike ¼ - ½ of the leaf sheath) and compared with an untreated control.

In the context of ICG Flanders Advisory (Agricultural Centre for Cereals) and in collaboration with the practical agricultural centre of POVLIT (Beitem), ILVO conducted a demonstration field trial in 2010. The final objective was to accelerate the transfer of useful information to the seed growers.

In 2001, all strobilurin treatments resulted in reliable yield increases compared to the untreated control, i.e., from 15 to 18% or 196 to 237 kg/ha more seed. The pure triazole treatments (Horizon and Tilt) had no significant positive effect on seed yield when compared to the control. Remarkably, these favorable results

effect of fungicides on seed yield of Italian ryegrass (diploid) - 2001 harvest and (tetraploid) - harvest years 2006-07-08-10

Treatments	2001	2006	2007	2008	Avg. 2006-07-08	2010 LCG
Tilt (0,5)	104,6 ^b	-	-	-	-	-
Horizon (1)	109,6 ^b	97,3 ^c	106,6 ^b	97,9	100,4	-
Amistar (1)	117,7 ^a	-	-	-	-	-
Allegro (1)	117,7 ^a	105,7 ^a	121,8 ^a	100,0	108,6	115,3
Sphere (1)	114,7 ^a	-	-	-	-	-
Opera (1,5)	-	106,9 ^a	124,6 ^a	102,8	110,9	-
Fandango (1,25)	-	104,4 ^{ab}	122,3 ^a	102,6	109,3	111,2
Amistar Extra (1)	-	103,9 ^{ab}	122,4 ^a	101,2	108,6	-
InputPro+Impuls(0,8+0,8)	-	102,1 ^{ab}	125,3 ^a	101,2	109,0	-
Untreated control (%)	100,0	100,0 ^{bc}	100,0 ^b	100,0	100,0	100,0
kg/ha	1337	2018	1868	2161	2016	1681
Disease pressure	-	-	+++	+	-	-

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were obtained in the absence of leaf diseases. The tonic effect of the used strobilurins led to better assimilate flow to the ears. This was reflected in a better floret site utilisation, more filled seeds (higher thousand seed weight), higher number of seeds per square metre, and ultimately, higher seed yields.

The three trial years (2006-07-08) had widely differing disease pressure and weather conditions. Over the three years, the seed yield of 'Meroa' was on average 5% higher than that of 'Salomé'. Only in the severe rust year of 2007 did they have equal seed yields. Since both cultivars responded in the same way to the fungicides (no interaction), the results are presented as average over the two varieties (Table).

The seed yield response to treatments was nil in 2008, small in 2006 and very pronounced in 2007. The most effective fungicides (i.e., strobilurins) increased seed yield by 9,3% (= 187 kg/ha) on average when compared with the unsprayed control. There were no differences between the strobilurin treatments

themselves. However, Horizon was clearly less effective for three years and led to an equal seed yield as the control, i.e., 100,4%.

These data indicate that the seed crops of Italian ryegrass can be managed more intensively. The registered strobilurin-fungicides can be used profitably in Italian ryegrass provided that the grass seed price (tetraploid) is at least € 0,50/kg. A single application at the beginning of ear emergence (spike $\frac{1}{4}$ - $\frac{1}{2}$) should normally suffice.

The flow of ILVO results into practice was highlighted by a well-attended afternoon presentation coupled with a field study visit on July 8, 2010. In this demo test, the beneficial effects on seed yield of the 2 strobilurins were confirmed by an average increase of +13,2% (223 kg/ha).

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afternoon presentation and field study on July 8, 2010



Soil and Crop Yield

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VFG-compost: effect on crop performance and soil quality

Organic matter (OM) has multiple beneficial effects on soil properties. These advantages include providing an array of nutrients to soils, improving water holding capacity and improving other physical properties of soil such as bulk density, penetration resistance and soil aggregation. Furthermore, OM serves as a food source for a large number of beneficial soil organisms. The maintenance of a high OM status in the topsoil is therefore crucial for sustainable long-term land use.

Data from the Soil Service of Belgium show a systematic decrease in the soil organic carbon content (organic matter contains 58% carbon) of agricultural soils since 1990. This is true of all important soil types. This decrease is generally attended by a decline in soil fertility and water availability and gives rise to more problems with compaction, erosion and diseases. The most obvious way of maintaining and/or increasing the OM content of the soil is by the application of exogenous organic amendments like slurry, farmyard manure and various compost types like VFG-compost (vegetable, fruit and garden waste that has been selectively collected and composted).

To assess the effect of VFG-compost, an experiment was conducted during 1997-2009 on a sandy loam soil at Gent University's experimental farm in Melle. The experiment combined an average yearly cattle slurry application (about 43 ton/ha) with a moderate yearly VFG compost application (22,5 ton/ha). During the experiment, maize was grown in a monoculture. After 13 years, the plots that received cattle slurry and VFG-compost produced the highest yields. Further, the yields of the plots that received either cattle slurry or compost were comparable. This led us to conclude that cattle slurry and annual compost application have more or less the same effect on maize yields over the long term.

VFG compost has an advantage over cattle slurry. A yearly amendment of cattle slurry does not maintain the OM content of the soil. But repeated VFG-compost application increases the soil organic carbon content of the soil by 0.02 percent per year. This is not surprising, given that compost contains much more organic



matter than cattle slurry. Furthermore, compost amendment substantially enhanced the earthworm population, whereas cattle slurry had only a minor effect on the earthworm abundance. Since earthworms play an important role in soil formation and in maintaining soil aeration and drainage, they are considered as one of the best available biological indicators of soil quality.

An annual high rate VFG-compost application not only ensures guaranteed crop yields but leads to better soil quality over the long term. Due to recent legislative restrictions and the movement toward sustainability, modern agricultural farming systems are confronted with a reduced input of mineral fertilisers. This implies a greater reliance on the self-regulating processes of the soil such as supply of nutrients, water regulation and disease suppressiveness. As soil is greatly affected by many agricultural management practices, sustainable land management is needed to build high-quality soils. This research has shown that the repeated application of VFG-compost can help farmers to maintain or increase the quality of their soils while ensuring stable crop yields.

Contact: Tommy D'Hose

Financing: Vlaco vzw.

Collaboration: Plant Production group (Ghent University, Dirk Reheul & Mathias Cougnon), ILVO



Step by step decoding of the azalea

In 2010, the Ghent Azalea was officially granted the European label of Protected Geographical Indication. The azalea, pride of the ornamental sector in East Flanders, was the first non-edible crop to receive this label. Only plants that comply with well-described quality standards and are both grown and forced in East Flanders can be commercialised as Ghent Azaleas.

In the PhD thesis 'Integration of phenotype, genotype and gene expression to unravel flower colour biosynthesis and complex plant quality traits in azalea', four unique and promising genetic maps were constructed. The molecular markers (DNA fragments) on these maps can be used to predict certain plant traits. This research revealed putative positions on the genome for important breeding traits such as colour, growth vigour and leaf morphology. This fundamental research will soon become applicable for faster and more accurate breeding.

Improving azaleas is a very slow and time-consuming process. On average, it takes 15 years before a cross can be introduced to the market as a novelty. It takes three years from the crossing until the first flower can be evaluated. This first selection is mainly for flower characteristics, whereas other plant quality traits can only be evaluated in a later stage. In this way, plants with attractive flowers but bad plant quality traits are often kept too long in the breeding cycle, only to be removed after several years.

Little is known about the inheritance of the majority of these plant characteristics in azalea. This research started from the well-studied flower colour biosynthesis, which served as a model for genetical genomics in azalea. In this approach, phenotypic (scorable) and genotypic (DNA related) data are combined with gene expression profiles of candidate genes on a genetic map to decipher the regulation of the traits under study. When phenotypic features are co-localised with candidate genes on the map, these genes (or their transcription factors) might influence the creation of the phenotypic variation. This model can in the future be implemented for other plant quality traits as well.

To determine the genes underlying a phenotypic feature, Quantitative Trait Locus (QTL) mapping is now commonly used. 'QTL' refers to the position where the triggering gene is located. QTL analysis has partially revealed the process of flower colour biosynthesis in azalea. However, for more complex features such as leaf morphology and plant architecture, no candidate genes are available yet. In this project, leaf morphology and plant architecture were scored in four populations (independent crosses of two non-related parents) and image analysis was used to the extent possible to provide data for QTL analysis. The focus was mainly on 'strong' QTLs, since these indicate the genes that can be used for breeding purposes. In the near future, candidate genes for these traits will become available for a more thorough study. This fundamental research can lead to improvements in the breeding cycle by means of a direct selection of the seedlings.

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During this PhD research project, 1500 plants were analysed using 1250 markers generated over a two-year period. The gene expression technique optimised during the study will also be implemented in the project on flowering regulation and quality in azalea (a collaboration between ILVO, Ornamental Research Station and Ghent University during 2008-2012). This project studies the genes that are switched on during the flowering process to understand what goes wrong with badly flowering plants.

Contact: Ellen De Keyser

Financing: Agency for Innovation by Science and Technology (VIS-CO 30907) and Azalea Innovation Fund

Collaboration: Research Centre for Ornamental Plants (Destelbergen), ILVO



seedbox of azalea

New variation in *Begonia* via unreduced gametes

Polyploidisation of plants is one of the fields in plant breeding. The term ploidy refers to the number of basic chromosome sets present in a specific plant genus. Up till now, the ploidy level has mainly been doubled by use of cell cycle disruptors such as colchicin, oryzalin and trifluralin. This process is better known as mitotic polyploidisation. Such manipulation sometimes results in plants with larger flowers, thicker leaves, changes in growth vigour, higher vegetative yields, more compact plants, higher stress tolerance, etc. It can also be used to restore the fertility in hybrids obtained from parent plants with differences in ploidy level.

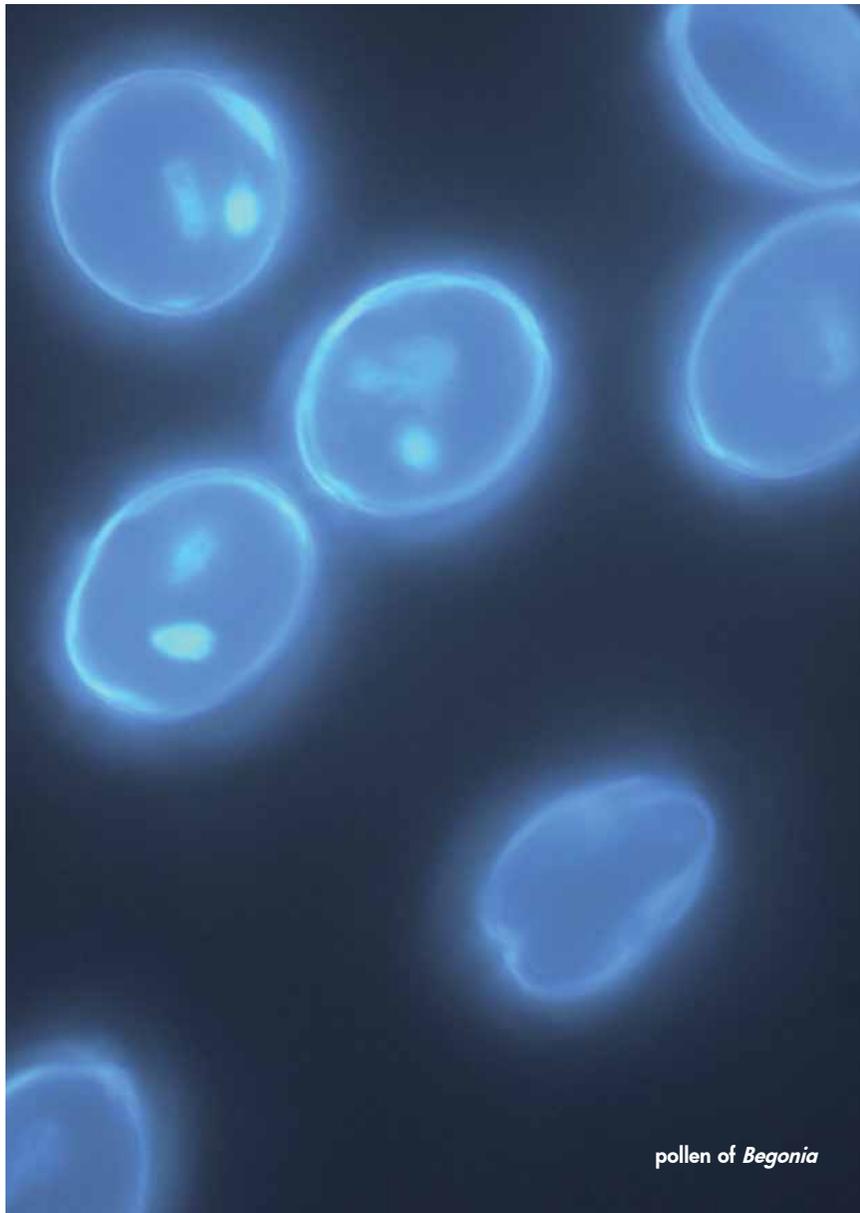
Meiotic polyploidisation refers to increasing ploidy level via use of $2n$ gametes (also known as diplogametes or unreduced gametes). Meiotic polyploidisation would result in a larger genetic variation within the progeny. Despite this advantage, this use of $2n$ gametes is less exploited within plant breeding than mitotic polyploidisation. In this work, the potential use of $2n$ gametes within ornamental breeding was investigated using *Begonia* as a model plant. We evaluated mostly $2n$ pollen instead of egg cells, as pollen is easier to isolate.

A large variation in chromosome numbers in *Begonia* species has been reported. Consequently, this genus has no readily discernable general basic chromosome number. *Begonia* chromosomes are also very small and difficult to count. As a possible alternative to chromosome counting, we performed flow cytometric genome size measurements. The results showed that a huge variation in chromosome number and mean chromosome size exists among the different *Begonia* species and cultivars. Genome size could not be correlated to chromosome numbers. In contrast, a positive correlation between pollen size and genome size was observed.

To use $2n$ gametes in an efficient way, a reliable screening method is necessary. Four main techniques are available: pollen size measurements, flow cytometric screening of pollen DNA content, evaluation of microsporogenesis and ploidy level analysis of the progeny. A flow cytometric protocol to analyse pollen

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pollen of *Begonia*

DNA content was established on germinated and non-germinated pollen. That technique was used, together with the abovementioned methods, to determine the frequency of $2n$ pollen within a *Begonia* collection. In this way, $2n$ pollen could be detected in 11 of the 71 genotypes screened. The frequency of $2n$ pollen production varied dependent on the method used.

A detailed cytological analysis of meiosis in five of the 11 $2n$ pollen producers showed that First Division Restitution (FDR) was the main mechanism behind $2n$ pollen production.

The major drawback to using $2n$ gametes in a breeding programme is that only a minority of the plants produce these gametes. Even if they are present, their frequency is usually too low to be of practical use. We therefore tested different techniques to induce $2n$ pollen production or raise their frequency, e.g., interspecific hybridisation, temperature stress, flow cytometric sorting of pollen and treatments with N_2O or cell cycle disruptors (such as trifluralin). The use of N_2O treatments resulted in $2n$ pollen able to germinate, but the effect was genotype dependent. Furthermore, by using this technique, male sterile plants could produce viable $2n$ pollen. The use of trifluralin mainly resulted in $4n$ pollen with a rather poor germination capacity. The other techniques showed no or barely any influence on $2n$ pollen production, although variation in temperature conditions had an influence on the frequency of $2n$ pollen production.

The results show $2n$ gametes to be an important tool for ploidy breeding. But use of $2n$ gametes in breeding programmes depends highly on finding an efficient way to artificially induce them. One particular challenge for the future is the potential to create mutants that produce high levels of $2n$ pollen. Meiotic polyploidisation should also be exploited further. The techniques developed at ILVO are now available to *Begonia* breeders, but they can also be applied for breeding other (ornamental) crops.

Contact: Johan Van Huylenbroeck
Financing: ILVO PhD scholarship

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Twenty years of industrial chicory breeding

Flanders has a tradition of cultivating chicory. Chicory used to be popular as a coffee substitute. The roots were dried in the oast (a kind of kiln), roasted and ground. Chicory is no longer used in this way, but chicory roots have regained popularity due to their inulin content. Inulin, a storage carbohydrate, is a chain of fructose molecules ending in a glucose molecule. In the 1980s, the Hainault group Warcoing SA started to produce fructose and inulin from chicory root. They were later followed by the Tiense Suiker group. Between 1990 and 2000, the chicory acreage in Belgium increased tenfold from 1500 to 15

000 ha. But in 2005, Belgium decided to stop the production of fructose from chicory because the European Union imposed a decrease of European sugar production. The chicory acreage was halved in 2006 and slightly recovered to the present 9 000 ha.

Inulin behaves like a soluble dietary fiber. The long inulin chains have a neutral taste. Inulin is not digested in the stomach but is rather fermented in the colon, which makes it low caloric. Moreover, it has a prebiotic action. In the colon it is an excellent substrate for the development of the beneficial bacteria *Lactobacillus* and *Bifidus*. Inulin also promotes the absorption of calcium. Adding water to inulin results in a structure that can be used as a fat replacer as it has the same mouthfeel and texture as fat. Besides long inulin chains, short chains occur (oligofructose). The shorter the chain, the sweeter the taste and the higher the caloric content. Inulin is also used as an ingredient in bakery and dairy products.

