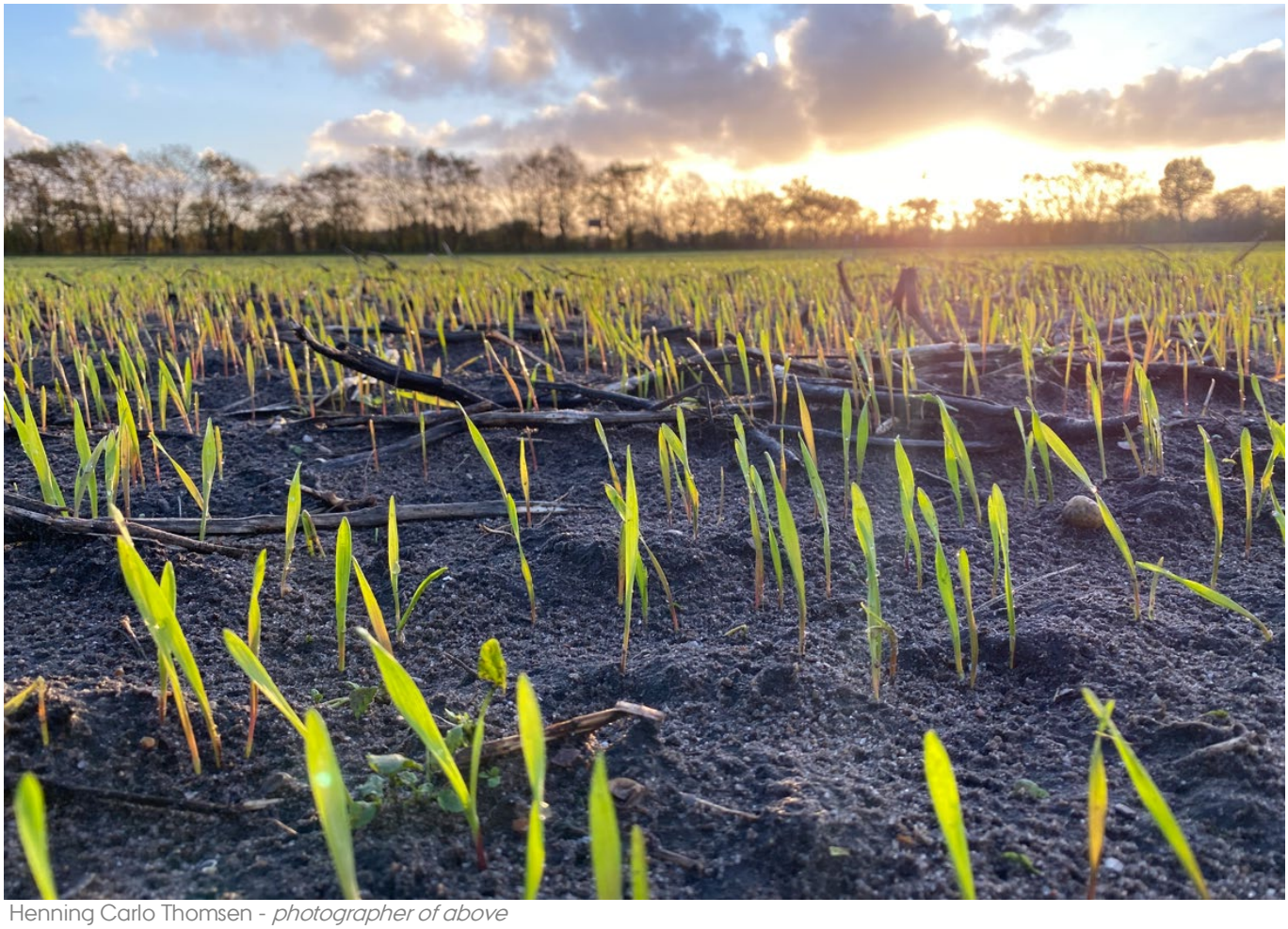
Master Thesis Projects
Topics within Agroecology

AGRO Environmental Management & Agrobiology MSc Programmes
2023 - 2024



Henning Carlo Thomsen - *photographer of above*

March 2023

Preface

Present catalogue of master thesis projects available in 2023-2024 has been prepared to help students in their decisions on selecting a topic for their thesis project. Proposals are presented in detail together with contact addresses as well as other practical information.

