



Flanders research institute for
agriculture, fisheries and food

MSCA individual fellowship hosting offers

The Flanders Research institute for Agriculture, Fisheries and Food (ILVO) is a public research institute located in Belgium. ILVO performs multidisciplinary, innovative and independent research aimed at economically, ecologically and socially sustainable agriculture and fisheries. Through this research, ILVO accumulates fundamental and applied knowledge which is vital for the improvement of products and production methods for quality control and the safety of end products, and for the amelioration of policy instruments as a foundation for sector development and agricultural policy for rural areas.

Recently, some important management decisions have been made to orientate the research at ILVO in a holistic framework of systems thinking as well as to combine ILVO's tacit knowledge with new technological approaches like genomics, metabolomics, (remote) sensing technology, precision farming, innovative food/feed production technology, new breeding technologies, modelling as well as participatory social sciences approaches. This means that a lot of the research at ILVO is conducted in Living Labs, such as a Food Pilot, fishing vessels, modern greenhouses and animal farming units, and in the context of inter- and transdisciplinary research. To accelerate and further improve this new research process, ILVO is looking to host experienced researchers at post-doc level in the framework of Marie Skłodowska-Curie or other individual fellowships.

Possible research items are shown below and are divided over the different research units of ILVO:

Technology and Food Science Unit

***Heat transfer and mass transport phenomena in thermal food processing.** They are very important, as they determine the processing time and conditions for optimal food quality and safety. We can establish accurate heat transfer models based on thermal properties of food and e.g. enzyme kinetics determined in laboratory conditions (using T-t curves). However, a spatial and temporal discretization of the heat transfer problem will result in exact time-temperature profiles throughout the food, so that the evolution of food quality and safety parameters during thermal processing can precisely be monitored. CFD software (computation fluid dynamics) with numerical modelling techniques can be used to optimize thermal food processing.

***Development and implementation of molecular and mass spectrometric analysis methods for GMO and food allergen testing, including e.g. ELISA, qPCR (quantitative real-**

time PCR), *ddPCR (droplet digital PCR)*, *LC-HRMS methods*. Within ILVO's Food Pilot it is possible to prepare allergen incurred food matrices mimicking real life food processing. This matrices can be used to study the impact of processing on allergens. This can either be focused on detectability (with ELISA, qPCR (quantitative real-time PCR), ddPCR (droplet digital PCR) or LC-MS/MS), on identifying stable proteotypic peptides or on investigating the modifications induced by this processing. The latter two using LC-high resolution mass spectrometry (LC-HRMS).

*** Precision crop farming.** As a research institute ILVO cooperates with government, industry, academia, civil participants and of course also with farmers to explore possibilities for innovation and economic added value by the application of remote sensing techniques in agriculture and precision application technologies for plant protection products and fertilisers. In addition, ILVO focusses on integration of data to come to smart solutions that can support farmers in their management. Several national and international projects are currently running within this research field, enabling interested post-doc researchers to perform valuable synergetic activities.

***Livestock emissions (gases, dust, odour).** ILVO is the reference institute of the Flemish government for the assessment and development of reduction techniques for livestock emissions (gases, dust, odour). Especially of interest are ammonia emissions from mechanically (pigs and poultry) and naturally ventilated (dairy & beef cattle) animal housing systems. Our research and collaboration efforts aim to develop innovative and widely applicable mitigation techniques (both front- and end-of-pipe). Therefore we study emission and ventilation processes at different scales (lab, test installations, farm) using advanced measuring techniques (e.g. ultrasonic anemometry, FTIR, laser absorption spectrometry, olfactometry) and modelling tools (e.g. mechanistic modelling, Computational Fluid Dynamics). ILVO has a modern test infrastructure, including real life animal houses. Several national and international projects are currently running within this research field, enabling interested post-doc researchers to perform valuable synergetic activities.

***Functional ingredients, functional food, novel foods, biobased applications from biomass.** ILVO has a Food Pilot (www.foodpilot.be) which is a unique technological application centre for the food and allied industry, encompassing complete processing lines for meat, juices, dairy, heating (UHT, sterilisation, pasteurisation), drying, extrusion, mixing and milling as well as analytical labs for microbiology, (bio)chemistry, physico-chemistry, taste panels. The Food Pilot invites professionals and experienced researchers as a Living Lab to perform cutting edge research on food technology, food quality, food authenticity and food safety to produce the food of tomorrow.