In the beginning of the 1990s ILVO transformed its moribund coffee chicory breeding programme into a full industrial chicory breeding programme. Since 1999, ILVO cooperates with Chicoline (Cosucra Groupe Warcoing SA) for the development of new varieties of industrial chicory with a high inulin yield per ha and a good inulin quality. The inulin yield is the result of the fresh root yield and the inulin content. The main quality parameter is the inulin chain length. The inulin chains in the chicory root are the longest at an early harvest from mid-September to mid-October. At later harvest dates, the cold weather induces the chains to break down. For a satisfactory root yield at an early harvest time, early sowing is needed to result in a sufficiently long growing season. Early sowing enhances the risk of bolting by spring cold without root development. Therefore, ILVO breeds for genotypes with a good bolting resistance and early vigour. Leaf health and persistence are also important. The desired root shape is ovoid, with low tare so that the roots may be easily lifted.

A persevered recurrent selection for bolting resistance at extremely early sowing (February) resulted in a gene pool with very low bolting tendency. This pool generated cultivars that can be sown from the beginning of April with almost no risk of bolting. Because of the good heritability of the inulin content and systematic selection (thanks to a fast screening method using a refractometer) we now have

a gene pool with a high inulin content. After the fructose production from chicory was stopped, the inulin chain length has become a very important selection criterion. Applying cold stress to the chicory roots before analysis allowed a sharp selection for the degree of polymerisation and resulted in cultivars with 10% longer inulin chains. At the same time, the presence of free sugars (glucose, fructose and sucrose) could be suppressed. This trait is desirable because the free sugars obstruct the purification of the inulin during the industrial process.

The current ILVO cultivars are synthetic varieties composed of 4 to 10 mother clones that are carefully selected for their root shape, health, bolting resistance, inulin content, quality and general combining ability. Inulin content and root yield are often negatively correlated. Because of this and of the low heritability of the root yield, the progress in yield improvement has been slow. The development of hybrid cultivars may lead to a significant increase of the root yield. Trials with hybrids, obtained after manual crosses between chicory inbred lines, show a clear progress in yield because of heterosis. Large-scale production of 100% hybrid seed from parental lines requires a line with cytoplasmic male sterility. Using asymmetric protoplast fusion within the *Cichorium* genus, we attempt to create this. Thanks to the improved bolting resistance early sowing is possible. However, growth during a cold springtime is disappointing. Therefore, we developed a screening method based on chlorophyll fluorescence to improve early growth at low temperatures.

During the past 20 years, about 20 cultivars from the ILVO breeding programme and the cooperation with Chicoline have been admitted to variety lists in Belgium, the Netherlands or France. In 2010, more than 6000 ha of the varieties 'Hera', 'Melci', 'Crescendo', 'Belcanto' and 'Echo' were cultivated. A new generation of high yielding, bolting resistant and high quality cultivars ('Canzona', 'Cadence', 'Diesis' and 'Dolce') is now ready to meet the needs of the farmer and the industry

Contact: Joost Baert
Collaboration: Cosucra Groupe Warcoing SA

Biodiversity of Flemish Vegetables

2010 was the International year of Biodiversity. ILVO's Plant Sciences Unit has a large gene bank that includes genetic resources of many agricultural and horticultural species. These accessions represent a large genetic diversity that is used in research projects such as the study of compounds in leek or of disease resistance, but also used in breeding programmes for new varieties. The collection also contains seeds of diverse origin of certain Flemish vegetables such as celery, leek and parsley.

ILVO, in its role as a governmental institute, takes responsibility to collect and conserve the genetic resources of plants threatened with extinction. These seeds are conserved in accordance with international standards for good conservation techniques and a correct description (minimum passport data). The ILVO collection contains seeds of diverse origin of cauliflower (Mechelse Vroege Bloemkool), autumn and winter leek, green and white celery and celeriac.

In 2010, ILVO researchers collaborated on the creation of a regional legislation to derogate from the commercialisation rules and conservation of varieties threatened with genetic erosion. This work, done in collaboration with the Flemish Agency of Agriculture and Fisheries, concerned the translation of the EU directives 2009/145/EU and 2010/60/EU on vegetables and fodder crops, respectively. The purpose is to stimulate the use and conservation of landraces and amateur races 'in situ', which will maintain a high level of genetic diversity in these crops. A separate variety list for these varieties is also provided in the proposed legislation, together with the maximum hectares of cultivation per variety and the maximum weight of seeds per package commercialised.

ILVO also participates in an ADLO (Flemish Government) project during 2010-2011 entitled 'Genetic diversity in vegetables in action'. Seeds are a very



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important production factor in agriculture. Until some decades ago, seed production of many crops took place on farm. Farmers selected the seed plants and thus created the varieties that gave good results on that farm.

Today, most of these landraces are lost and replaced by commercial available cultivars. That's a pity because the farmer's selections are a rich source of genetic diversity and carry with them the creativity of many generations. To stop this genetic erosion, the Flemish Government supports this ADLO project to promote the farm seed production of certain crops. The activities of the project are focused toward professional agriculture and are done in collaboration with farmers that still maintain their own landraces, e.g., selections of Brussels endive for ground culture, selections of leek, celery or cauliflower.

The first function of this project is to highlight the exemplary function of these farmers who are devoted to landraces during so many years and give them the recognition that they deserve. Second, this project aims to spread the landraces and the knowledge of how to maintain them to younger farmers interested in growing plants for seed. The continued existence of a landrace depends not only on the seeds themselves, but also the knowledge of selection criteria and the expertise on selection, multiplying and conservation of seeds.

For this project regional demonstration fields were organized for leek at ILVO, for cauliflower at PCBT and for Brussels endive at Herent. Leek as a vegetable shows high diversity in leaf color, plant length, thickness of stem, erectness and the width of the leaf blade. According to these characteristics leek is classified in types, such as Bulgarian Giant (very long, thin stem and very pale leaves), Summer Giant, Autumn Giant (very thick and long stem), Blue green autumn and winter leek (short stem, dark green or blue green leaves). Thanks to this diversity, leek is available fresh during all seasons of the year. Early types grow faster, while late types are growing slower and persist in the cold winter climate, and some regrow after the winter. Other qualities are evaluated once the leek is harvested. Here, we see that modern varieties score often better than old ones for the current culture and have high scores for disease tolerance, uniformity and presentation.

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Financing: ADLO (Flemish Government)
Collaboration: Ghent University, PCBT, Nat. Proeftuin Witloof, ILVO



genetic biodiversity in horticultural species

Better quality grass/clover fodder

Both the dairy farmer and the government are asking for fodder with a better intrinsic quality and/or more sustainable production. Some of the particular traits desired are nitrogen efficiency in cattle and fatty acid composition of forages.

Grasses (when intensively exploited) and clovers are protein-rich crops. Only about one quarter of this protein, however, is used by the cow. Much of the protein is degraded in the rumen. The micro-organisms of the rumen can again use this degraded protein, provided they have sufficient energy. The nitrogen efficiency can be improved by increasing either the energy supply either the protein stability (rumen escape protein).

Due to oxidation during wilting, lipolysis during ensiling and biohydrogenation in the rumen of ruminants, only a fraction of the poly-unsaturated fatty acids of the fodder ends up in milk and meat. There is thus a need to increase and/or protect the poly-unsaturated fatty acids in the fodder. Red clover is suspected to

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have a protective effect against fat breakdown during ensiling and possibly in the rumen. This could be due to the high content of polyphenols and polyphenol oxidase (PPO).

In this project, entitled 'Improving the quality of grass-clover mixtures for forage production', screening methods were developed for large-scale evaluation of protein stability and fatty acid composition of grasses and clovers. With these screening methods were the variation and the heritability of the two traits studied. In addition, the impact of wilting and ensiling on the fatty acid composition of grass/clover mixtures were investigated.

Simple methods with acceptable accuracy were developed to estimate protein stability and fatty acid composition of grasses and clovers. For both traits, we used near infrared reflectance spectroscopy (NIRS) on dried and ground samples. Variation for both parameters was found in most grasses and clovers (timothy, Italian and perennial ryegrass, tall fescue, orchard grass, meadow fescue, and red and white clover). Positive and negative selections were performed between individual plants. The results of their offspring suggested a good heritability of both properties. Given the negative correlation between the protein stability and its intestinal digestibility, breeding for an optimal nitrogen efficiency is not easy.

Laboratory silage experiments have shown that both the species and the cut affect the fatty acid content and composition as well as the lipid metabolism. Average lipolysis was lower in red and white clover than in ryegrass. Wilting to a higher dry matter content of silage decreased the unsaturated fatty acid content. This seemed more related to the wilting duration than to the dry matter content achieved. Lipolysis in the silage was clearly influenced by the degree of fermentation in the silage. The bound phenols had an inhibitory effect on lipase activity and the damaging of red clover (activation of the PPO) reduced the lipase activity measured. Incubations in rumen fluid suggested that the fat in red clover silage was protected, but this was not confirmed by a higher concentration of protein bound phenols in damaged red clover. One explanation is that biohydrogenation - contrary to expectations and earlier findings - was reduced by the ensiling itself. No explanation could be found for the lower lipolysis in white clover.

It seems possible to select for better protein stability and linolenic acid content in grass and clover. The developed screening methods are reliable, variation exists, and the characteristics are moderately to highly heritable. A short field period and a reduced fermentation can reduce the fat degradation in the forage. There are indications that this degradation in clover silage is usually more limited than in ryegrass silage. It is clear that bound phenols can inactivate enzymes and damaging of red clover can strengthen this process. The effect of PPO on the protection of fats in the rumen is not yet clear.

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Financing: Agency for Innovation by Science and Technology

Collaboration: Ghent University-Lanupro, ILVO



evaluation of individual grass/clover plants on the fatty acid composition

From Field to Fork

The Technology and Food Science Unit

Agricultural Technology and Safer Food

The Technology and Food Science Unit (T&F) comprises three research areas: 'Agricultural Engineering', 'Food Safety', and 'Product Quality and Innovation'. This unit also provides many services which are managed by a separate Business Unit and Service Centre.

The Agricultural Engineering research group combines traditional technical expertise with modern mathematical and IT-based methods. These innovative agricultural production systems are environmentally friendly and add value for industry and society because they are good for plants, animals and humans. For example, Agricultural Engineering develops new methods to measure dust and gas emissions from agriculture and horticulture, and invents new technology that automatically analyses animal parameters such as lameness or weaning dimensions. This group also works on mechanisation, technology for agricultural harvest and post-harvest technology, and specialised applications for spray technology.

The Food Safety research group studies the chemical and microbiological safety and quality of foods of animal and plant origin. They study pathogens, spoilage organisms, molecular techniques, risk assessment, contamination sources, detection methods for contaminants and veterinary drug residues, new screening methods, development of chromatographic confirmation methods, and procedures to detect mycotoxins.

The Product Quality and Innovation research group works on GMOs and allergens as well as improving the functional quality and valorisation of foodstuffs. This research group is also working on a production platform for recombinant proteins. These researchers are experts on the quality of milk and dairy products and quality assessment in terms of origin, variety and processing of vegetable products. They are now building expertise in meat products and ready-to-eat meals.

The Technology and Food Science Unit also offers several services. Food authenticity and food safety testing (including GMO analysis) is performed in accredited laboratories. ILVO is the national reference laboratory for milk and milk products, allergens and GMOs. T&F also performs reference tasks for the Milk Control Flanders (MCC) and determines water content in poultry meat. This unit provides monitoring and accreditation services in the accredited Spray Tech Lab and the related inspection service for sprayers, along with a monitoring service to approve milk cooling tanks and milk technicians. A team from T&F also measures emissions from stables. There is advice available on new practices and technologies on dairy farms, (farm) dairy producers (the 'Dairy TAD') and small to medium enterprises. The Technology and Food Science Unit also advises the government on food safety, quality and authenticity (including GMOs), and Flemish recognition of the food quality rules.

The newly renovated and expanded Food Pilot food processing plant enables industry and research institutes to test new food and feed processing techniques. At the Food Pilot plant, companies can perform small-scale testing with custom-made devices and new materials.

Ground-breaking new research: GMO co-existence and more

In 2010, the Technology and Food Science Unit received a substantial new source of funding. Together with Ghent University and other ILVO units, T&F received a grant from EFSA (European Food Safety Authority) to research the inclusion of coccidiostats in vegetables. Several new projects were also funded by IWT-SME (Flemish Society for the Promotion of Innovation in Science). Among these are projects to develop a new method of preparing a stable emulsion for use in food, and prototypes for new harvesting techniques and mechanical weed control in small fruits.

ILVO is also breaking new ground in the field of GMOs. In the spring of 2010, ILVO sowed the first European commercially available GMO maize (MON810) in an experimental field. The aim was to examine whether the proposed Flemish co-existence rules held up in actual field conditions. The GMO maize was sown surrounded by conventional corn with a very similar genetic background and synchronous flowering. On the basis of extensive sampling in both maize varieties, T&F determined whether the GMO maize had spread to the surrounding corn. The processes of sowing, harvesting, transport, etc. were also examined for possible inadvertent distribution of the GMO maize. The results (available in March 2011) are relevant to monitoring needs and concerns about possible contamination. These results will also enable the development of practical and economically feasible scenarios for sampling and analysis.

Relevant results in food and feed: animal-human transfers, allergen testing, and more

To examine food quality and the presence of pathogens and residues in food and feed, one needs to know the most appropriate methods. Sometimes these methods even need to be developed and evaluated (validated) before the food can be tested accurately. Then the right foodstuffs need to be chosen and only then can they be tested. In 2010, the Food Safety research area presented very relevant results in a broad range of food and feed testing.

This group has made an important discovery about the transfer of antibiotic resistance from poultry to humans. This research proved that an ESBL-producing *E. coli* strain (with antibiotic resistance) from poultry meat does colonize in a simulated human gut, and further, that the ESBL-resistance gene transfers to the gut flora present. In other research, the spore-forming bacterium *Bacillus cereus* present in animal feed was shown to be present in more than half of 575 human food samples. T&F researchers proved this to be linked to inadequate cooling

of the feed. In milk research, T&F researchers found a cold-loving bacteria that interferes with testing for antibiotics in milk. This was accomplished during the validation process of testing for antibiotic residues in raw milk.

In allergen testing, research revealed dubious performance of two tests for the detection of hazelnut and soybean allergens. These commercial methods for detecting allergens in both unprocessed raw materials and finished products (cookies) were found to be not entirely reliable.

Computer discs and rotor harrows: farming meets technology

As of 2010, the Agricultural Engineering research is now listed on the AGR-ICT (Information and Technology in Agriculture) ERA-net (European Research Area) European website. The aim of this project is to better organise existing and future European research to make it more responsive to the ever-changing needs of the farmer. T&F was commissioned to research the existing ICT and robotics in agricultural research on mapping this for Belgium. The first inventory was published in the book entitled 'ICT-AGRI Country Report: Report of Organization or Research Programmes and Research Institutes in 15 European Countries.' The book will become available as a free download from www.ict-agri.eu. This instrument will assist the formation of European research consortia, who will better coordinate their research. Finding partners with similar and/or complementary competences will become easier thanks to this website.

ILVO has continued its tradition of offering demonstration days in 2010. On September 9, 2010, ILVO organised the demonstration day 'Seedbed after Plowing' in collaboration with ADLO, Fedagrim, the KBIVB and IWD. Eleven companies from across Europe demonstrated 18 machines ranging from a simple chisel plough, rotary tiller or disk harrow to real seedbed combinations with different teeth and roles. Despite the pouring rain, the demonstrations in Merelbeke were a success.

Knights in White Lab Coats

Research on Food Safety

Measuring spoilage in fish and fishery products

Current standard methods are limited in the analysis of spoilage microorganisms of fish and fishery products. ILVO's Technology and Food Science Unit has concluded that it is not possible to detect several microorganisms capable of inducing spoilage on plate count agar, the reference growth medium for total viable count analysis of fish and fishery products. Therefore, we recommend using a combination of this medium with a general salt-containing medium or with selective media specific for the spoilage microorganisms if those are known. The identification and characterisation of the specific spoilage organisms of seafood is necessary to determine the remaining shelf life. Once the spoilage potential of those microorganisms is known, it might be possible to make suggestions to the seafood industry to exclude the source or to minimise the growth of those spoilage microorganisms in order to extend the shelf life of the product.

Spoilage of fish is mainly due to bacterial growth and the formation of metabolites. It is therefore important to determine the (microbial) cause of the rapid fish spoilage. In general, the microbiological quality of fish and fishery products is determined by a total viable count analysis. However, not all microorganisms present on fish are capable of interacting in the spoilage process. Only the specific spoilage organisms (SSOs) cause spoilage and those are often seafood specific. These microorganisms are able to grow during cooled (iced) storage and cause off-flavors and taste. By understanding the nature of the SSOs, predictions of the shelf life might be more accurate. In the end, it may be possible to suggest ways to eliminate the source or reduce the occurrence of SSOs during processing. To date, the SSOs of only a few commercial fish species such as salmon, halibut and cod have been studied. ILVO researchers are now working to identify the SSOs of important commercial fish species and crustaceans for the Belgian market such as ray (*Raja* sp.) and common shrimp (*Crangon crangon*) in order to improve the shelf life, quality and safety of these seafood products.

