RESEARCH GROUP www.list.lu/fr/recherche/environment/research-groups/group/agro-environmental-systems-group/

Agro-environmental Systems

At the Agro-environmental Systems (AGRO) research group, we rely on a holistic approach for investigating the bio-geophysical functioning of agro-environmental systems. Our goal is to better understand and manage the interactions of agriculture and natural resources in a context of increasing societal demands and climate change. We deliver policy support and decision support tools for farmers to meet the challenges of a sustainable agriculture. To address these challenges, we rely on our competences in agronomy, climatology, and environmental chemistry.

MAIN EXPERTISE FIELDS

- Environmental monitoring: pests in oilseed rape, diseases in cereals, weeds in wheat, maize and oilseed rape, pest and diseases in viticulture, environmental impact of pesticides
- Pesticide reduction in agriculture and viticulture: crop rotation, crop cultural management, disease forecast, use of less harmful or biological products, biological or biotechnological pest control
- Climate change: adaptation strategies in viticulture and horticulture
- Pollinator decline: honeybee colony losses - from monitoring to prevention strategies
- Digital decision support tools for agriculture and viticulture
- Innovative diagnostic tools in plant pathology: genotyping, analytical chemistry and remote sensing
- Soil microbial diversity: the microbiome and microbial processes that moderate nutrient cycling, carbon sequestration, and soil health

RESEARCH CHALLENGES

Our activities are mainly wired around use-inspired basic research, as well as applied research activities. More specifically, we focus at three complementary domains:

Crop protection

We target a reduction of pesticide application and a more widespread use of techniques – aligned with EU regulations and directives on food quality and sustainable use of pesticides. Our deliverables consist of knowledge generation, knowledge transfer and method development in the domains of:

- Pest and disease monitoring services, including resistance management
- Scientific basis for local decisions on the use of plant protection agents which respect non-target organisms, like pollinator insects
- Development and evaluation of sustainable cropping techniques for reducing the use of pesticides as well as adapting to changing environmental factors, especially droughts

PRECISION AGRICULTURE AND VITICULTURE

In cooperation with the REMOTE group and the HOST platform, we also participate in the development of new approaches for precision agriculture based on drone and fixed-wing, as well as lab based data acquisition (visible, thermal and hyperspectral).

Climate-agro-environmental systems interactions

We aim at predicting the impact of climate change on agricultural systems (including arthropod-plant interactions), as well as achieving a better understanding of its role as one of the major sources of anthropogenic climate forcing. We deliver (non-exhaustive list):

- High-resolution regional climate simulations and projections based on recent emission scenarios
- Local and regional impact studies of climate effects on agro-ecosystems
- Assessment of agricultural management on soil health, soil carbon, and soil nutrient cycling

Development of smart agricultural approaches for transforming agricultural systems to guarantee ecological intensification and ensure food security under a changing climate.

APPLICATION AREAS

- Agricultural monitorting: pests in oilseed rape, diseases in cereals, weeds in wheat, maize and oilseed rape, pest and diseases in viticulture, environmental impact of pesticides
- Pesticide reduction: crop rotation, crop cultural management, disease forecast, use of less harmful or biological products, biological or biotechnological pest control
- Precision agriculture: agroecosystem protection and management, digital decision support tools for agriculture and viticulture
- Global change & agriculture: adaptation strategies to climate change in agriculture, viticulture and horticulture, pollinator decline, vegetation response to global change; water cycle-vegetation feedbacks, mitigation strategies to enhance soil carbon sequestration and reduce greenhouse gas emissions from agricultural soils

MAIN ASSETS

- Decision support tools for pesticide and fertiliser management in drinking water protection zones
- Decision support tools for controlling diseases and pest insects in agriculture and viticulture
- High-resolution regional climate simulations
- Collection of well-characterised fungal strains that was established within the framework of the FP7 European Project MycoRed, Luxembourg Microbial Culture Collection.The information on the strains is freely available. Fungal strains are available to academia and industry on request.
- Black rot module of the viticultural disease warning system, Vitimeteo.

EQUIPMENT

- We operate well equipped soil microbial, mycology and entomological laboratories, as well as climate chambers to investigate effects of changing environmental factors (e.g., temperature, humidity, radiation and CO_2 levels) on multi-trophic systems.
- We use soil chambers and a mobile gas analyser for the assessment of different greenhouse gas emissions (CO_2, NH_3, CH_4, N_2O) from agricultural sites.
- We run and co-develop a suite of established software for terrestrial systems and atmospheric simulations: Weather Research and Forecast Model (WRF), the Terrestrial System Modelling Platform (TerrSysMP), and the Community Land Model (CLM).