***Bio-informatics and systems biology in the context of gut health research.** A new research line has started on gut health of production animals as well as animals as human model (e.g. mini-pigs). Several influencing factors are investigated such as composition of the diet, antibiotic usage, alternatives for antibiotics, pro- and prebiotics. Analytical approaches such as gut bacterial metagenomics, metabolomics, transcriptomics, gut physiology and morphology, .. will be used. A thorough bio-informatics and systems biology approach will be needed to link and interpret the multitude of multidisciplinary data for which experienced researchers are invited to join this research line.

***Ex vivo gut simulations to explore alternatives to antibiotics and antibiotic resistance transfer phenomena.** The use of antibiotics in animal husbandry is much under pressure

because of the rising issue of antibiotic resistance which is now regarded as one of the global threats of human health by the World Health Organization (WHO). There is an urgent need to find, on the one hand, suitable alternatives for the common antibiotics, but on the other hand to know the consequences of justified and remaining antibiotic use in animal husbandry in regard to the spread of antimicrobial resistance. *Ex vivo* simulations of the bacterial gut ecosystem of animals (mainly pigs, poultry) but also of humans are very useful for these kind of studies because they don't need animal experiments and can be more standardized and controlled in the lab. They are based on continuous fermentation bioreactors in which specific parts of the gut are simulated by inoculation with animal fecal material and computer controlled establishment of gut environmental conditions including (semi-)continuous feeding and excretion. In these *ex vivo* experiments, interesting bioactive components such as phytochemicals, peptides, probiotics, prebiotics, etc. can be tested for their antibacterial activity together with the behavior of introduced pathogens of zoonotic or veterinary importance or antimicrobial resistant bacteria such as *E. coli*. Samples from the bioreactors are analysed by metagenomics, metabolomics, drug residues with LC/MS-MS, spread of antimicrobial resistance through qPCR and ePCR.

Plant Sciences

***Precision crop phenotyping.** Precision phenotyping is very relevant in the context of plant breeding. ILVO develops dedicated plant phenotyping tools based on the capture and analysis of images obtained under controlled environments, in the greenhouse or in the field. In the field we use drones that can be equipped with different cameras (visual, NIR, thermal, hyperspectral). We have phenotyping experience with different crops, including forage grasses, maize, wheat or soybean. In the context of these activities, ILVO is partner of the Belgian plant phenotyping node.

***Functional-Structural Plant Modelling.** Functional-Structural Plant models (FSPM) are mathematical descriptions of plants, in which ecophysiology is merged with plant architecture. As such, virtual three-dimensional plant models are generated and used to perform *in silico* experiments. These models are innovative tools for studying competition (e.g. crops with weeds) and mutualism (e.g. agroforestry) between species. Furthermore, FSPMs are used to design ideal theoretical phenotypes for specific climatic/geographical areas, or specific growing systems, assisting breeders to select and cross plants with interesting beneficial traits.

***Pollen metabarcoding.** Next generation sequencing (NGS) and more specifically amplicon sequencing can be used to investigate the taxonomic composition of complex samples. Based on the sequence variants present in the pool of amplicons, the taxonomic composition is determined. At ILVO, we have both wet-lab (library preparation) and dry-lab (bioinformatics) experience with molecular barcodes corresponding to different groups of organisms, such as bacteria (16S), fungi (ITS2), nematodes (18S). We have the ambition to extend our molecular toolbox with protocols for pollen metabarcoding using one or more barcodes suited for plants, for example *rbcL*, *matK* or ITS. These protocols can be used to investigate pollination networks and plant-pollinator interactions, aspects of particular relevance for optimizing the seed yield of insect-pollinated crops.

***Exploring genetic diversity in breeding gene pools.** In an integrated approach, we develop strategies that combine functional gene annotation and candidate gene selection for agronomical relevant traits. For instance, pathways that control plant architecture (related to yield), or secondary metabolite biosynthesis (related to quality). We then design highly efficient Next Generation Sequencing (NGS) based genotyping assays to screen for genetic diversity in breeding germplasm, and combine this with bioinformatics approaches to predict the functional consequences of DNA-polymorphisms. This approach to identify naturally occurring genetic polymorphisms is complemented with the development of highly multiplex CRISPR-Cas genome editing techniques for the targeted introduction of sequence variants in multiple genes of the same pathway or multiple members of a given gene family. Combined, these techniques allow to identify or create elite breeding materials.