The aim of this project is to optimise several techniques necessary for the isolation and characterisation of the microbiota on seafood when it is freshly caught, during processing and on the shelf. Conventional techniques such as total viable

count analysis and biochemical tests, as well as molecular techniques (PCR, sequencing analysis, DGGE, GC/MS and SIFT/MS) will be investigated. The same techniques are also implemented to identify and characterise the SSOs of ray and common shrimp. Based on this knowledge, measurements to reduce spoilage and to improve shelf life, quality and safety of fish and fishery products can be suggested.

Plate count agar, the reference medium suggested by the ISO (International Organization of Standardization), is limited in the analysis of the microbiological quality of seafood. Several dominant microorganisms capable of inducing spoilage are unable to be detected on this general growth medium. General media with extra salts and minerals such as marine agar or Long and Hammer medium are necessary to isolate these microorganisms. Although the use of these media gives a better overview of the total microbiota on seafood, freshly caught as well as at the end of shelf life, DGGE (denaturing gradient gel electrophoresis) analyses have shown that many dominant microorganisms are still undetectable by conventional plating techniques.

ILVO researchers have identified the dominant microorganisms of ray and common shrimp, both freshly caught and at the end of their shelf life. The results show that the microbiota at the end of the shelf life of these seafood products is mainly dominated by only a few genera such as *Pseudoalteromonas*, *Pseudomonas* and *Psychrobacter*. GC/MS and SIFT/MS analyses, carried out in cooperation with Ghent University's Lab of Food Microbiology and Food Preservation, showed that only a few of these isolated strains were able to cause off-flavors and sensory deviations and can therefore be called specific spoilage organisms.



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***Bacillus cereus* strains (too) often present in food products?**

Bacillus cereus is a sporeforming micro-organism that occurs frequently in our environment and in our food. When too many of these bacteria are present in food, they can cause mild food poisoning that is usually limited to diarrhea and vomiting. In some rare cases, however, *B. cereus* has caused liver damage or even death. Some strains of this bacterium are psychrotolerant, meaning that they can grow at low temperatures such as those used to store dairy products and ready-to-eat meals. In 2010, ILVO collaborated with the Food Safety and Food Quality Department of Ghent University to investigate the prevalence and characteristics of *B. cereus* in food products. Preliminary results show that some products may require more stringent minimal processing conditions to guarantee the production of safe food products with a long shelf life. Further research is necessary to investigate this in detail.

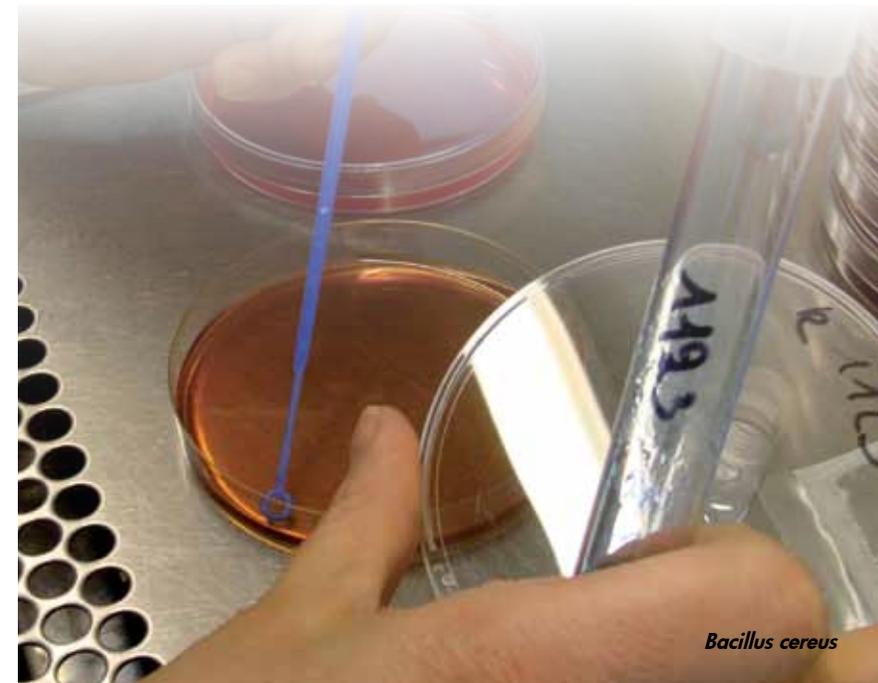
B. cereus is frequently found in ingredients or food products that are heated during the production process. Spores of this bacterium can survive pasteurisation and are even triggered by the pasteurisation process for germination to vegetative cells. This gives them a selective advantage over the non-sporeforming heat-sensitive microbiota. High spore levels of *B. cereus* present a risk for food spoilage and food poisoning.

In a Flanders' Food project performed at ILVO, the presence of *B. cereus* was investigated in ready-to-eat food products or ingredients thereof after semi-selective enrichment and plating on a selective medium in order to detect low contamination levels directly after processing. During the cooled storage of these food products, these low numbers of psychrotolerant *B. cereus* would be able to grow out to more risky numbers. *B. cereus* was found in slightly more than half of the 575 analysed samples. The bacterium was most present in samples of raw basmati rice and some ready-to-eat food products (béchamel and bolognaise sauce and lasagna) and somewhat less in samples of cooked pasta, fresh minced beef and vegetables (carrots, celery, paprika and Chinese cabbage). Only a small fraction (2.6%) of the isolates was psychrotolerant (growth at $< 7^{\circ}\text{C}$), but a large portion of the isolates was able to grow at temperatures corresponding to a small temperature deviation during cooled storage (e.g., 88% of the isolates grew at 10°C). For about half of the investigated isolates, all genes for the production of diarrheal toxins were present. Nevertheless, this is not yet proof that

these toxins are actually produced. The gene associated with the toxin causing vomiting was not found in any investigated isolate.

This study has shown that *B. cereus* occurs frequently in different types of food products. Further data on spore or germ levels in positively tested food products are absolutely necessary in order to make an adequate risk evaluation for producer and consumer. The producer should also take account of the high ecological diversity of *B. cereus* observed in the analysed food products. This is illustrated by the observation that a large difference in heat resistance of the spores was found for some selected isolates.

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Knights in White Lab Coats

Research on Food Safety

Transfer of Antibiotic Resistance From Poultry to Humans

Could people acquire the antibiotic resistance called ESBL after consuming contaminated chicken? The answer is yes, according to an ILVO experiment that used a simulation of part of the human intestinal tract. This finding needs to be investigated in more detail to assess the real risk for the consumer. More information will be necessary to calculate the number of ESBL-producing *E. coli* arriving in the human gut after consuming chicken meat.

The bacterial enzymes called ESBLs (extended spectrum β -lactamases) provide resistance to most of the β -lactam antibiotics, which are the most important group of antibiotics in both veterinary and human medicine. β -lactam antibiotics include penicillins (e.g., ampicillin, (benzyl)penicillin), cephalosporins (e.g., ceftiofur, cefotaxim) and monobactams (e.g., aztreonam). Resistance to these β -lactam antibiotics has been increasing for bacteria of both animal and human origin. This presents a great risk to human and animal health. For this reason, there is great concern that the wide spread usage of antibiotics in animal production, such as the 1st to 4th generation cephalosporins, is creating a reservoir for resistant bacteria and resistance genes.

Two theoretical scenarios exist for resistance transfer from animals to humans. First, gut bacteria that have become resistant due to production of ESBL, such as certain strains of *E. coli* and *Salmonella*, could be transmitted to humans directly through food or contact with animals. The other possibility is that the resistance gene can be transferred indirectly to humans. In this case, the gene encoding for a certain type of ESBL-resistance is transmitted from one bacterium to another bacterium by means of different genetic mechanisms, such as transfer via plasmids carrying an ESBL-gene.

ILVO has investigated the second form of transmission. Researchers constructed an in vitro model of the human gut in the form of a continuous anaerobic fermentor. An ESBL-producing *E. coli* bacterium (i.e., an *E. coli* with a bla_{TEM-52} carrying plasmid) originating from broilers was added to this simulation system at different time points. A lactose-negative mutant was constructed on the basis of this donor strain in order to be able to differentiate it on a bacteriological level

from both the normal human fecal *E. coli* from the volunteer as well as from the transconjugant *E. coli*. The latter are the human fecal *E. coli* which have acquired an ESBL-resistance from transfer (through conjugation) of a plasmid derived from the donor strain of chickens.

Two important events were observed: the donor strain from chickens was able to maintain itself well in the simulation, even without selective antibiotic pressure. And, already 24 hours after administration of the donor, human transconjugants were observed. Depending on the experiment, one human transconjugant was formed per 1000 up to 100.000 human *E. coli* bacteria. When the antibiotic cefotaxim was administered to the simulation during a few days, a considerable increase in colony forming units of both the donor strain and the transconjugants was observed.

The simulation has shown that the possibility exists that an external ESBL-producing *E. coli* strain from chicken meat colonises the simulated human gut. Furthermore, the ESBL-resistance gene is transferred to the human gut microbiota at a certain frequency. Currently, the risk of consumer exposure to ESBL-producing *E. coli* is not insignificant; for example, ceftiofur resistant *E. coli* already occurs very frequently in poultry.

Contact: Marc Heyndrickx

Collaboration: Faculty of Veterinary Medicine (Ghent University), CODA (Centre for Research in Veterinary Medicine and Agrochemistry), ILVO



Innovative feed additives to reduce *Salmonella* excretion by pigs

In 2010, the first part of the Flanders' Food project concerning the reduction of *Salmonella* excretion by pigs was conducted. Three of the six tested feed additives showed promising results. In 2011, these products will be further tested at farm level. The ultimate goal is to reduce *Salmonella* in the pork supply chain from farm to distribution level.

Salmonella, particularly *Salmonella* Typhimurium, is often detected on pork in Belgium. According a EU baseline study, this serotype was found on 7.8% of Belgian pigs at slaughter age and on 10.9% of the carcasses. As most other member states have better results, these results may have implications on the export of pork to these member states, not to mention the impact on Belgian public health.

In this project, we study control measures in the primary production to reduce *Salmonella* in the pig industry. Feed additives based on organic acids and essential oils may help reduce the pigs' *Salmonella* excretion in two ways. First, they may prevent the spreading of *Salmonella* in the pen, as *Salmonella* is transferred from one animal to the other directly or indirectly via the orofaecal route. Second, they may reduce the number of *Salmonella* excreting animals transported to the slaughterhouse, which would decrease the risk of carcass contamination.

The feed additives were studied in a challenge test. Six additives were added to the basic feed then tested on weaned pigs that had been experimentally infected with a well-characterised *Salmonella* Typhimurium strain. For four weeks, the effect of the feed additives was evaluated via bacteriological, serological and zootechnical parameters and compared to positive control animals (infected pigs on the basic feed without feed additives) and to negative control animals (non-infected pigs on the basic feed without feed additives).

None of the six tested feed additives showed optimal results both on *Salmonella* excretion and serological and zootechnical parameters. When evaluating the results of *Salmonella* excretion during the test and the number of *Salmonella* bacteria in the ileum, the cecum, the tonsils and the ileocaecal lymph nodes after slaughtering, three promising feed additives were selected. These three additives will now be tested on farm level. The effect on the *Salmonella* excretion by the pigs on farm level and the contamination of the carcasses in the slaughterhouse will be studied.

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reduction of *Salmonella* in pigs

Knights in White Lab Coats

Research on Food Safety

Inhibitory effects by *Pseudomonas* spp. in raw milk on microbiological inhibitor assays for the detection of antibiotic residues

An ILVO researcher was the first to make the remarkable discovery of bacterial inhibitors in antibiotic-free raw milk produced by cold-loving *Pseudomonas* bacteria. These bacteria appear to be responsible for false positive test results when testing milk for the presence of antibiotics by bacterial inhibitor tests.

As part of a regulatory milk quality programme, ILVO's Technology and Food Science Unit was called in to investigate two farms whose milk tested low positive for antibiotic residues. The farmers had never given antibiotics or chemotherapeutics to the cows, as later proven through lab analysis, yet their milk tested positive. Two *Pseudomonas* strains, identified as closely related to *Pseudomonas tolaasii*, were isolated from milk of a farm that frequently tested false positive on Delvotest. The isolates showed growth at 5 to 7°C in raw milk. The result was a high lipolysis and the production of bacterial inhibitors. These bacterial inhibitors, with a molecular weight of < 1 kDa, were revealed to be heat-tolerant and inhibitory to *Geobacillus stearothermophilus* var. *calidolactis*, the test strain used in most of the commercially available microbiological inhibitor tests for milk. The bacterial inhibitors also showed antimicrobial activity against other Gram-positives and interfered in yoghurt production.

The bacterial inhibitors themselves have not yet been identified. Characterisation assays ruled out the theory

that the inhibition was caused by the elevated level of free fatty acids. Instead, they point in the direction of cyclic lipodepsipeptides, which are toxins with antimicrobial properties.

Our findings indicate that extended refrigerated storage of raw milk - milk is kept up to three days at the dairy farm – not only can induce later spoilage of the milk destined for consumption, but can also result in false-positive microbial inhibitor test results.

Contact: Wim Reybroeck

References: Reybroeck, W. (2010) Screening for residues of antibiotics and chemotherapeutics in milk and honey. Ph. D. Thesis, Faculty of Veterinary Medicine, Ghent University, 295 p



Maize silage: how to identify and detect moulds and their mycotoxins

ILVO has developed fast and reliable methods to detect and identify moulds and mycotoxins in maize silage. Maize silage can now be screened for more than 20 different mycotoxins at the same time.

Moulds in maize silage can imply several risks. The general quality of the feed decreases in terms of taste, odour, and/or colour. More importantly, moulds are able to produce secondary metabolites or mycotoxins that negatively influence animal health, animal welfare and animal production. Some mycotoxins can be carried over into animal-derived products. The risk thus exists that consumers could be infected by consuming milk, eggs or meat from animals fed contaminated maize silage. Mould growth can occur on the crop (preharvest) or after harvest (postharvest), e.g., after exposing the maize silo to air.

The first task of this project was to develop detection and identification methods for moulds in maize silage. We began by searching for a suitable growth medium to isolate, detect and count moulds in silage. Dichloran rose-bengal chloramphenicol (DRBC) agar proved to be the most suitable. This isolation technique was combined with microscopical and molecular identification of the moulds isolated. *Penicillium paneum*, *Penicillium roqueforti* and *Aspergillus fumigatus* were the most prevalent moulds in silage. For the first time, *Penicillium carneum* was isolated. As *Aspergillus fumigatus* as well as its variant *ellipticus* can be present in maize silage, a rapid technique was developed to differentiate between these isolates. Additionally, a chemical multimycotoxin Ultra High Performance Liquid Chromatography – tandem mass spectrometry (UHPLC-MS/MS) method was developed and optimised to enable detection of more than 20 different mycotoxins in one analysis. This was achieved for mycotoxins produced by moulds that were grown in the laboratory as well as for mycotoxins present in maize silage.

ILVO successfully developed detection and identification methods for moulds and their mycotoxins in maize silage. Our research indicates that reliable and optimal detection and identification is only feasible through combining different analytical techniques (conventional, molecular and chemical).

Contact: Els Van Pamel, Els Daeseleire & Geertrui Vlaemynck
Financial support: Agency for Innovation by Science and Technology
Collaboration: Faculty of Sciences, Biology (Mycology) (Ghent University, Prof. A. Verbeken), ILVO



Detection, Improvement and Innovation

Research on Product Quality and Innovation

Pasteurisation of horse milk: most commonly used test not accurate

Horse milk is gaining popularity and is often consumed as raw milk. The most reliable method to verify whether milk has been correctly pasteurised is a test that determines the marker enzyme alkaline phosphatase. This test, accurate for the milk of most species, was evaluated for horse milk at ILVO. Our tests revealed that it is apparently not a suitable indicator for the pasteurization efficiency of horse milk when applied under the conditions of the reference method for alkaline phosphatase in milk products. To date, no alternative marker enzyme for safe pasteurisation has been identified. However, the determination of the degree of denaturation of certain thermolabile whey proteins would be a useful step toward the development of an alternative method.

Raw milk can contain pathogenic micro-organisms. For this reason, effective pasteurisation is necessary to kill the pathogens. The public health service also needs to verify the efficiency of the pasteurisation using a reliable test. The alkaline phosphatase test is the pasteurisation test usually used for cow and goat milk. When the milk has been insufficiently heated or contaminated after pasteurisation with raw milk, the alkaline phosphatase tests positive. The principle of the test is as follows: alkaline phosphatase is a generally present enzyme in milk. In cow and goat milk, it is scarcely less inactivated during pasteurisation than almost all pathogenic germs. The concentration of the enzyme must be sufficiently high for the test to be sensitive. It is generally accepted that a 6 decimal reduction of the pathogenic micro-organisms in comparison with the enzyme yields a safe milk.