SELECTED PUBLICATIONS

2021

- Frequency of Deoxynivalenol Concentrations above the Maximum Limit in Raw Winter Wheat Grain during a 12-Year Multi-Site Survey. Pallez-Barthel M, Cocco E, Vogelgsang S, Beyer M. Agronomy, 11, 960.
- Advances in Catchment Science through Integrated Hydrological Modelling and Monitoring. Bertoldi G, Camporese M, Sulis M. *Water* 13.
- Long-term adaptation of European viticulture to climate change: an overview from the H2020 Clim4Vitis action. Santos JA, Yang C, Fraga H, Malheiro AC & al. IVES Technical Reviews, vine and wine

2020

- Re-visiting the incidence of environmental factors on a pre-imaginal population of the red gum lerp psyllid, glycaspis brimblecombei moore, Junk J, Eickermann M, Milenovic M, Suma P, Rapisarda C. Insects 11: 1–12.
- The debate on a loss of biodiversity: can we derive evidence from the monitoring of major plant pests and diseases in major crops?, Dam D, Pallez-Barthel M, El Jarroudi M, Eickermann M, Beyer M. Journal of Plant Diseases and Protection. In press.
- Quantitative use of passive sampling data to derive a complete seasonal sequence of flood event loads: a case study for maize herbicides in Luxembourg. Gallé T, Frelat M, Huck V, Bayerle M, Pittois D, Braun C. Environmental Sciences: Processes Impacts 22: 294-304.
- Diversity of mobile genetic elements in the mitogenomes of closely related *Fusarium culmorum* and *F. graminearum sensu stricto* strains and its implication for diagnostic purposes, Kulik T, Brankovics B, Van Diepeningen AD, Bilska K, Żelechowski M, Myszczyński K, Molcan T, Stakheev AA, Stenglein S, Beyer M, Pasquali M, Sawicki J, Wyrębek J, Baturo-Cieśniewska A. Frontiers in Microbiology 11: 1002.
- Searching molecular determinants of sensitivity differences towards four demethylase inhibitors in *Fusarium graminearum* field strains, Pasquali M, Pallez-Barthel M, Beyer M. Pesticide Biochemistry and Physiology 164: 209–220.
- A review of the potential climate change impacts and adaptation options for European viticulture, Santos JA, Fraga H, Malheiro AC, Moutinho-Pereira J, Dinis L-T, Correia C, Moriondo M, Leolini L, Dibari C, Costafreda-Aumedes S, Kartschall T, Menz C, Molitor D, Junk J, Beyer M, Schultz HR. Applied Sciences 10: 3092.

2019

- Natural compounds for controlling *Drosophila suzukii*. A review, Dam D, Molitor D, Beyer M. Agronomy for Sustainable Development 39: 53.
- An immission perspective of emerging micropollutant pressure in Luxembourgish surface waters: A simple evaluation scheme for wastewater impact assessment, Gallé T, Pittois D, Bayerle M, Braun C. Environmental Pollution 253: 992-999.
- Incorporating a root water uptake model based on the hydraulic architecture approach in terrestrial systems simulations, Mauro S, Couvreur V, Keune J, Cai G, Trebs I, Junk J, Shrestha P, Simmer C, Kollet ST, Vereecken H, Vanderborght J. Agricultural and Forest Meteorology 269–270: 28-45.
- An eight-year survey of wheat shows distinctive effects of cropping factors on different *Fusarium* species and associated mycotoxins, Vogelgsang S, Beyer M, Pasquali M, Jenny E, Musa T, Bucheli T, Wettstein FE, Forrer H-R. European Journal of Agronomy 105: 62-77.

2018

- Winter honey bee colony losses, *Varroa destructor* control strategies, and the role of weather conditions: Results from a survey among beekeepers, Beyer M, Junk J, Eickermann M, Clermont A, Kraus F, Georges C, Reichart A, Hoffmann L. Research in Veterinary Science 118: 52-60.

Partenaires

Ministry of Agriculture, Viticulture and Rural Development
Administration des services techniques de l'agriculture
Administration de la gestion de l'eau
Association luxembourgeoise des services d'eau
Institut viti-vinicole
Veterinary Services Administration
Agricultural Chamber
Lycée technique agricole
agroptimize s.a.
Luxembourgish beekeeper association – FUAL
Centrale Paysanne Luxembourgoise
Luxemburger Saatbaugenossenschaft
Università degli Studi, Catania
HORIBA, Inc.

Contact

5, avenue des Hauts-Fourneaux
L-4362 Esch-sur-Alzette
tél : +352 275 888 - 1 | LIST.lu

Jürgen JUNK (juergen.junk@list.lu)

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY | LIST