***Unravelling plant behavior using machine learning.** Grasslands cover a large part of the agricultural and natural area, and are therefore agronomical and ecologically of substantial importance. In the face of Climate Change, it is essential to understand the behavior of grasses in response to the environment in which they grow to safeguard the diversity they harbor and the ecosystem and economic services that they deliver. ILVO has completed several projects with multi-location field experiments in which large sets of phenotypic and genomic data have been generated. We use machine learning techniques to explore patterns in the reaction of plants to their environment, and develop predictive models of their response to future climatic

conditions. These machine learning models are used to study the effect of Climate Change on grassland adaptation at the genotype and phenotype level, and assist breeders in the selection of plants with the highest potential.

***In vitro regeneration of (recalcitrant) protoplasts.** ILVO- Plant Science Unit has gained experience in protoplast regeneration in various crops. Regeneration is very species dependent and the process has been thoroughly monitored, however without in-depth understanding of its molecular and physiological backgrounds. Comparing regenerative and non-regenerative circumstances for particular genotypes will provide more insight. The effects of culture system, phytohormone addition, medium refreshment...will be evaluated. More precisely, we want to study phytohormone metabolism with an array of chromatographic tools, evaluate genome silencing and DNA condensation with molecular and microscopic tools and link these to particular regeneration events (first divisions, callus formation, organogenesis...). Subsequently the effect of significant parameters will be tested on non-regenerative genotypes.

***Mass spectrometric analysis for plant (a)biotic stress hormone profiling using LC-MS/MS and LC-HRMS methods.** Within ILVO-Plant Sciences Unit breeding involves the evaluation of stresses in plants. Plant hormone analysis by MS is available for different stress related hormones such as salicylic acid, jasmonic acid, abscisic acid, etc. The goal is to reveal relationships between plant developmental stages, genotype, etc. and plant hormone regulated stress responses. Stresses involve drought, insects, mites and pathogens.

***Ornamental plant breeding.** ILVO-Plant Sciences Unit has ongoing breeding programmes in azalea, nursery plants and garden roses in close collaboration with growers. Therefore different techniques are used linked to (interspecific) hybridisation and to overcome pre- and postzygotic incompatibilities: embryo rescue, genomic and fluorescent in situ hybridisation (GISH and FISH), molecular markers, ploidy and genome size estimation, fertility testing, etc. Specific breeding goals we focus on are new innovative genotypes, scent, disease resistance, compact plants, etc. Research can be performed on a specific crop for a specific breeding goal using different techniques.

Animal Sciences (including Fisheries)

***Youngstock feeding and management.** ILVO is running several trials with dairy (Holstein) and beef (Belgian white & blue) young stock on colostrum management & feeding management. Especially of interest are the impact of feeding and management strategies on growth performance, rumen development, rumen and intestine microbiome development and function, feed efficiency. Our research and collaboration with e.g. Ghent University, University of Liège combines specialties of feed, feed evaluation, performance trials and in depth microbiome analyses techniques. Besides trials in our specialized animal facilities, we also work closely together with Flemish dairy and beef farms to translate interesting findings to the sector. Interested post-doc researchers are welcome to perform synergetic research activities in the area of microbiome development and evolution, rumen physiologic research and/or immunological research in cattle young stock.

***Non-invasive monitoring of nitrogen excretion and efficiency in cattle.** ILVO animal science unit has a long track record on feeding trials, feed evaluation and nitrogen balance trials. We are well equipped in these research area with up to data dairy cattle production facilities, several single and few double cannulated cows within our herd to perform in sacco feed evaluation trials. Recent research is oriented towards low protein diets both in dairy and beef in order to work on ammonia emission reduction in a source oriented way. Within the different feeding and nitrogen balance trials, we have collected a elaborative set of feed, milk, urine and feces samples. Interested post-docs could develop a non-invasive or limited invasive ready to use monitoring system for nitrogen excretion, ammonia emission and nitrogen efficiency based on milk, saliva, blood and/or spot urine samples.

***Livestock emissions on animal level.** ILVO animal science unit has an experience of almost a decade to measure greenhouse emissions of individual animals. The facility contains open circuit chambers and different onsite gas emission analyzers including GreenFeeds. This makes measurement possible in our research barn and at animal farms. Our research and collaboration efforts aim to investigate the effect of different diets and additives on the production of greenhouse gases by the targeted animals. Most research is done on dairy cows and methane since they are the major emitters and with the most impact in animal agriculture. Interested post-doc researchers test new or promising diets and additives to mitigate on-farm methane emissions.