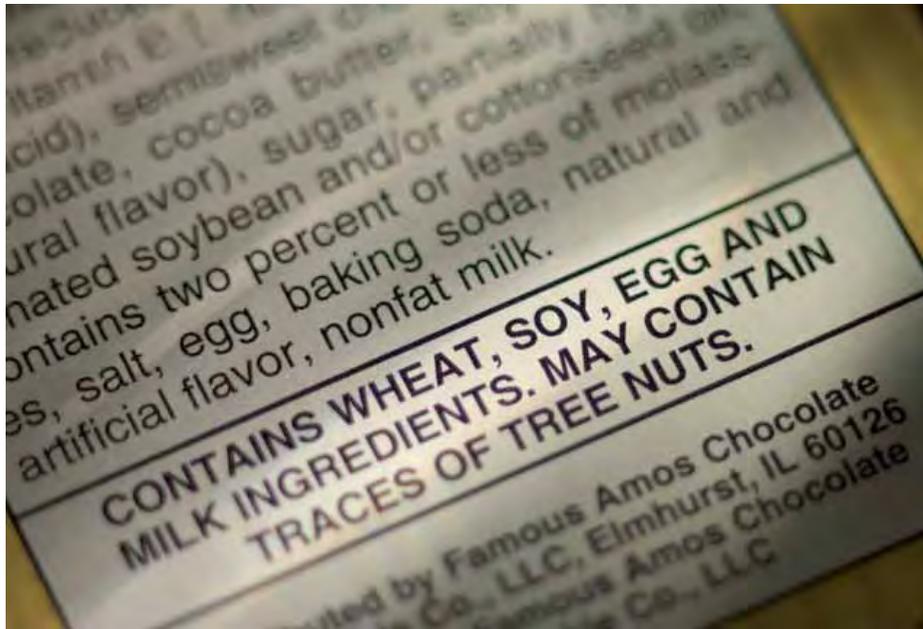
Different species of animal have differing concentrations of alkaline phosphatase. Tests where horse milk was heated under different conditions (different time/temperature combinations) demonstrated that the present alkaline phosphatase activity was too low to be representative for a six decimal reduction of the



number of pathogenic germs. Therefore, this method has to be rejected as a reliable test for efficiently pasteurised horse milk.

Contact: Jan De Block & Sophie Marchand
Collaboration: The research was part of the 11th Workshop of the EU CRL for Milk and Milk Products dedicated to Alkaline Phosphatase (workshop for national reference laboratories)

Detection, Improvement and Innovation Research on Product Quality and Innovation



Allergen detection in food products: hazelnut and soybean tests not always accurate

The increasing focus on food allergies has arisen from both the increase in food allergies and the ubiquitous presence of allergens along the food chain. Since 2003, when European Directive 2003/89/EC was enacted, food producers must label food allergens in the ingredient list whenever they are present in the product, even at trace levels. Reliable analytical tools are thus needed, both by the food producers to monitor their production process and by the authorities to discover labelling malpractice. At the time the European legislation was enacted, none of the available analytical methods had been officially validated. Even now, only a few tests have been validated.

ILVO researchers have assessed the currently available tools for detection of hazelnut and soybean, two of the most common allergens. The study included both ELISA and real-time PCR assays.

First, different isolation protocols were evaluated based on studies of both bio-analytes, i.e., protein and DNA. This highlighted the importance of selecting a suitable protocol. Comparison of the different assays illustrated that the obtained result was highly dependent on the test used. This was true for both ELISA and real-time PCR methods.

A detection method has to comply with the parameters of sensitivity and specificity to exclude false negative and false positive results, respectively. Although ELISA proved to have a better sensitivity compared to real-time PCR for the detection of hazelnut in cookies, PCR had a better score in terms of specificity. It is moreover important to have a test that is robust enough to detect allergens in raw materials as well as in processed food products. The study demonstrated that a correct quantification with both detection platforms was influenced by matrix effects as well as food processing.

From this study it can be concluded that a profound evaluation of the available methods is required to verify their suitability for the desired application and that analytical results should be interpreted with caution.

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Collaboration: Ghent University (Prof. Bruno De Meulenaer), Antwerp University (Dr. Didier Ebo),
Université de Liège (Dr. Marie-Louise Scippo), ILVO

Detection, Improvement and Innovation

Research on Product Quality and Innovation

'Molecular Farming' produces recombinant proteins in plants

Plants are an important source of food, but they also produce a wide range of other valuable products, like aspirin derived from the willow bark or rubber from the rubber tree. These products are naturally produced by the plant. But biotechnology now makes it possible for plants to produce all kinds of other valuable products. Nowadays, many products used in daily life such as certain medicines or enzymes found in detergents are already made in genetically modified cells. The term 'Molecular Farming' refers to using the plants to produce these proteins. The Flemish Institute for Biotechnology (VIB) in Zwijnaarde is conducting fundamental research on the molecular improvements of this technology. ILVO is working with VIB to evaluate the implementation of this application in the following ways.

First, ILVO is working to improve the plant yield. For example, ILVO is examining 'varieties' or accessions of thale cress (*Arabidopsis thaliana*, a relative of rapeseed). This model plant is used most often in fundamental research. ILVO is working to find accessions with a higher seed and protein yield. Recently, 96 ecotypes were evaluated, of which 51 appeared to have a higher yield than the reference accession used in laboratory research.

Related species of thale cress were also evaluated for further increases in production. *Arabidopsis kamchatica* was one promising relative, as it produced more and bigger seeds and has the added advantage of being perennial. Recently, ILVO researchers succeeded in genetically modifying this plant in an efficient way for the first time.

The technological developments themselves are crucial, but finding support for this technology is at least as important. Therefore, researchers at ILVO organised six discussion groups to introduce Molecular Farming to greenhouse

growers. Results showed that the sector is interested in this innovative application, but the newness of this technology invokes many questions.

ILVO will continue to search for other potentially valuable plants for Molecular Farming applications both in the greenhouse and in the field. ILVO aims to produce a first product on an industrial scale soon. This process will reveal any stumbling blocks to growth and commercialisation in Flanders.

Contact: Rolinde Demeyer & Bart Van Droogenbroeck
Collaboration: VIB, Ghent University, ILVO



large-scale production of *Arabidopsis thaliana* is possible in greenhouses

'Electronic Potato' Roots out the Bruisers

Correct potato husbandry can be an arduous task. It takes experience and requires investment in land, propagating material, fertilizers, crop protection, labour and equipment. Recouping this investment depends on getting the highest possible yield. Part of that is to ensure that the potatoes reach the consumer or processor with a minimum of bruising or mechanical damage. Damaged potatoes can lead to serious quality loss, and in the worst case to rejection of the whole batch. Most of the damage occurs during the mechanised aspects of process of harvesting, handling and transporting the tubers that most damage occurs. Prevention and minimisation of mechanical damage is essential. ILVO applies an innovative technique to optimise the process of harvest and transport from the field to the consumer and/or processor.

Unlike the tuber characteristics and the environmental factors, the intensity in handling the potato can be manipulated in a relatively simple way. Mechanical damage can be reduced dramatically by adjusting potato harvesters, feeding lines (e.g., hoppers, cleaners, sorters, conveyor belts and store loaders) and washing installations. ILVO offers help to farmers, contractors and the processing industry to correctly adjust their equipment. One of the main tools that ILVO uses

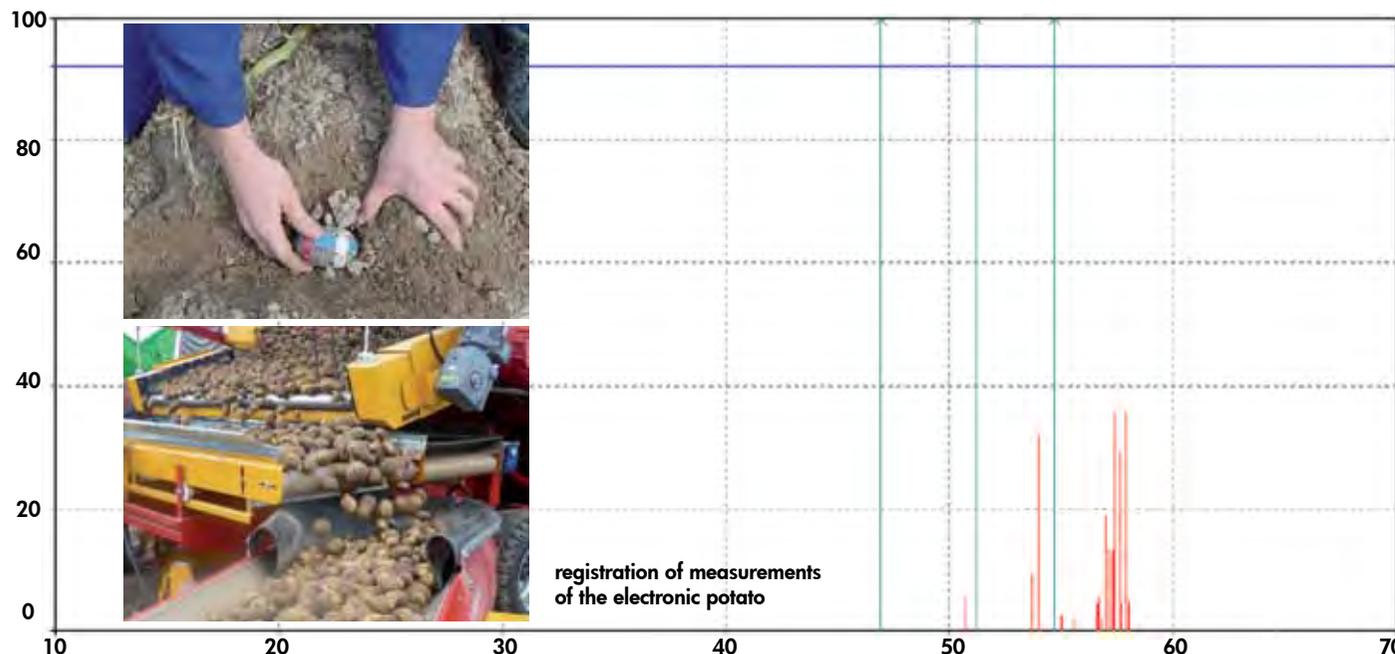
to diagnose the places presenting the highest risk for damage is the so-called 'electronic potato' or PTR 200, already in use since 2000. This electronic sensor in the form of a potato is included in the potato stream during transport and storing. Along the way, this sensor registers any form of impact. The combination of the electronic potato and ILVO's expertise makes it possible to almost immediately detect high-risk places along the potato handling chain.

Our measurements have resulted in a few important conclusions. High-standard harvesting is only possible in combination of (1) a driver who knows his job, (2) good communication between farmer and driver concerning the field characteristics and the potato's sensitivity to bruising and (3) a machine that is well maintained and adjusted.

One of the most important criteria for adjustment of a harvester is the ratio between driving speed and speed of the first chain or digger web. In normal conditions a 1:1 ratio is suggested. In dry conditions the chains should be running slower than the driving speed, while in wet conditions they should be running faster. It is also recommended that sequential parts gradually run slower. That way the complete line will be normally filled and damage will be limited. The other important adjustment criteria are the adjustment of roller cleaners, shaking intensity and aggressiveness of cleaning parts.

In transport, anti-shock equipment is absolutely necessary: a shock absorber system, a drop mattress, or both. The feeding lines seem to be the biggest single cause of bruising in the potato industry, although the criteria for adjustment are very similar to those of the harvester. Special attention to the speed of the cleaning rollers is needed here. A well thought-out installation of the feeding line can prevent many problems. The feeding line should be as short as possible and free of T-junctions.

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21st-Century Agriculture

Research on Agricultural Engineering

IT and Robotics in Agriculture: 'ICT-Agri'

Europe is a world leader in a range of fields of ICT development and innovation. Many research groups attempt to adopt automation techniques and adapting them for the specific needs and conditions required for agriculture or the typical characteristics of biological products.

The cooperation across country and sectoral boundaries has ample room for improvement. There is a significant overlap for specific application areas and technologies. Moreover, some agricultural problems are not handled properly, although suitable solutions are available in other sectors.

The project named 'ICT-Agri' (Coordination of European Research within ICT and Robotics in Agriculture and Related Environmental Issues) began on 1 May 2009 as an ERA-net (European Research Area) for a period of over 4 years. The project consortium is comprised of 18 partners and 12 observer organisations covering 20 countries. This ensures a unique platform for building and maintaining international collaborations and networks. The project goal is to map and analyse existing research and identify future needs in the sector. ILVO, as Belgian partner, is involved in mapping the current research. The first result of the work is compiled in the book titled 'ICT-AGRI Country Report'. Meanwhile, a website (www.ict-agri.eu) has become operational, which links to the 'Meta Knowledge Base' available at <http://db-ictagri.eu/usr/Home.php>. It centralises information regarding research units, specific information on current research, expert knowledge, new developments, products, software and standards.

Registering in the meta knowledge base gives researchers, developers, companies and policy-makers the opportunity to be part of a network dedicated to the use of ICT and robotics in agriculture. It forms the perfect tool for research

units to look for suitable partners with similar or complementary skills, leading to new European research consortia. Registered stakeholders have the ability to participate in a European Strategic Research Agenda (SRA), from which two European calls for proposals are initiated.

An industrial partner such as a software developer may use the database to search for specific applications of a product/technique in agriculture. On the other hand, scientific partners can use it to pick up new industrial expertise to match their research application projects. For the agricultural and fisheries sector, it also works both ways. Agricultural organisations are able to find information about the development phase of an interesting innovation, and they can find the appropriate network with knowhow and expertise to answer questions about their current practical needs. Policy-makers can use the database to detect gaps in research areas, which will assist in guiding their research programmes.

Contact: Stephanie Van Weyenberghe & Jürgen Vangeyte
Financing: EU



21st-Century Agriculture Research on Agricultural Engineering



21st-Century Agriculture

Research on Agricultural Engineering

Use of subsoil implements on chicory harvesters

In Belgium, about 7000 ha of chicory are cultivated for inulin production in the production units of the Orafiti-Beneo and the Cosucra-Warcoing group. Inulin is a long chain sugar, which digests slowly and has only a slightly sweet taste. Since inulin has minimal increasing impact on blood sugar, and is not insulemic it is considered suitable for diabetics. It also stimulates the growth of intestinal bacteria. Due to its stabilisation into a creamy structure in water, it is an ideal fat substitute in food products. In the cosmetics industry it improves the stability of mousses and foams.

Chicory has relatively long and sensitive roots and its harvest is fairly delicate as farmers aim for the entire and undamaged roots. Generally, modified sugar beet harvesters are used to lift the roots and remove the excess soil from the roots. During harvest and transport the damage to the roots should be minimised.

This research to improve harvest quality of chicory is a close collaboration between the Belgian Institute for the Improvement of the Beet (KBIVB-IRBAB), ILVO and the Walloon Agricultural Research Centre (CRA-W), the Orafiti-Beneo and the Cosucra-Warcoing group. Currently, the losses during harvesting are 5 to 15%, with a great part due to the breaking of the end tip of the roots, which remain in the ground. From 2003 to 2005, ILVO was mainly responsible for the adjustment of the chicory harvesters. Since 2007, ILVO researchers compare different subsoil teeth profiles and their impact on the yield when using this kind of equipment to facilitate the lifting of the roots from the soil. First, the two phase harvesting systems were analysed. The effect of each type of subsoil implement on the harvesting quality was evaluated under different conditions. A specific measurement protocol was agreed upon between all partners. Based on Orafiti's extensive experience and insights in chicory harvesting, a specific design of subsoiler was developed and adopted for use in the comparisons.

Bad weather conditions in 2007 made the first results of the tests only partly useful to compare the different subsoil implements. For this reason, the measurement and analysis protocol needed to be improved. In these exceptionally wet conditions the use of a subsoil implement did not improve harvest quality. Depending on the soil

conditions, the new design teeth showed an improvement compared to existing designs. Unfortunately, a second analysis using more powerful statistical methods showed no significant differences between the techniques under comparison.

In a second set of experiments, one-phase self propelled harvesters were investigated and a short economical analysis was performed. In this case it was shown that subsoil implement has a positive influence on the harvested yield thanks to a reduction of losses caused by the breaking of the root tips.

In the most recent harvesting season, the Holmer Terra Dos equipped with harvesting forks was tested. The chicory industry expects this machine to improve the harvest quality significantly. With only preliminary results, it seems that some import yield difference can be seen. The machinery specially designed for harvesting chicory shows better results. Nevertheless, losses are not only caused by lifting the roots from the soil. Losses during cleaning can also be as great as from harvesting.

Contact: Jürgen Vangeyte & Donald Dekeyser
Collaboration: Royal Belgian Institute for Beet Improvement, ADLO (Flemish Government), Centre Wallon de Recherches Agronomiques, ILVO



harvesting chicory

Low-emission pig stables: code of good practice

Upon demand of the Department for Sustainable Agricultural Development (ADLO), a code of good practice was made for the use of low-emission housing systems in pig husbandry. European legislation resulted in the implementation of different techniques and housing systems to reduce ammonia emissions. In order to comply with these European directives, the Flemish Government decided (decree of 19th of September 2003) that new pig and poultry housing systems must be built 'low-emission'. Only small reconstruction works are acquitted from this obligation. The official 'list of housing systems for ammonia reduction' (MD 19th of March 2004) describes the allowed low-emission techniques and systems.