The project proposals presented in this catalogue are primarily intended for students of the **Master's Degree Programme in Agro-Environmental Management** and in **Agrobiology** at Aarhus University, but will also be available for students of Biology, Geography, Geology and other master degree programmes within Natural Sciences (e.g. International Master in Soils and global Change). The proposals can also be relevant for bachelor thesis students as far as the students have the scientific prerequisites needed to accomplish a specific project.

If you contemplate making a master or bachelor thesis project on a topic not mentioned in this catalogue, please contact and discuss it with one of your course lecturers, or contact a relevant scientist at one of the departments.

Your thesis work can be performed at Department of Agroecology or one of the other research departments involved in the master's degree programmes (see also catalogues from these departments). During your thesis work you will be attached to the specific section within the department where the main supervisor is situated.

Three thesis types are offered:

- **Thesis 30 ECTS credits**
  Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
- **Thesis 45 ECTS credits**
  Experimental thesis in which the student is responsible for collection and analysis of original raw data. The quality of the data collection, analysis, and editing must be included in the overall assessment.
- **Thesis 60 ECTS credits**
  Experimental thesis in which the student is responsible for planning of trial design and methods as well as collection and analysis of original raw data. The quality and independence of own trial design, planning of data mining from original data bases, or the development of new theories must be included in the overall assessment. The quality of the data collection, analysis, and editing must also be included in the overall assessment.

The two Agroecology Master's Degree Programmes, Agro-Environmental Management and Agrobiology (see www.agro.au.dk/en/education/bachelor-and-master-degree-programmes) builds on components from multiple disciplines at Aarhus University. Therefore, studies in relation to both environmental, social and economic sustainability and the interactions between agroecology, management, economy, and environmental sciences are encouraged. You therefore get a broad education with specialized skills. The strong research base means that the teaching is undertaken by leading international scientists within the main study areas. During your studies you will get a holistic understanding of the impacts of agriculture on environment, nature and climate, and how these impacts can be managed.

With an **MSc in Agro-Environmental Management** you will be well equipped to seek a wide variety of jobs. With extensive knowledge and interdisciplinary expertise in the area of agriculture, nature, environment, and climate interactions there are job opportunities in, for example, regional environment agencies, municipal nature conservation offices, agricultural advisory services, consulting engineers, teaching, NGOs in nature and environment, EU institutions, ministries, and other public authorities. Research is also an obvious career choice. Read more at: https://masters.au.dk/agro-environmentalmanagement

Read more about the **MSc in Agrobiology** at: https://masters.au.dk/agrobiology and take also a look at the MSc thesis catalogues from the other departments (www.studerende.au.dk/en/studies/subject-portals/agroecology-food-and-environment/bachelors-project-masters-thesis-and-other-projects/project-catalogue/).

Table of content

1. Impact of climate change on sil readiness in Northern Europe

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Lars J Munkholm, Emmanuel Arthur

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil tillage, soil mechanics, climate change, modeling, decision support.

Short project description
To qualify the suitability of soils for tillage and traffic, the term readiness has been introduced. The readiness of a soil for an operation is a combination of the workability (soil conditions are optimal for a given field operation as tillage or sowing) and trafficability (soil-machine conditions allow sustainable traffic in the field, i.e. without subsoil compaction), both of which are influenced by the soil properties, the weather, the crop, the operation and the machinery used. The time a field is in a state of readiness for an operation is then the window of opportunity for the farmer to enter the field and perform this operation with an optimal use of resources. In the present project, the state-of-the-art knowledge on machinery-soil-climate interactions for planning of field operations at the farm scale will be utilized to evaluate the impact of a range of climate change scenario on soil readiness for different field operations. Output from the simulations will be in form of, for specific production systems we believe will be used in Northern Europe in the coming decades, the number of days of soil readiness for specific operations depending on different climate change scenario. Results from the project will help identifying the coming challenges for mechanized agriculture in Northern Europe.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extend of the study and on the number of scenarios to be tested (for example: comparison of past, present and expected climate)

Additional information
Lamandé, M., Greve, M.H., Schjønning, P., 2018. Risk assessment of soil compaction in Europe - rubber tracks or wheels on machinery. CATENA 167, 353-362.
Obour P.B., Jensen J.L., Lamandé M., Watts C.W., Munkholm L.J., 2018a. Soil organic matter widens the range of water contents for tillage. Soil Tillage Research 182, 57-65.
Obour P.B., Kolberg D., Lamandé M., Børresen T., Edwards G., Sørensen C.G., Munkholm L.J., 2018b. Effect of compaction and sowing date on soil physical properties and crop yield of a loamy temperate soil. Soil Tillage Research 184, 153-163.
Obour P.B., Keller T., Lamandé M., Munkholm L.J., 2019. Pore structure characteristics and soil workability along a clay gradient. Geoderma 337 1186-1195.