***Macromineral requirements and interactions between minerals in pig diets.** The development of phytase allowed to produce low phosphorus pig feeds. However, in the field, nutritionists fear the effect on bone health. In this renewed context of low phosphorus diets, there is increased interest and questions on the interactions between minerals and how these affect the requirements. While this knowledge is well studied in poultry, in pig diets there are still ample questions remaining on the digestible calcium and phosphorus content for optimal growth, bone health, intestinal health and minimal excretion to the environment. ILVO has the equipment and expertise to carry out performance trials, digestibility trials, determination of body composition to get better insights in these questions.

***In vitro methods for pig feed evaluation.** Optimal nutrition starts with proper evaluation of feedstuffs. Especially, byproducts show a large variation in quality so that correct feed evaluation is crucial for incorporating them in pig diets. As in vivo trials are time-consuming and expensive, ILVO is developing *in vitro* methods and NIRS techniques to estimate the digestibility, energy and protein value of pig feeds.

***Increase the taste and quality of the Flemish pork.** Flemish pig industry has selected for animals with a high lean meat percentage, low feed conversion and high cutting efficiency. Recently, however, concerns are increasing about the low sensory and technological meat quality for both the fresh market and processed meat products. One of the problems is the high incidence of Pale Soft and Exudative (PSE) like meat. In addition, pork is characterised by a low intramuscular fat percentage, which leads to less tasty meat. Flavor, tenderness and juiciness are nevertheless the most important factors during the choice and purchase of (pork) meat. The intended stop of surgical castration in 2018 highlights questions about meat quality, as the production of intact boars can negatively influence the sensory quality of pork. Immunocastration can offer an alternative, both regarding the risk of boar taint and the improvement of meat quality, but more information is needed (e.g. optimal timing of the second vaccination, differences can be expected based on the pigs' genetics). The general aim is to improve the taste and quality of the Flemish pork meat to meet the demands of the consumers and the producer. This aim will be implemented in 5 objectives: 1) charting of the needs of the sector (for fresh and processed meat) 2) implementing a fast online/at-line measuring method for meat quality, 3) using the choice of genetics (terminal sire line) and timing of immunocastration to produce more tasteful and quality pork meat, without negative effects on zootechnical results and carcass quality, 4) gaining insight into the variation of meat quality within the current offer of pork in Flanders according the lean meat percentage and sex of the most common sire lines, and 5) informing and sensitizing the sector via a guide on how to produce more tasty and appealing pork meat with better technological quality.

***Extended production cycle in laying hens**

Laying hens are kept in production until the age of 75-80 week, but the actual egg production period is only 55-60 weeks long. During a single laying cycle a hen can produce on average 360 eggs. Extending the egg production period and keeping hens longer, possibly until 100 week of age would not only contribute to increased profitability but also to more sustainable food production. However, there are several bottlenecks in extending the production period of laying hens such as declining persistency and egg quality, decreased bone quality, health and welfare. To tackle these problems, a multifactorial approach is needed. Improved genetic selection has to be accompanied by optimal nutrition and management to be able to produce 500 eggs until 100 week of age which should be feasible by 2020, as layer breeding companies predict. ILVO has the equipment and expertise to carry out layer performance trials, digestibility trials, determination of egg quality and body composition to get better insights in these questions.

***To reduce emissions from the poultry industry**

For the poultry industry, concerns about emissions such as ammonia, odor and dust are multifaceted and include issues of poultry performance, health, and welfare, and environmental impact. Pressure is being placed on poultry producers to reduce their emissions but at the moment they are lacking efficient and affordable solutions. Research is needed to improve or develop methods of new techniques in poultry husbandry management or concerning adaptations in nutrition to reduce the poultry emissions. Environmental pressure is an important scientific topic within ILVO that has the expertise as well as the equipment for investigating emission reducing strategies.

***Alternative protein sources for the poultry industry**

In the last years more attention is being put on the use of local feed resources, particularly for protein sources, both for broilers and laying hens. The feed industry and by-product industry is active in this topic and several alternatives to soya have appeared in the last 10 years: macro

and micro algae, new by-products from the rapeseed and sunflower processing industry, legumes (peas, faba beans, etc) , insects, single cell protein production from bacteria and/or yeasts and extraction of protein from grass and other green crops. However, there is still information lacking and research is needed on how poultry react to these protein sources in terms of performance, health and welfare. ILVO has the expertise and the facilities to carry on scientific research that evaluates the impact of new feedstuffs and protein sources on animal digestive physiology, health and performance.