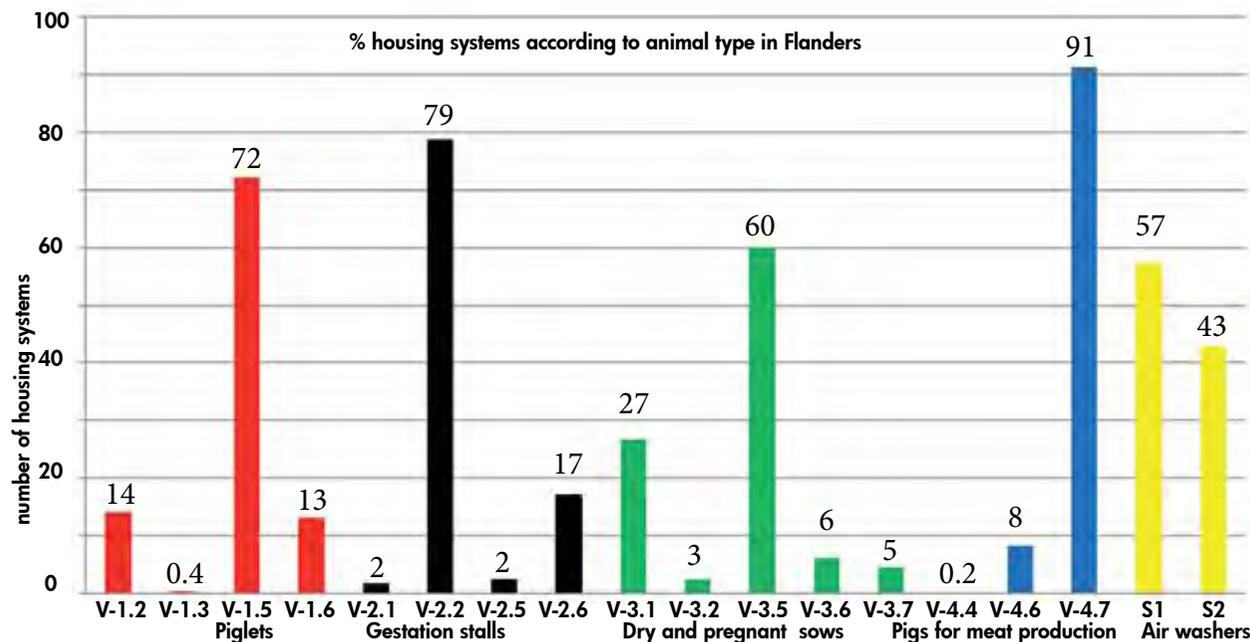
This study is the first examination of the working characteristics of these systems as used in practice. The switch to an low-emission housing system implies a big adaptation for the farmers. Moreover, nearly all new technologies have to deal with growing pains.

This code of good practice covers only the pig husbandry industry and is available for each farmer. This code is based on the findings of several farm

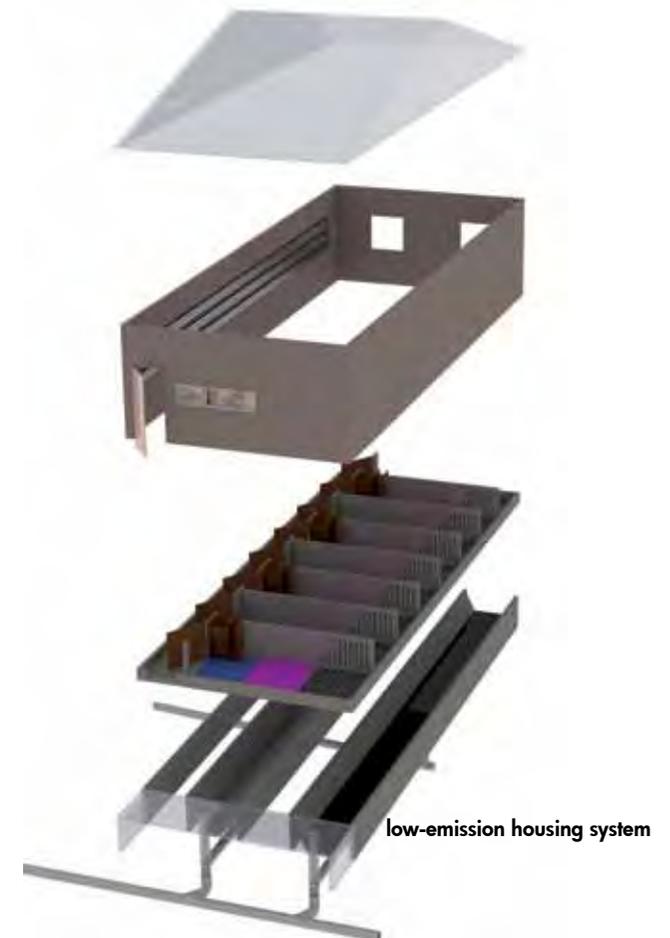
visits during which the farmer was interviewed concerning the use of these new techniques.

The most used housing systems (1.5, 1.6, 2.2, 2.6, 3.1, 3.5, 3.6, 4.7, S2 en S3) and related techniques are discussed in this code. An overview of the use in Flanders for each listed housing system is provided (see table).

Contact: Peter Demeyer
Collaboration: : PIVAL, ILVO



figures valid on 28 March 2008 (source VLM)



All Creatures Great and Small

The Animal Sciences Unit

From Cows to Oysters

The Animal Sciences Unit focuses its research on (more) sustainable livestock husbandry (cattle, pigs and poultry) and exploitation of marine resources, the protection of the continental and marine environment, the improvement of animal welfare and the production of high quality and safe animal products. Animal Sciences also provides specialised services for government and industry.

The Animal Nutrition research group studies the nutrient supply for cattle, pigs and poultry while also addressing their nutritional needs. This group's nutritional physiology research is based on digestion and balance trials. The livestock sector validates these results: they now see that more accurate feed evaluation, better utilisation of nutrients, optimum production of milk, meat and eggs with a high nutritional and health value, and a lower environmental impact (lower emissions) are clearly within reach.

Animal Husbandry and Welfare scientists study livestock farming systems from a broader perspective. This group searches for possible avenues to more socially acceptable animal production as well as methods and strategies to evaluate and improve animal welfare. They focus on evaluating animal welfare using objective, valid and innovative indicators that are specifically developed for measuring animal welfare.

One main focus of our Fisheries research is to study the relationship between the exploitation of the aquatic environment and its quality, while meeting the demand for a comprehensive management plan for governments, industry and society. Fisheries' main tasks are: to study the ecology and quality of the aquatic environment; research on food safety and quality; fisheries biology; developing aquaculture on land and in the sea; innovative research in fishing gear technology; marine product quality; and product technology. This research is directed from a concern for the ecosystem and focuses on several parts of the food chain.

The Animal Sciences Unit also provides services in the form of ANIMALAB and other specialised technological advice and services. ANIMALAB provides animal and marine analyses; delivers services and advice; and serves as the national reference laboratory for Belgium. This lab houses research on animal feed and the nutritional value of animal products. These researchers also measure the quality of fish, crustaceans and mollusks; determine contaminants in environmental samples and the fat of fish products; and carry out biological and environmental research. The Animal Sciences Unit also serves the agricultural industry through specialised and technological advice as well as contract research. Some examples are PreventAgri for injury prevention on farm, the ADVIS and CIVIS projects, etc. In 2010, we published a comprehensive booklet of all services offered by the Animal Sciences Unit. Visit the ILVO website for a free copy of this service listing (available as a download or hard copy).

Champions of the Environment and of the Animals

The Animal Sciences Unit not only works to clean up the environment through reducing nutrient emissions from animals, but they also are finding ways to measure and reduce methane emissions at animal level. In 2010, the Animal Sciences Unit designed and built methane chambers to measure the methane emission of individual cows. This unique facility, to be completed in 2011, will be used for doctoral research as well as a European project. The Animal Sciences Unit also did its part to make chickens happier by completing a protocol for evaluating the welfare of broilers. Male piglets have ILVO to thank for doing research on alternatives to non-anesthetised surgical castration. In 2010, the first research results of the alternative piglet castration project were published. In this collaboration with the Flemish government and the sector, ILVO evaluates the implementation of various alternatives for surgical castration without anesthesia on commercial farms. In related research, the reliability of various detection methods for meat with boar taint is studied, along with research on ways to upgrade boar tainted meat by including it in new meat products. Other piglet research strives to reduce weaning problems and to improve piglets' growth performance through testing ingredients, feed additives and new feeding strategies.

The ins and outs of animal nutrition

Animals' excretion of nitrogen and phosphorus is of primary importance for environmental reasons. ILVO researchers have studied whether organic dairy cows excrete more N and P than conventionally-managed cows, and the search continues for poultry feeding strategies that improve N and P utilisation and reduce N and P excretion.

The Animal Nutrition research group also studies pigs, particularly the influence of food structure and fiber content on health and growth performance of pigs. Other research may lead to more vital piglets per litter. This doctoral research has begun by determining to what extent the methylation potential in the sow varies during the different stages of production. The next step will be to attempt to alter the methylation potential by adding methyl donors to the feed, which may result in a rise in the number of vital piglets per litter.

The use of antibiotics in feed has been severely curtailed. This has given rise to many different alternatives to antibiotics, and agribusiness continues to want objective evaluations of these alternatives. ILVO has examined the value of various probiotics, prebiotics, enzymes, acids, yeasts, essential oils and coccidiostats. These compounds also can affect intestinal health and nutrient utilisation, which in turn affect zootechnical performance and nutrient emission.

Dr. Gerard Huyghebaert retired this year. In his honour, an academic seminar on poultry science was organised for over 100 members of the poultry industry.

Fisheries under pressure

The European Common Fisheries Policy was and is reformed. Fish stocks appear to insufficiently protected. For ILVO-Fisheries, this means that existing measuring factors such as population dynamics, stock size, discards and exploitation of commercial fishing (including sole, plaice, cod and whiting) and crustaceans

(mainly shrimp and lobster) were no longer sufficient. The governments requesting advice urge that the measurement methodology be reviewed from an ecosystem perspective.

In the fishing gear research, ILVO continues to study alternative gear techniques that are beneficial to the ecosystem and the fishermen. In 2010, several changes to the beam trawl were tested in collaboration with the sector. Also in the shrimp fishery and passive electrical selective fishing methods, there was a scientific progress with a view on implementation in a commercial setting. The contact with industry and consulting and services were intensified in 2010.

The aquaculture research focused on sustainable shellfish farming in open sea, with a focus on mussel culture (suspension culture) and a sustainable and cost-effective production of marine microalgae for aquaculture. ILVO gradually acquires a strong expertise in toxic phytoplankton.

ILVO-Fisheries remained loyal to the long-term data collection to monitor the quality and quantity of various wildlife groups in and on the sea bottom and in the water column. Any loss of suitable habitat, through changes in the benthos and the food chain, can lead to smaller exploitable fish resources. ILVO continued the research on chemical contaminants in biota and the environment, and biological and biochemical effects of pollution, effects of disposal of dredged material and sand and gravel operation, windmills and fishing, mainly in the Belgian Continental Shelf. Analyses took place of the fish quality (KIM-score) and food safety of fishery products (fish disease and chemical contaminants) at the request of several clients.

In the context of the Belgian EU Presidency, ILVO co-organised a two-day symposium was organized on 9 and 10 November 2010 in Ostend, with 150 participants. The symposium showed various possibilities for cooperation in the triangle of science, fishing and politics.

Diving into Questions, Coming Up with Answers

Fisheries Research



Benthic indicators: road signs that point the way to a healthy environment

A number of European guidelines have been drafted (the Water Framework Directive, the Marine Strategy Framework Directive, the Habitat Directive, and Natura 2000) to ensure the quality of marine ecosystems. Benthic indicators, which measure the bottom-dwelling organisms in the sea, are an important aspect of these guidelines. In 2010, the Bio-Environmental research group has contributed to the development, application and interpretation of such indicators through several research projects.

One of Fisheries' indicator-related projects was part of the European 'MESMA' project (Monitoring and Evaluation of Spatially Managed Areas; www.mesma.org). Here, an overview was compiled of all existing indicators and their usefulness in assessing the environmental status of marine ecosystems (Pecceu *et al.*, 2010).

Additionally, a viewpoint paper was published in the journal 'Marine Pollution Bulletin'. Twelve scientists of different nationalities described the challenges of translating the guideline principles into applicable and accurate methods (Van Hoey *et al.*, 2010a). This publication was supported by the Benthic Ecology Working Group of the International Council for the Exploration of the Sea (ICES). Issues related to the assessment of 'good environmental status', such as the incorporation of an ecosystem approach, the use of benthic indicators, the

definition of 'sustainable' reference conditions, impact measurements and the development of adequate monitoring programmes, are discussed. An important conclusion was that the perfect method does not exist and that it is imperative to incorporate expert judgment in the governmental implementation of the guidelines.

During a Federal Public Service project on Marine Conservation Objectives, indicators and conservation perspectives were defined with regard to protected species and habitats in the Belgian Part of the North Sea in function of the Habitat and Bird Directives (Degraer *et al.*, 2010).

The 'Benthic ecosystem quality index (BEQI)' was used to assess and evaluate the ecological status of benthic life in the Belgian coastal zone during a 3-year period (2007-09) (Van Hoey *et al.*, 2010b). This ecological status (expectedly) appeared to be only moderate, which is likely the result of the combined effects of multiple pressures (harbor construction works, eutrophication, invasive species, shrimp fisheries).

The work involved in developing, applying and optimising the use of indicators is far from finished. Not only do European guidelines require regular evaluations of environmental status, the use of indicators also hold many uncertainties that still need to be explored

Contact: Kris Hostens, Gert Van Hoey & Ellen Pecceu

Financing and collaboration: MESMA: 21 international partners from 13 countries; Financed by EU-FP7 and the Flemish government

ICES-BEWG: see website <http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=53>, participation financed by ILVO-OC

Habitat and Marine Conservation Objectives: FPS Health, Food chain safety and Environment, Royal Belgian Institute of Natural Sciences RBINS, Management Unit of the North Sea Mathematical Models MUMM; Ghent University Marine Biology Section, ILVO-Fisheries Bio-Environmental Research Group - Financed by FPS Health, Food chain safety and Environment

Water Framework Directive: ILVO-Fisheries Bio-Environmental Research Group, Financed by FPS Health, Food Chain Safety and Environment

Pecceu E., Borja A., Buhl-Mortensen L., Hostens K., Kroncke I, Mirto S., Panayotidis P., Reiss H., Skjoldal H.R., Vega T., Voge, S. & Zenetos, A. (2010) Indicators measuring trends in ecological quality status of benthic habitats. In: MESMA (2010) Deliverable 1.1. Review Document on the Management of Marine Areas with particular regard on Concepts, Objectives, Frameworks and Tools to Implement, Monitor, and Evaluate Spatially Managed Areas, EU 7th framework report, 191-262

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Degraer S., Courtens W., Haelters J., Hostens K., Jacques T., Kerckhof F., Stienen E. & Van Hoey G. (2010) Bepalen van instandhoudingsdoelstellingen voor de beschermde soorten en habitats in het Belgische deel van de Noordzee, in het bijzonder in beschermde mariene gebieden. Eindrapport in opdracht van de Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Directoraat-generaal Leefmilieu. Brussel, België. 132 pp.

Mussels and *Phaeocystis*

Mussel farming (*Mytilus* sp.) has been ongoing for ten years in various areas of the Belgian Part of the North Sea. Mussels are filter feeders, which means that they filter unicellular organisms and other particles out of the water. Their food intake therefore correlated with the concentration of particles in the water. Particles that are too large or unsuitable are rejected as pseudofaeces via the gills.

Along with other microalgae, huge numbers of the algae *Phaeocystis globosa* appear in spring in the North Sea. This is called the *Phaeocystis* bloom. During such a bloom, the individual cells are packed in a gelatinous polysaccharide matrix. Small colonies are filtered out of the water by the mussels and ingested, but large colonies (with a diameter up to 1 cm) are filtered out and then immediately rejected as pseudofaeces. The gelatinous nature of the algae colonies can clog the mussel gills and reduce their filtration capacity. Despite this hindrance, ILVO

researchers hypothesised that the food intake would remain constant, because the colonies are present in massive numbers.

The AMORE III project was started to examine the above hypothesis in more detail. We studied whether *Phaeocystis* influenced the mussels' physiological status as expressed in terms of the lipid, protein and glycogen content of the mussels. Mussel and water samples were taken from the shellfish area D1 in the Belgian Part of the North Sea. These samples were then examined in the laboratory. These samples indicated that the mussels' physiological status fluctuates greatly during the year, but that any possible influence of *Phaeocystis* is masked by reproduction and the massive amount of available food in spring. The experiments show that mussels are capable of filtering *Phaeocystis* out of the water, but that most colonies are rejected as pseudofaeces, which costs energy. However, no decrease in energy levels was observed during the *Phaeocystis* bloom. Most probably, the small colonies that can be ingested by the mussels compensate for this energy loss. In the end, the presence of *Phaeocystis* affects the mussels' physiological state only slightly or not at all.

Contact: Kris Van Nieuwenhove

Financing and Collaboration: The AMORE III project was funded by the Belgian Science Policy and was carried out by the Université Libre de Bruxelles (ULB), the Management Unit of the North Sea Mathematical Models (MUMM), the Université de Mons (Umons), and ILVO. At-sea sampling was performed by the Stichting voor Duurzame Visserijontwikkeling vzw and Reynaert-Versluys BVBA.

Project report:

Lancelot C., Rousseau V., Lacroix G., Denis K., Gypens N., Grosjean P., Van Nieuwenhove K., Desmit X., Parent J.-Y., Tesseleer Lillo N., Ruddick K. & Delbare, D (2011) Combined effect of changing hydroclimate and human activity on coastal ecosystem health AMORE III., Final Report. Brussels: Belgian Science Policy 2011 – 52 p (Research Programme Science for a Sustainable Development)



Diving into Questions, Coming Up with Answers

Fisheries Research

Biomarkers: another way to monitor persistent pollutants

Monitoring the quality of the marine environment is traditionally done using two strategies, i.e., biological and chemical monitoring, which measure the biodiversity and pollutant concentrations, respectively. However, a sustainable policy needs a third strategy: monitoring the biological effects of pollution. For this purpose, molecular, biochemical and histopathological biomarkers need to be developed for some representative North Sea species (e.g. brown shrimp) in relation to gene expression, enzyme activity and tissue damage, respectively. One of the major pollutants in the North Sea is tributyltin (TBT). Up to the mid-1990s, this product was used in paint to prevent fouling (i.e., attachment of hardsub species) on ship hulls and buoys. TBT causes imposex in shellfish, a phenomenon where female animals become infertile. Imposex can therefore be used as a biomarker for TBT. The effects of TBT are less apparent for crustaceans, although a sharp decline in the shrimp populations was observed during the 1960s to the mid-1990s, when TBT was still widely used.

In this study, we investigate whether TBT may exert an adverse effect on the development and reproduction of shrimp through endocrine disruption, particularly through the molting hormone receptor. To do so, the gene sequence of the receptor was determined and transfected into a cell culture. The cells will illuminate after administering the molting hormone, as the receptor stimulates the production of luciferase. A low dose of TBT significantly decreased this activity, and after a brief exposure of shrimp to an acute TBT concentration, the expression of the receptor strongly decreased in the female shrimp's ovaries. Through this pathway, TBT might influence the development and reproduction of shrimp, which will be further investigated through this chronic exposure study. We also want to screen the impact of TBT on a wider range of genes, through the use of a custom-made shrimp 'microarray' (currently containing 700 gene fragments). Genes that are strongly influenced may then be used as a molecular biomarker for TBT in shrimp in the future.

Contact: Johan Robbens

Collaboration: This doctoral research is conducted in the Chemical Monitoring and Product Technology research group by Yves Verhaegen, PhD student at ILVO and Ghent University (Prof. Guy Smagghe)



search for pollutants on brown shrimp

Biosensors: valuable allies for screening persistent substances

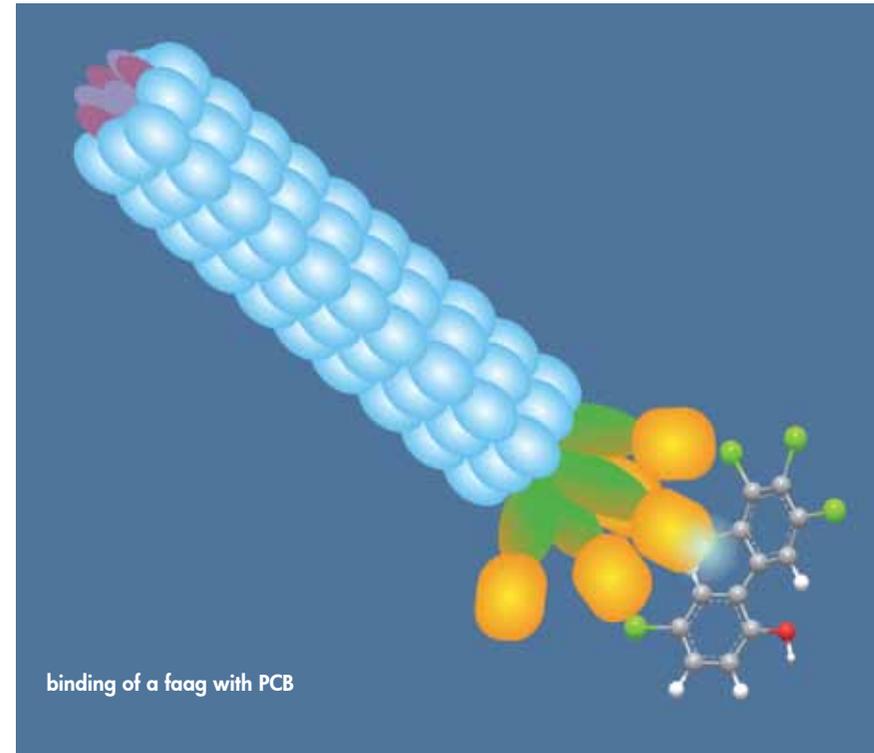
The detection and monitoring of persistent substances in food and the environment is essential for assessing and preventing risks to human health and the environment. The persistent character of these substances means they are not (or very slowly) degraded and may bio-accumulate in the ecosystem and eventually end up in food. The current chemical analytical methodologies (LC-MS, GC-MS) are very sensitive, but they are also expensive, slow and labour intensive. For these reasons, frequent monitoring is almost impossible and the proper risk assessment becomes complicated. Alternatives are needed that allow for routine and rapid screening.

Biosensors may be the answer. They consist of a biological recognition molecule that recognises the (persistent) substance, and a transduction system which translates the binding of both into a measurable electrical signal. Antibodies have long been the most popular biological recognition molecules in biosensors. Due to recent developments in biotechnology, nanotechnology and surface chemistry, innovative biological recognition molecules can be developed, such as phages, aptamers and molecular imprinted polymers (MIPs). Due to their excellent properties, i.e., high affinity and specificity, rapid, inexpensive and animal-friendly production, low variation between different batches and high stability, these molecules are very attractive alternatives for antibodies.

This study evaluated phages, aptamers and MIPs for their potential to specifically recognise a number of persistent compounds (PCBs, dioxins, antibiotics, mycotoxins) and their usefulness within a biosensor setup. The specificity and affinity of these molecules are characterised by SPR (Surface Plasma Resonance). The molecules are linked with different sensor surfaces, ranging from simple gold nanoparticle-based dipstick tests to more complex electronic measurement platforms. Such biosensors can be a major breakthrough, as they permit more frequent monitoring of both environmental and food samples. This will allow for a more complete risk assessment.

Contact: Johan Robbens

Collaboration: This research is part of the doctoral research of Bieke Van Dorst, Jaytry Mehta en Elsa Rouah-Martin, students at ILVO and Antwerp University (Prof. Ronny Blust)



Input and Output

Research on Functional Animal Nutrition

Gastric health and growth performance: the composition of pig feed

Many pigs have stomach ulcers. *Helicobacter suis* is a bacterium that is associated with these ulcers. Both feed structure and feed composition may play a role in preventing this disease in pigs. To this end, an experiment was designed to examine the effect of fiber size and feed particle size on growth performance and gastric mucosa integrity.

In this experiment four diets were compared: a coarsely ground feed with a high fiber content, a coarsely ground feed with a low fiber content, a finely ground feed with a high fiber content and a finely ground feed with a low fiber content. The animals showed similar (good) growth rates, except for the animals which received the coarsely ground feed with a high fibre content. This indicates similar results with a low or a high fiber content in the feed, if the latter is ground fine enough.

All of the experimental pigs' stomachs were collected at the slaughterhouse. Scientists from the Faculty of Veterinary Medicine then scored each stomach from 0 (healthy) to 5 (stomach ulcer). Pigs fed the coarsely ground high fibre diet showed many fewer stomach lesions than the pigs on the other three diets.



stomach of a pig score 0 (left) and score 5 (right)

In the current trial we could unfortunately not find a feed that reduces gastric lesions while yielding good performance results. Using other fiber sources or a feed with an intermediate particle size are strategies that can be tested to find a way to reduce gastric lesions while maintaining performance. Further research into the role of *Helicobacter suis* in the occurrence of gastric lesions is also needed. This test was conducted with animals infected with this bacterium, but it cannot be excluded that the results would differ in animals that are free of *Helicobacter suis*.

Contact: Sam Millet

Collaboration: Research Group Veterinary Public Health and Zoonoses University of Ghent, ILVO

Broiler strains benefit from different nutrient composition

Is there a different optimal nutrient composition for broilers of different strains? In this experiment, the impact of nutrient density in terms of energy and/or protein on live performance, metabolism and carcass composition of broiler chickens of two commercial broiler strains was investigated.

The trial design comprised 6 treatments (2 strains and 3 dietary treatments) and each treatment consisted of 5 pen replicates of 30 broilers per pen. During the whole rearing period, each pen received one of the respective diets that varied in dietary energy and crude protein levels: 1) the control diet (Cont diet), 2) the control diet with a 10% reduction for both MEn and crude protein (LM/LP) and 3) the control diet with a 10% reduction for crude protein only (LP). Zootechnical performance at different times during the experiment and slaughter yield of 3 broilers per pen were determined.

In general, chickens receiving the LM/LP (diet 2) diet had a significantly lower body weight and feed intake compared to the broilers on the other dietary treatments. Slaughter yield was significantly reduced by dietary treatment: broilers receiving the LM/LP diet reached the lowest values and no differences were observed between the control and LP diet. Body weights of the Cobb chickens were higher

Input and Output Research on Functional Animal Nutrition

at each age compared to their Ross counterparts. Cobb birds were on average more efficient than the Ross birds as their feed conversion was significantly lower.

The greater tolerance of Cobb broilers for deficient feeds may be accounted for by their higher feed intake. However, Cobb broilers were more efficient in converting energy to body weight which again may indicate a lower need for dietary energy. It is obvious from the present study that nutritional requirements of modern commercial broiler genotypes are different. Therefore it is important for producers to know the most optimal diet composition for the strain of broilers they are rearing for a maximum economic profitability.

Contact: Evelyne Delezie
Collaboration: Division of Livestock-Nutrition-Quality (Leuven University), ILVO



nutrient composition for broilers

Input and Output

Research on Functional Animal Nutrition



nutrient excretions calculated on dairy farms

Nutrient excretions from organic dairy cows similar to conventionally raised cows

Given the differences in production on organic dairy farms versus conventional farms, questions have arisen about whether the Flemish manure legislation should have specific N and P excretion figures for organic dairy farms. Possible reasons for this are the more extensive nature of the organic dairy farms, the slowly digestible feed, the lower protein levels in the grass, the smaller proportion of concentrate, and so on.

Researchers began this project with a survey of the organic dairy farms to understand the specific nature of organic dairy production. These results were used in the design of the trials and in the final calculations. Over a two-year period, during the period the cows spend in the barn and during the grazing season, several feeding trials were performed at ILVO with 100% organic feed in accordance with organic practice. In addition, validation tests were carried out on three commercial organic farms to estimate their N and P balance and to compare those with the values obtained from the other trials.

Using the data collected, N and P excretion standards were calculated on an annual basis in the same way as was done for conventional dairy farms. This showed that for farms with milk production around 6500 liters per year, the N-excretion of organic farms corresponds to the values of the Flemish manure legislation (including an accounting of the milk production and the corn and grain area relative to the total area). When milk production differs more from this average value, the error of the estimate of the Flemish manure legislation increases, with an overestimation of the excretion for farms with a production exceeding 6500 liters and an underestimation for farms with lower milk productions. For the P-excretion the picture is less clear, but there are indications that the P-excretion is somewhat higher on organic than on conventional dairy farms, especially in the lower yielding ones. When averaged over all Flemish organic dairy farms, there is little reason to justify specific excretion standards for organic dairy farms.

Contact: Sam de Campeneere, Alex De Vlieghe & Nico Peiren
Collaboration: Louis Bolk Institute (Driebergen, the Netherlands), ILVO

Quantifying Contentment

Research on Animal Husbandry and Animal Welfare

The yum-yum factor matters to calves: spelt speeds weaning

The diet of rearing calves consists mainly of milk (replacer) during the first weeks of life. This is an expensive and time-consuming operation. It is therefore desirable to shorten the milk feeding period without negatively affecting the health and development of the animal. Weaning can provoke some distress, but this can be reduced by appropriate feeding management or offering palatable feeds. In both cases, the intention is to facilitate the transition from a milk diet to a solid feed and improve the animal's welfare at the same time. Calves appear to like the taste of spelt, which may stimulate concentrate intake. Because they need to eat a minimum 5.25 kg of concentrate per week before they can be weaned, spelt may increase the intake and thus speed the weaning process.

In an experiment with double muscled female calves, the concentrate of the control group (15% barley and 15% wheat) was replaced by 30% spelt and fed to calves of the test group. Beside a fixed amount of milk replacer (10% of birth weight with a concentration of 125 g powder per litre) concentrate intake was gradually increased till a maximum of 3 kg per day. Grass hay and drinking water were freely available. Weaning occurred about one week earlier for calves receiving spelt. Daily gain from start to weaning and from weaning to the end of the trial was similar to that of the control group.

Earlier achievement of a concentrate intake level of 5.25 kg per week may suggest that spelt is more palatable. The first means of investigating the palatability was to measure concentrate intake during half an hour during the morning at weaning, after having withdrawn the feed during the preceding night. Interestingly, the intake rate was not higher for concentrate containing spelt. A possible reason for a higher concentrate intake and the earlier weaning can be due to the faster disappearance of spelt from the rumen. However, the degradation rate of the organic matter was lower for spelt than for barley and wheat, and a similar result was obtained for the concentrates containing spelt versus barley and wheat. The different degradation kinetics mean a longer retention of spelt in the rumen. This result would rather exert an inverse effect on spelt intake.

In another experiment, both concentrates were offered simultaneously, and intake of each was recorded. Five double muscled females and five Holstein females,

aged 5-6 months, were studied to investigate the effect of breed. Concentrates were fed in separate mangers (cafeteria feeding) in addition to grass hay. Feed intake was registered at different times during the day. This procedure was repeated during 4 consecutive days. Intake was significantly different between breeds. Holstein calves clearly preferred concentrate containing spelt: intake was higher than from concentrate without spelt at every moment of the day. Approximately twice as much concentrate with spelt was consumed. Intake of double-muscled calves was considerably lower in comparison with Holstein calves: 6.25 vs. 6.86 kg/d. Double-muscled calves consumed slightly more concentrate without spelt: 54% of the total concentrate intake. The energy value of the concentrate with spelt was ca. 5% lower. Because of their lower intake capacity, double-muscled calves may try to eat for calories, preferring concentrate without spelt, and with the highest energy content. It is questionable if similar results can be obtained when both concentrates would be iso-caloric. Regardless, these results indicate that palatability is a dynamic interplay of factors

Contact: Leo Fiems
Financing: Flemish Government



Quantifying Contentment

Research on Animal Husbandry and Animal Welfare

Measuring the welfare of broiler chickens: testing and refining the Welfare Quality® protocol

During the EU Welfare Quality® project (2004-2009), standard protocols were developed for evaluating the welfare of farm animals on commercial farms. Unlike other welfare evaluation methods which are based on a description of the housing and management, these protocols use indicators of welfare that are scored on the animals themselves whenever possible. The Welfare Quality® protocol also includes a method to integrate the different indicators into an overall welfare index. For broilers, the protocol has two parts: one carried out on the farm and another carried out in the slaughterhouse.

In this study, the Welfare Quality® protocol was implemented and tested under semi-field conditions to investigate the effect of different light intensities, stocking densities and genotypes on the welfare of broilers. Many of the animal-based welfare indicators proved to be sensitive to the induced differences in housing and management, particularly for different stocking densities.

The protocol proved to be well substantiated. In addition, it accounts for the multiple dimensions of welfare. Nevertheless, a number of possible improvements were identified. First, the method to integrate data from the individual indicators into an overall welfare index proved to be either too rigid or too robust. Once small gaps exist in the data set, integration is not possible. Moreover, certain aspects of welfare have no animal-based indicators, or have no indicators at all. This project filled some of these gaps. Therefore, animal-based indicators were developed and validated for the evaluation of prolonged thirst, both on the practice farm (based on voluntary water consumption) and on the slaughter line (based on blood volume during bleeding). There was also a 're-fill of a vacated area test' test designed to evaluate the extent to which chickens need more space.

One drawback is that the Welfare Quality® approach is rather time-consuming (per company, 195 minutes on the farm and 125 minutes at the slaughterhouse). This hinders its large-scale application. The time spent on the evaluations could

be reduced by automating certain measurements. Meyn S.A. has developed an image processing method for the automatic scoring of foot pad dermatitis at the slaughter line. This automatic system has not yet been perfected, however; comparison of the automatic scores with manual scores given by a trained person revealed that the first prototype had some shortcomings. These findings are now being taken into account to develop an improved version of the automated system.

Contact: Roselien Vanderhasselt and Frank Tuytens
Collaboration: Leuven University, Research station for Poultry Husbandry (Geel), ILVO



measuring the welfare of broiler chickens

Jumping for space: how much effort will broiler chickens make to decrease stocking density?

How much do broiler chickens care about having more space than the currently allowed stocking densities? To answer this question, we developed and applied a method where the broilers had to jump or climb over a hindrance to achieve a lower stocking density. The current density limit is 42 kg/m^2 , equivalent to 15-20 broilers per square metre depending on their expected body weight at the end of the rearing period. The effort consisted of jumping or climbing over a barrier to move from an area with high stocking density (15 birds/m^2) to a lower density area (12 or 9 birds/m^2).

The effort made to achieve lower stocking density was compared with the amount of effort made to get to feed. Feed is of course vitally important, and animals can thus be expected to make a great effort to reach it, especially when hungry. After six hours of feed deprivation, the broilers crossed a maximum height of 14 cm to eat. When the broiler crossed the same 14 cm barrier to get more space, this indicated a clear intention to move from the high density area to the low density area. Not only did the chickens prefer to have more space, they were willing to make a considerable effort to get it.