***Development of an ecosystem-based approach for managing brown shrimp (*Crangon crangon*) in the Southern North Sea.** As a research institute, ILVO cooperates with governments (national and EU level), fishing industry representatives, academia and with fishers to explore possibilities for sustainable resource exploitation. Assessment and management of stocks, ecosystem effects of fishing, the development of innovative fishing gears and monitoring of ecosystem status and functioning are core research lines. ILVO plays a key role in the evaluation of (Belgian) fisheries by collecting necessary data in order to give advice on fishing opportunities (TAC) as an active member in ICES Working Groups.

Brown shrimp (*Crangon crangon*) is considered a key species in the coastal ecosystem of the Southern North Sea. The brown shrimp stock is a commercial target but also an important prey to a large variety of predators, mostly fish. Currently, brown shrimp fisheries are not subjected to European TAC legislation or management. However, recent significant fluctuations in population dynamics have raised the question if there is any indication that the brown shrimp stock is fished at unsustainable levels. Ecosystem-based management including the role of predators, food availability and climate change could provide a better understanding of the brown shrimp stock dynamics. ILVO invites post-doc researchers with a high interest in fisheries and modelling to develop an ecosystem-based approach for managing brown shrimp (*Crangon crangon*) in the Southern North Sea, to discuss the ecological and socio-economic implications and to recommend measures to reach a long-term sustainability for the brown shrimp stock.

***Development of technologies to monitor ecosystem effects of fisheries.** A key element in ecosystem monitoring includes monitoring of fisheries catches, benthic habitats and a continuous development of monitoring technologies to increase our capacity to addressing policy questions arising within the ecosystem approach to fisheries management and the common fisheries policy. The combination of high-tech experience using optical imaging techniques developed for agricultural purposes and a close collaboration between ILVO and the fishing industry creates an excellent platform to explore and develop new monitoring techniques for an improved observation of fishing activities, their catches and habitats in which they fish. Our interest primarily lays in the development of innovative detection technologies for both commercial and non-commercial species. We seek post-doc researchers with an interest in the development of detection technologies for underwater applications, e.g. seabed mapping and monitoring, as well as applications on-board vessels such as automated registration of catches. Monitoring techniques may include acoustic detection technologies using multi-beam echo sounders and fish finders or detection technologies in the visual spectrum using hyperspectral imaging. Equally ILVO will collaborate with the applicants to develop classification systems using machine learning software to convert the results from the developed detection technologies into real-life applications. ILVO invites post-doc researchers with a high technological and fisheries interest to develop techniques to improve scientific monitoring of the ecosystem within a fisheries context.

Social Sciences Unit

Participatory farm modelling. ILVO has a research line focusing on the participatory development of farm models that support on-farm decision making. In order to facilitate adoption of these models in practice, stakeholders are involved in the development process from the very beginning onwards. They help in defining the system and system boundaries to be modelled, and contribute to incorporating tacit knowledge from practice into the models. Models are developed for different agricultural sectors (pig, dairy, etc.) and are transformed into user-friendly decision support tools. Besides analyzing participatory model development as a process, an important focus of the research lies in analyzing the interplay between strategic ‘long term’ decisions and operational ‘short term’ decision making, and dealing with this interplay in modelling efforts.

Participatory GIS for open space management. Open space is under pressure due to the increasing population density and processes of urbanisation and counter-urbanisation. Remaining open space is scarce and the subject of debate. Various functions such as nature development, residential development, recreation, food production, flood protection,... compete and claim the same valuable pieces of land. Both rural, urban and peri-urban communities are faced with the question of how to deal with these competing claims and how to preserve/manage open space in a context of urbanisation. Specifically in the context of climate change, these issues will become even more prominent, as open space is a crucial asset for climate adaptation. Within this research line we explore the potential of using participatory GIS as a tool to stimulate this dialogue and envisioning processes within resourceful community management of open space. Participatory GIS is a methodology that can be applied to reveal stakeholder’s values for specific places (often referred to as “public participation GIS”) or to gather (spatially explicit) tacit knowledge from stakeholders (referred to as “participatory mapping”). Moreover, it can be applied to support multi-actor discussions and problem solving processes in spatial planning. This field of research is situated on the interface between community participation digital geospatial techniques.

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