Contact: Stephanie Buijs
Collaboration: Swedish University of Agricultural Sciences (Uppsala)

Published as: Buijs S., Keeling L.J. & Tuytens F.A.M (2011) Using motivation to feed as a way to assess the importance of space for broiler chickens. *Animal Behaviour*, 81, 145-151



Space for Change in a Changing Space

The Social Sciences Unit

Interwoven research

ILVO's Social Sciences Unit was born in 2006 when parts of the former Centre for Agricultural Economics and the former Stedula group became part of ILVO. That cross-breeding led to a new mission for Social Sciences: to present and clarify, on a scientific basis, the social choices with respect to sustainable and competitive Flemish agriculture and fisheries.

This mission, together with the expectations of Social Sciences' stakeholders (policy-makers, the agricultural sector and fellow researchers) led the group to organise its research around three focal points:

- ✓ *the integrative approach to sustainability, based on the various levels of agricultural systems and decision-making;*
- ✓ *the dynamism of development processes within the agricultural and fisheries sectors and in the countryside;*
- ✓ *the spatial qualities of the urbanised countryside in Flanders and its development.*

These three foci are the basis for the three strongly interwoven research areas within the unit: INTEGRATIVE, TRANSITIONAL and SPATIAL ASPECTS.

Eight research clusters

Interconnectedness of research projects across the three areas gave rise to eight 'clusters' or themes. These clusters spearhead the content of the Social Sciences Unit's current and future research.

Four clusters study the development of the agricultural holding, system or sector, namely Resilience of Agriculture, Optimising Farm Management, Analysing Agricultural Systems, and Networking. The Resilience cluster examines to what extent the system can cope with changes, risks and uncertainties. Optimising Farm Management builds representative and communicative decision support models and aims to make them applicable at farm, sector and policy-making level. Analysing Agricultural Systems focuses on the agro-ecological system and discovers which trade-offs exist either between various environmental aspects or between economic and ecological features. The Networking cluster looks at the farm within its wider context of supply and market chains or similar networks to find out how farms function within this context.

The other four clusters focus on rural development. They include Conceptualising Rurality, Integrated Regional Development, Governance and Understanding and Designing Multi-Stakeholder Processes. The Conceptualising Rurality cluster investigates the current developments in the countryside and their impact on spatial quality. Integrated Regional Development maps integrated development

Space for Change in a Changing Space

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processes within regions. The region-specific character of the processes is a key factor in this research. The Governance cluster studies the role of the actors in the development processes. It examines to what extent innovative relations between farmers and a large set of rural/social actors can help create a sustainable and socially acceptable sector. Finally, Understanding and Designing Multi-Stakeholder Processes analyses, designs and optimises policy-related multi-stakeholder processes in rural development. This research includes the study of mechanisms for a participatory approach in the social learning process.

A year full of sustainability and rural development

Some eye-catching achievements of the Social Sciences unit in 2010 were the organisation of the PhD Winter School, finalising the Pigs2win and SVAPPAS projects, the central role played by the Social Sciences Unit in the policy working group on Agricultural Architecture, and our collaboration both within and outside ILVO on the study of agrobiodiversity.

One key factor in the Social Sciences Unit's mission is sustainability of production systems in agriculture and horticulture. In 2010, two projects presented conclusive answers to the question of how weigh economy and ecology against each another. The Pigs2win project modelled the trade-off between income and environmental pressure for pig finishing farms. This model has now been

incorporated into a farm-specific decision support system that will be supplied to the sector. The SVAPPAS project further developed the innovative Sustainable Value Analysis method for sustainability assessment in the agricultural sector.

The various assessment systems, such as the ones mentioned above or the Monitoring Tool for Integrated Farm Sustainability (MOTIFS), still need indicator sets for operational measurement. For this reason, coupled with the third generation agri-environmental schemes, a study was carried out on the interactions between agriculture and biodiversity. The next question is how to best implement these assessment systems in practice. To do so, Social Sciences researchers also observe the people as they engage in the learning process of how to use the systems developed at ILVO. In this way, 'social learning' - the mutual learning process between farmers and developers - was integrated into the Social Sciences Unit's research in 2010.

Another important topic was the qualitative use of the Flemish countryside and the place of agriculture in these rural areas. This type of research is performed in close collaboration with policy-makers. This year, Social Sciences led the 'Agricultural Architecture' policy working group and also collaborated with the regional government of West Flanders to study the role of agriculture in the rural identity in the Westhoek. Participatory learning processes were an integral part of the research goals and methods of this work as well.

Sustainable and Thriving

The Research of the Social Sciences Unit

Agrobiodiversity: a pillar for the third generation of agro-environmental schemes

ILVO's Social Sciences Unit, in cooperation with ILVO's Plant Sciences Unit and the Institute for Nature and Forest Research (INBO), published a report on agrobiodiversity in 2010. Agrobiodiversity is a broad term for all living creatures and ecological processes in the agricultural system.

The report drew the following conclusions: 1) to stimulate agrobiodiversity in Flanders, a broader policy is needed for the integral rural area; 2) the current agro-environmental schemes can effectively be optimised and expanded; and 3) fragmented application of measures obtains only marginal results.

The interactions between agriculture and agrobiodiversity are complex. Intensification of agriculture has led to a decrease in agrobiodiversity. Agriculture can positively affect the conservation of fauna and flora, as many farmland and meadow birds depend on agricultural activities for food and nesting. In turn, agrobiodiversity can have positive, neutral or negative effects on agriculture. 'Functional agrobiodiversity' has a supporting function (e.g., the effect of earthworms on soil quality), 'competitive agrobiodiversity' has a negative

effect (e.g., plagues) and 'neutral agrobiodiversity' does not significantly affect agricultural production (e.g., the presence of skylarks).

Besides the obvious marketable products of agriculture, agro-ecosystems also deliver services to the society. These benefits are called ecosystem services (ESS). They include regulating ESS (e.g., water filtration) and cultural ESS (e.g., recreation). When providing these ESS, agriculture largely depends on the agrobiodiversity present.

An analysis of these relations and insights on the ecology of agrobiodiversity leads to suggestions for measures that stimulate agrobiodiversity and the associated ESS.

The agrobiodiversity report was based on the analysis of 20 existing agro-environmental schemes and suggests 17 new agro-environmental schemes. The effects of all measures on agrobiodiversity, ESS and agricultural production were investigated. Finally, the effectiveness for different farm types and the relevant spatial level (i.e., field, farm or landscape level) of the measures were judged. Many of the existing and suggested measures are applicable to cattle farms and farms in wet areas. Arable and vegetable farms had an average number of applicable measures. Only a limited number of measures are effectively applicable for fruit growing and flower farms.

The final report, entitled 'Agrobiodiversity, Pillar for the Third Generation of Agro-Environmental Measures' has been presented to the appropriate administration. The conclusions found in this report can contribute to the foundation of a scientifically sound biodiversity policy in Flanders.

Contact: Karoline D'Haene & Bert Van Gils
Financing: Department of Agriculture and Fisheries - Division Monitoring and Study (AMS)
Collaboration: Research Institute for Nature and Forest INBO (projectcoördinator), ILVO

D'Haene K., Laurijssens G., Van Gils B., De Blust G. & Turkelboom F. (2010) Agrobiodiversiteit. Een steunpilaar voor de 3^{de} generatie agromilieumaatregelen. Report in assignment of Afdeling Monitoring en Studie (AMS), Brussels, 216 p



Pigs2win: farm-specific decision support for higher income and lower environmental pressure

In 2010, the Social Sciences Unit of ILVO finalised an exemplary mathematical model that aims to support pig farmers in their decision making. The model, called Pigs2win, is a means to forecast the economic and environmental effects of farming measures.

The intensification of agricultural production requires farmers to not only fight to remain competitive, but also to consider the environmental impact of their production activities. Making decisions to improve economic performance and reduce environmental pressure is not straightforward, because the ideal improvement measures are farm-specific. Knowledge is also lacking about the mechanisms that determine the relationship or trade-offs between economic and environmental performances of farms. Decision support systems can be helpful, but they will only be applied in practice if the user perceives them to be useful and user-friendly.

The researcher has two important tasks: to decipher the mechanisms that determine economic-environmental trade-offs at farm level, and to incorporate these mechanisms in a mathematical system that is clear and user-friendly.

ILVO scientists applied production theory to clarify the trade-off mechanisms. Production theory considers the relationship between input(s) and output(s) of a production process, i.e., the production function. In pig finishing, for example, feed and piglets can be considered as inputs, while the output consists of kilogram marketable pig. Through linking price information to input(s) and output(s), economic performances of farms can be calculated. Environmental performances of farms can be assessed in a similar way through linking environmental coefficients to input(s) and output(s). In pig finishing, for example, nutrient contents can be linked to feed, piglets and finished pigs, which allows for the calculation of nutrient emission as a measure for environmental performance. In that way, a framework can be constructed based on the relationship between production, economic and environmental performances of farms.

The result is a framework for analysing economic-environmental trade-offs at farm level. Our research shows how different management interventions may result in different economic-environmental trade-offs. Moreover, it shows how trade-offs are farm-specific and how they depend on the market conditions and environmental regulations.

Second, the researchers used the resulting production-theoretical knowledge to construct an actual decision support system. ILVO involved potential end-users and farmers from the start of this development process.

The process resulted in Pigs2win, a decision support system for pig farms. Pigs2win ensures that the user benefits from the advantages of production theory without being confronted with its complexity and specific terminology. Production theory is used to identify farm-specific improvement paths for economic and environmental performances, while all communication between user and decision support system uses traditional key performance indicators (feed conversion, daily weight gain etc.). Due to the involvement of potential end-users in the development of Pigs2win, the decision support system complies with multiple conditions to allow for a successful implementation in practice. Pigs2win is not only useful for farmers and farm advisors, but also for policy-makers, who can simulate the effect of various policy options on the improvement paths for economic and environmental performances.

Contact: Jef Van Meensel
Reference: Van Meensel J. (2011) Farm-specific decision support for economic-environmental trade-off analysis using production-theory-based methods. PhD thesis, Ghent University, 185 p



Sustainable and Thriving

The Research of the Social Sciences Unit

Sustainable Value Analysis: a new approach to sustainability analysis and monitoring

In agriculture, as in many other industries, sustainability is an important issue. Various assessment and monitoring methods have been developed, but few of them are used in practice as policy orientation tool. The reason for this is that most methods are burden oriented. This means that they aim to measure the undesired impact of production on the environment.

ILVO and Ghent University joined forces to find an alternative to these burden oriented methods in the Sustainable Value Analysis of Policy and Performance in the Agricultural Sector (SVAPPAS) project. The final report of this European project was presented in 2010. The aim of the project was to test the application of a novel sustainability assessment method, the Sustainable Value method, in the agricultural sector. During the project, many promising pathways for application were identified. The method makes it possible to steer European policy choices more in the direction of sustainable development. This project resulted in a series of extensions and modifications of specific interest for analyses in the agricultural sector.

The Sustainable Value method (SV) introduces two alternative perspectives: First, the method applies a value-oriented approach to impact assessment. The value-oriented approach assesses and aggregates resource use impacts according to their effect on value creation rather than according to their physical burden. Second, by integrating principles from financial economics, Sustainable Value assesses resource use from the viewpoint of the investor or resource supplier (i.e., a private investor or the government), rather than from the perspective of the resource user (i.e., the farm manager), or victim of resource use (i.e., the natural environment). SV focuses on the question how value creation can be maximised from the perspective of this supplier (i.e., society), who can allocate a given bundle of resources to different resource users. To do so, opportunity costs are used as guiding principle. These refer to the difference in value created when a firm's resources are invested in the best available alternative.

The method can advise decision makers, such as policy makers, in their search for more value creation in a sustainable manner. The objective of the Sustainable Value Analysis of Policy and Performance in the Agricultural Sector (SVAPPAS) project was to test, elaborate and apply this new method in the agricultural context. Another goal of the project was to evaluate the suitability of the EU Farm Accountancy Data Network (FADN) data for Sustainable Value analysis. This



project brought Figge and Hahn, the original developers of the Sustainable Value method, together with a multidisciplinary group of agricultural and ecological economists including the ILVO Social Sciences Unit.

In the project the following methodological extensions were elaborated:

1. Design and test of alternative benchmarks (points of comparison for firms or sectors), such as best practice benchmarks or policy driven benchmarks, and new calculation methods for the associated opportunity costs.
2. Account for the negative impact of resource use and determination of optimal firm pathways to achieve the desired reduction in resource use together with maximal value creation. As such the value-orientation of the method was extended with an impact-orientation.
3. Account for the difference in risk-return profiles between firms. Some firms generate a high sustainable value by taking more risk. By adapting the risk of the benchmark, it is possible to identify whether a firm's sustainable value score is due to taking additional risk or due to better resource management.
4. Examine the possibility of using the method for policy assessment (such as the impact of nitrate reduction targets) and policy design. An example of the latter is the determination of subsidies based on the sustainable value scores of firms.
5. Furthermore, different empirical applications were elaborated in the project, such as an analysis of the sustainable value created by German, Swiss and Belgian dairy farming and of the European pig sector. The project showed that the agricultural sector is a worthwhile sector in which to apply and further develop the method, owing to the many interesting sustainability issues and the availability of large datasets.

Contact: Koen Mondelaers, Bert Vander Venet & Ludwig Lauwers
Financing : European Commission (FP6 STREP EU)
www.svappas.ugent.be

Social learning: a participative process leading to better sustainability of dairy farms

In 2010, the Social Sciences Unit consolidated its expertise on the effectiveness of participative learning processes. This field research took place during two sustainability projects:

1. (Self)-screening of sustainability of dairy farms through discussion groups using MOTIFS (Monitoring Tool for Farm Sustainability). This took place during the so-called 'Melkveecafés' ('Dairy Cafés').
2. Optimisation of farm sustainability through discussion groups using MOTIFS as well as concrete action plans made by experts and dairy farmers.

Through participatory observation and interviews, ILVO researchers have identified critical success factors that can promote learning and changes in attitude. These trumps include the combination of group discussions and individual results, the strength and clarity of MOTIFS, and the diversity of themes.

Socially justifiable entrepreneurship is a hot topic. To increase both the sustainability and the competitiveness of a farm, the farmers continually have to update their knowledge and acquire new skills. Sustainability is a complex matter and as such is often not easily accessible. However, the use of different learning processes, from 'individual learning' to 'social learning', helps farmers to not only understand the range of ideas about sustainability but also to change their actions.

Social learning appears to be a very effective method to communicate the complex knowledge about sustainability. Farmers, when brought together in discussion groups, captured the knowledge on the theme (first order learning), but also appeared to change their attitudes, norms, perceptions and behaviour appear (second order learning).

The 'Melkveecafés', organised in cooperation with Division of Monitoring and Studies (AMS) of the Flemish Government's Department of Agriculture and Fisheries, were a first test case to research how the use of MOTIFS in discussion groups can stimulate social learning processes. To evaluate the social learning processes, semi-structured interviews were taken from the participating farmers.

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This was done before and after the use of MOTIFS. The interviews showed that contact with colleagues and experts was a very positive experience. The farmers also indicated that the integration of economic, ecological and social sustainability was a plus, especially linked to their own farm management. They see MOTIFS as an aid to get an overview of their farm and become aware of their strengths and weaknesses. The tool stimulates them to compare results quickly with colleagues. However, it took some time before the farmers fully understood the concept.

After the 'Melkveecafés', ILVO researchers noticed changes in knowledge and attitudes: the dairy farmers were more conscious of sustainable aspects of farming.

A number of conditions can foster the success of the discussion sessions. The composition of the group, the basic data that is used and the organisation and procedure of the discussion session were important. The farmers have to actively contribute. Their bookkeeping has to be correct, so indicators can be calculated that are useful for the discussion and so the evolution of their farm can be tracked based correct data. Farmers also have to be willing to make their farm results public. Indicators are important to start the discussion. Indicator values lead to reflection and farm improvement, but always have to be interpreted depending on the farm situation.

A follow-up project called DAIRYMAN will build on the abovementioned expertise. Research will be done to find out whether discussion groups lead to sustainable management changes. Experts will also develop an action plan in cooperation with the individual farmers. The methodology to improve the effectiveness of MOTIFS continues: social learning and specific individual advice will generate more knowledge on the learning processes and changes by farmers.

Melkveecafé

Contact: Fleur Marchand & Karoline D'Haene

Collaboration: Department of Agriculture and Fisheries - Division Monitoring and Study (AMS)

Campens V., De Mey K., D'hooghe J. & Marchand F. (2010) Melkveecafé: Samen grenzen verleggen. Beleidsdomein Landbouw en Visserij, afdeling Monitoring en Studie, Brussel en Instituut voor Landbouw- en Visserijonderzoek, Eenheid Landbouw & Maatschappij, Merelbeke
De Mey, K., D'Haene, K., Marchand, F., Meul, M., Lauwers, L. Learning through stakeholder involvement in the implementation of MOTIFS, an integrated assessment model for sustainable farming in Flanders. *International Journal of Agricultural Sustainability*.

Dairyman

Contact: Lies Debruyne & Fleur Marchand

Financing: Interreg IVB

Collaboration: Research institutes, advices services, knowledge transfer centres and commercial pioneer farms from Flanders, Wallonia, the Netherlands, France, Luxembourg, Germany, Ireland and Northern Ireland. In Flanders: Boerenbond, BAM (Bedrijfsadviesing Melkveehouderij), Hooibeekhoeve and 12 commercial pionier farms. General project coordinator: Plant Research International – Wageningen



Agricultural Architecture in Flanders

At the request of the Flemish Government's Agriculture and Fisheries Department, ILVO's Social Sciences Unit studied the architectural practice of farmers in Flanders. Researchers uncovered a certain degree of shortsighted planning in agricultural companies, paired with missed opportunities in the legal framework. In a future extension of this research, ILVO will publish a guide to good architectural practice. The Flemish Government's architects have examined the impact of the industrialisation and scale enlargement of agricultural buildings in the Flemish landscape. Their findings were published under the title 'Agricultural Architecture in Flanders.' The report contained several case studies and six recommendations for the sector and policy-makers. The Social Sciences Unit was then asked to create a policy group and translate these recommendations into an applicable policy.

The policy group discovered a number of questions that needed to be answered before making concrete proposals, such as:

- What is the entire construction process, from an idea to the result?
- How does the government handle permit applications?
- What are the existing initiatives and subsidies related to architectural policy actions?
- What are the possibilities for including agricultural architecture into the relevant study curricula?

From a literature study and discussions with the appropriate authorities and experts, ILVO researchers found the following answers to these questions. Farmers invest in new infrastructure to ensure their income and, if possible, to increase it in the future. The building process starts by drawing a concept of the planned construction. The older farmers rely primarily on the building contractor, the cattle food manufacturer, an architect or a consultant. The younger generation, in contrast, makes their building plans largely on their own because they have both more knowledge and more opportunities to gather information. The building plans focus on the functional, technical and economic aspects, while aesthetics remain subsidiary in most cases. A remarkable result is that the architect often has little input. His or her contribution to the process mainly consists of obtaining the building permit. 'Organisational myopia' was identified as a frequently recurring problem: farmers are often so strongly fixated on the current situation that they don't have a long-term vision or look at the new investment in function of their whole business.



Conversations with the government workers revealed that they pay little attention to the architectural and landscape features when assessing a building application. Furthermore, no structural subsidies exist for matters related to agricultural architecture. A number of pilot projects have been started, however. In education, farm buildings are completely absent from engineering and architectural courses. Farm construction only appears in agricultural courses.

Armed with this information, the policy group designed an action plan and will implement it starting in January 2011. The action plan focuses on the actions that can be taken within the existing policy in the short term. In a first phase, the Social Science Unit will develop a guide based on the existing know-how and literature about Flanders. The guide will explain what is meant by good architecture and includes the functional, economical and aesthetic aspects. In the second phase, the researchers will explore various means to change the attitudes of both industry and the government.

Contact: Bert Pecceu & Elke Rogge
Financing: Flemish Government – Department of Agriculture and Fisheries

Pecceu B., Rogge E. & Dessen J. (2010) Beleidswerkgroep 'Agrarische architectuur'. Mededeling ILVO n°82, Instituut voor Landbouw- en Visserijonderzoek, Merelbeke, 38 p

Sustainable and Thriving

The Research of the Social Sciences Unit

Westhoek Inspires: regional development based on regional identity

The province of West Flanders commissioned the Social Sciences Unit to research regional identity in Westhoek, a rural region in West Flanders. After conducting 20 semi-structured interviews, 400 online surveys and five focus groups, the researchers sketched an overview of the experiences and expectations for the region as expressed by residents, entrepreneurs and regional associations. This research was then translated into recommendations for strategic and communicative development in the region.

In September 2009, 'Streekwerking Westhoek' (loosely translated as the 'Regional Working Group of Westhoek') started a regional branding project called 'Westhoek Inspires'. This project was financed by the European Fund for Regional Development. Other regional partners in the project are the provincial tourism department and RESOC Westhoek, a civic socio-economic association. The regional partners wanted to explore regional identity in the Westhoek, focusing on the present and future while honouring the past. The project has three target groups: the residents of the Westhoek, the entrepreneurs from the region and the tourists from outside the region. The main goal of the regional branding project in the Westhoek is to develop a common communication strategy. The goal of this strategy is to promote the region to both residents and outsiders. Likewise, the goal of the Regional Working Group of Westhoek is to further develop regional identity to be a force for enhancing regional attachment and social cohesion in the region.

The research revealed a very strong regional attachment to the Westhoek. Many people feel strongly connected to their region, but for different reasons. The open space and wide landscape, the calmness, the dialect and the social dynamics of the region are the most important identity markers. The most dominant regional identity is seeing the Westhoek as an open space where one can find peace of mind. This is reflected in the dominant regional development processes, which focus mainly on maintaining open space, the landscape and the quietness. However, other residents of the region fear that conserving these characteristics too rigidly will threaten the economic development of the region. ILVO's research also concluded that the residents and regional associations want a stronger tourist, social, cultural and economic profile. Such a profile is needed to promote the region in a more modern way. Such a regional identity can be used to mobilise the residents to cooperate for the future, strengthening the already

existing regional attachment. If the Westhoek wants to be a region with vision and a future, they need to work in a dynamic way on regional identity and find the right balance between evolution and tradition.

Communication is crucial in regional development processes. Published research advises that all social, economic, tourist and cultural actors have to broadcast the same message. Each partner is free to emphasise a different facet of the common story. Regional identity is a dynamic concept that can change and evolve according to new perspectives. The ILVO report concludes that many stakeholders consider the regional level as the most ideal level to prepare regional development strategies. Many respondents see the regional government as the ideal, neutral and motivated partner to develop and implement these regional development strategies.

Contact: Lies Messely
Financing: Provincie West-Vlaanderen

Messely M. & Dessein J. (2010) Betekenis en mogelijkheden van streekidentiteit als mobiliserende factor in de Westhoek. Instituut voor Landbouw- en Visserijonderzoek, Eenheid Landbouw & Maatschappij, Merelbeke, 49 p., www.west-vlaanderen.be/provincie/beleid_bestuur/gebiedsgerichte_werking/streekhuizen/streekhuis_esenkasteel/Documents/Eindrapport_Streekidentiteit%20Westhoek.pdf





Sustainable and Thriving The Research of the Social Sciences Unit

Twenty in a Monastery: PhD Winter School

Early in 2010, the Social Sciences Unit organised an international scientific meeting on the subject of sustainability. This 'PhD Winter School', which took place in the remote monastery of the 'Minderbroeders' in Vaalbeek, was an unusual concept that proved to be fruitful. During four days, twenty doctoral researchers shared their enthusiasm, diversity, eagerness to learn and passion for sustainability research. These researchers from various backgrounds were associated with research institutes from all over Europe and represented four continents. This meeting also reflected ILVO's growing interdisciplinarity with the presence of representatives of the Animal Sciences and Technology and Food Science units.

The theme of the PhD school was broad: 'an institutional approach to the analysis of systems, systems change and transition in natural resources'. This was reflected in the research presented: governance in Finnish national parks; optimisation of cattle rearing in South Africa or pesticide use in apple cultivation in Switzerland. Flemish horticulture and fisheries, GMOs and intensive pig production, molecular farming and farming impact studies also came on the programme. The common theme was change processes in natural resource management.

Apart from the exchange between peers (a key aspect of this PhD Winter School), three renowned speakers also gave lectures that complemented or challenged the current sustainability creed. Thomas Hahn of the Stockholm Resilience Centre introduced the topic 'Resilience'. Krijn Poppe of the Dutch LEI talked about transition science while Jim Woodhill of Wageningen University and Research Centre elaborated on the notion of 'complexity' and its relation with development.

The organisers made great efforts to develop the innovative concept of the Winter School. They purposefully avoided doing too much too fast with too many papers in an overloaded programme. The key word 'slow conference' led to debate and critical but constructive discussions.

Should ILVO wish to play a first class academic role in the future, organising more events of this kind will be indispensable. Not only will our own researchers be able to construct and be part of an international network that will improve their own research, but every participant will return home with a good impression of ILVO.

ILVO at a Glance

ILVO's Operations

Personnel Services

ILVO is a great place to work, according to the results of the personnel survey completed by ILVO staff in March 2010. The personnel services staff were delighted to hear the outcome of this survey, which also indicated that an ILVO employee is a happy employee and that most members of its personnel believe that making importance on making ILVO a pleasant place to work needs to stay a priority.

We continue to work toward a structured competency-based management. In 2010, several aspects of this work were refined. In spring 2010 the first phase of the 'FuFa@ILVO' project was completed. This 'Function Families' project started by assigning meaningful and uniform descriptions to the research functions. The second phase, scheduled to end in spring 2011, will do the same for the remaining functions.

Job-related training has now become easier to request and keep track of. In early 2010, an automated and paperless system created an easy way for each individual to request training and register participation in their personnel file. This document is a required part of the PLOEG evaluation file, which makes a first link to competency-based evaluation.

We also spent time preparing the employees for the testing required to become a state employee. Many of the employees who passed this test have received tenured status with the Flemish Government. This, in combination with the new hires, resulted on 1 January 2010 in more than 200 tenured government employees at ILVO for the first time.

The work towards 'Efficiency and Effectiveness' continued. Members of Personnel worked together with the various ILVO units to examine which HR processes could be improved. The need to optimise our basic services (personnel administration, payroll of ILVO-OC, time registration, etc.) has stimulated us to question our existing systems and look for innovation. To this end, we worked with ICT to make and implement a new version of the existing personnel database.

An internal evaluation coach now provides individual guidance on the Bottom Up Evaluation of supervisors, resolution of performance problems, and coaching.

Positioning, efficiency, valorisation, and multi-disciplinary working: ILVO's internal working groups take the lead

A dozen interdepartmental working groups have been responsible this year for improvements in positioning, sustainability, processes, efficiency related to cultivated ground, and interdisciplinary cooperation. A few highlights:

The **Accreditation** working group streamlined the trainings, certification assignments and calibration assignments, as well as the general quality control for all of the ILVO labs seeking (re-)accreditation.

The **Valorisation** working group formulated proposals for a policy on disseminating knowledge and innovative products, processes and technologies.

The **GMO (Genetically Modified Organisms)** working group organised a debate between ILVO's genetics experts and researchers from other disciplines to define the broader context of GMO research. ILVO distances itself from the currently polarised debates in the media and the battle for the consumer's approval. Instead, we focus on the objective evaluation of the possibilities to safely use GMOs in light of a more sustainable, innovative and more profitable agriculture and horticulture.

For the first time, the **Organic Agriculture** working group organised a structural discussion in combination with a study day on research in, about and for the organic agriculture sector.

The **Development Cooperation** working group discussed ILVO's role in this area and formulated a vision text about how ILVO can contribute to development of third-world countries.

total staff composition as of 31/12/10, number of staff expressed in full-time equivalents (FTE)

	male/FTE	female/FTE	total/FTE	percent OC (%)
A-level	120/116	125/114.3	245/230.3	59.2/60.7
B-level	47/45	59/48.6	106/93.6	47.2/46.9
C/D-level	120/113	88/65	208/198	38.5/40.1
Total	287/274	272/227.9	559/501.9	49.2/50.8

Environment and Employee Health

ILVO has a tradition of investing in environmental and health-related projects. One of our major priorities is to properly dispose of the wastewater generated at the Merelbeke-Melle campus.

In the first phase, a new wastewater sewage pipe has been installed. That water will flow into a collector installed by Aquafin. The next step will be to connect the various sites to this sewer system.

ILVO employees responded in droves to a call for tips about how to be more sustainable at home and at work. This initiative resulted in a poster with a few handy tips from ILVO employees, posted during Sustainability Week in October 2010.

The employees continued to be informed about health issues at work using the familiar 'Waakvlam' newsletters and posters.



ICT

The ICT department supports the information technology needs of all ILVO employees. The six ICT employees manage the computer infrastructure and networks spread over ILVO's seven locations. In addition, ICT also provides custom-made applications for ILVO's various research and management needs. ICT staff are also responsible for the technical construction of the ILVO website and Intranet. These functions are carried out in collaboration with the Communication staff.

ICT highlights from 2010:

- A thorough uniformisation of the (Windows) ILVO network environment
- The implementation of a centrally-managed LIMS (Laboratory Information Management System)
- Development of a database application to track training

ILVO at a Glance

ILVO's Operations

Communication, popularisation and dissemination

Two former journalist/editors joined ILVO's Communication department in 2010. Their task is to popularise and thoroughly disseminate important research results to the stakeholders (e.g., government, agriculture, horticulture and fisheries industries, the food industry, trade organisations and partners) and to the general public. ILVO views popularising communication as an important non-scientific valorisation of the scientific knowledge generated, as well as being an obvious form of service to the community.

The vision of ILVO's external communication thus aims for more articles in the trade press and general press, more visibility and participation in relevant trade shows, clarity and larger audiences at congresses, symposiums, study days, demonstrations, speeches and tours led by ILVO or in which ILVO participates. We plan to renew both the form and content of our own e-channels (www.ilvo.vlaanderen.be and the quarterly newsletter 'Nieuwsgolf') as well as the various ILVO informational brochures.

The new communication team sent over 20 press releases in the second half of 2010. Several of these resonated in the media, such as news about nematodes in potato culture, the field testing of GMO maize to evaluate co-existence of GMOs with traditional maize, doctoral research on antibiotic resistance in chickens, and the valuable leek powder as demonstrated in the Agriflanders trade show. For example, the following TV channels presented at least one ILVO-related report: VRTjournaal, VTM news, NTV, Kanaal Z, Focus, WTV, AVS, Ketnet, and others. Elsewhere in this report, you can see an illustrated selection of articles about ILVO from the trade and general press.

Starting in 2010, ILVO set up a collaboration with the Flemish Info Center for Agriculture and Horticulture (VILT). Each month, about 10,000 readers receive a relevant packet of ILVO discoveries as part of the 'Gevilt' newsletter.

Important efforts for internal communication were also made in 2010. Practical announcements were communicated via updates to the Intranet and a monthly 'Newsflash'. The community-building quarterly newspaper called 'OVLI' (ILVO turned upside down and with a lightly ironic undertone) continues to be filled by a dedicated team of writers. As per tradition, ILVO holds two collective

personnel events in summer and winter. The communication department raised the enthusiasm of all ILVO in both events. At the end of 2010, instead of the usual ILVO new-year's drink, we held an ILVO-visits-ILVO event at the ILVO site in Ostend. The winter event was also combined with the so-called 'DIVE FOR LIFE', a frigid dip in the North Sea in exchange for sponsoring for the charity program 'Music For Life'. Fifty-four ILVO employees jumped into the ice-cold water in winter weather of 2°C and wind at 7 knots. This action, a follow-up to last year's participation in Music For Life, brought in €12,277 for this good cause - double the amount of 2009.



Management Control and Finances

Keeping Our House in Order

In the spring of 2010, ILVO received the mandates from the Internal Flemish Audit Administration (IAVA), based on their 2009 audit. Three interdepartmental working groups were formed to implement the recommended improvements. This led to the actualisation of the ILVO Quality Handbook, which describes ILVO's operations in detail, along with the work processes and their risk analysis. The point of departure as always remains the optimisation of ILVO's organisational management.

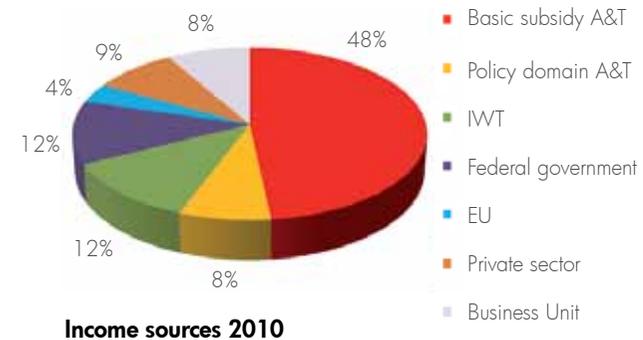
In the fall, the Committee of Scientific Directors (COWEDI) met in a strategic seminar to set ILVO's future operational goals. This should guarantee that the abovementioned improvement actions, along with the related advice generated by the three working groups, will be implemented in 2011.

Follow-up of the operational goals for 2010 was realised by elaborating various new critical success factors (KSFs) and their related critical performance indicators (KPIs) during the end of 2009 and beginning of 2010. The research units and ILVO's administration are both required to adhere to these performance indicators. The consolidated Balanced Score Card (BSC) system was implemented. The COWEDI also evaluated the KPIs.

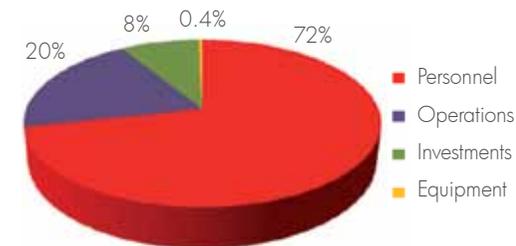
Finances

ILVO's finances rest on a double support. As an Internally Autonomous Agency (IAA) of the Flemish Government, ILVO receives a basic subsidy for the operations, investment and personnel paid by the Flemish Government. In addition to this subsidy, ILVO has traditionally gained approximately 50% of its income from the separate corporate personality called ILVO Own Capital (OC). ILVO, being a scientific institute, can also receive various grants to carry out project research and also has income from the various Business Units associated with the different research units.

Each year, ILVO management combines the income from the Flemish Government and OC to form a complete picture of the total operational cost of the institute.



Income sources 2010



Expenses 2010

Publications



Plant Sciences

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