2. Consequences of soil deformation on soil physical properties

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Emmanuel Arthur

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil mechanics, soil structure, soil physical properties.

Short project description
The use of too heavy machinery in agriculture in non-optimal and often waterlogged, soil conditions triggers one of the main threats to soil quality in Europe and brings a considerable risk to the quality of agricultural soils around the world. When a soil's internal strength is exceeded by an applied stress, the soil deforms, creating a soil state that is referred to as compacted soil. Soil deformation below a wheel is complex, and usually described as a combination of compression and shearing. There is a need to better understand the consequences of soil deformation on soil physical functioning in order to prevent detrimental agricultural practices.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extend of the study and on the number of scenarios to be tested (for example: comparison of past, present and expected climate)

Additional information
Lamandé, M., Greve, M.H., Schjønning, P., 2018. Risk assessment of soil compaction in Europe - rubber tracks or wheels on machinery. CATENA 167, 353-362.
Lamandé M, Schjønning P, Dal Ferro N, Morari F, 2021. Soil pore system evaluated from gas measurements and CT-images: a conceptual study using artificial, natural and 3D-printed soil cores. European Journal of Soil Science 72, 769-781.

3. Toward a new paradigm for soil stress-strain relationship: effects of the soil structure

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Emmanuel Arthur

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil mechanics, soil structure, soil physical properties.

Short project description
Compaction of agricultural soils due to traffic in the field compromises a range of ecosystem services, including food production. Prevention of soil compaction requires accurate knowledge of its resistance to mechanical stresses. So far, this resistance is commonly defined as a unique threshold based on a concept developed for the ability of soil sediments to support buildings. Especially for agricultural soils affected by soil biota, soil deformation has been observed for stresses lower than this threshold. We hypothesize that strength of agricultural soils follows the hierarchical organization of their structure. Aggregation levels of agricultural soils can be compared to Chinese boxes, and structure deformation occurs progressively at each level during compression.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extend of the study and on the number of scenarios to be tested (for example: comparison of past, present and expected climate)

Additional information
Lamandé M, Schjønning P, Dal Ferro N, Morari F, 2021. Soil pore system evaluated from gas measurements and CT-images: a conceptual study using artificial, natural and 3D-printed soil cores. European Journal of Soil Science 72, 769-781. https://doi.org/10.1111/ejss.1299
Naveed M., Schjønning P., Keller T., de Jonge L.W., Moldrup P., Lamandé M., 2016. Quantifying vertical stress transmission and compaction-induced soil structure using sensor mat and X-ray computed tomography. Soil and Tillage Research 158, 110-122

4. Arsenic dynamics in soil amended with seaweed

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Lorenzo Pugliese

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil water dynamics, leaching, soil physical properties, toxicity.

Short project description
Arsenic (As) is present throughout the earth's ecosystems in low concentrations but is prevalent in aquatic environments due to rocks weathering, and is naturally bioaccumulated by marine products (i.e. seaweed). Traditionally, seaweed has been used as a fertilizer and soil conditioner for many centuries. In the past few decades, the demand for seaweed fertilizers in horticulture has increased across the globe due to its image as an eco-friendly resource. Arsenic is a known carcinogen and has many associated health effects. Little information on soils amended with seaweed and dynamics of As contained in seaweed amendment in soils exists in literature.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extend of the study and on the number of scenarios to be tested (for example: comparison of past, present and expected climate)

Additional information
H. Castlehouse, C. Smith, A. Raab, C. Deacon, A. Meharg, J. Feldmann, 2003.
Biotransformation and accumulation of arsenic in soil amended with seaweed
Environ Sci Technol, 37, 951-957.
Antonia O'Neill, Bhaskar Sen Gupta, Debra H. Phillips, 2014. Distribution of arsenic and risk assessment of activities on a golf course fertilised with arsenic-containing Ascophyllum nodosum seaweed. Science of The Total Environment 482–483, 252-259.
M. Shimizu, Y. Arai, D.L. Sparks, 2011. Multiscale assessment of methylarsenic reactivity in soil. 1. Sorption and desorption on soils. Environ Sci Technol, 45, 4293-4299.
M. Shimizu, Y. Arai, D.L. Sparks, 2011. Multiscale assessment of methylarsenic reactivity in soil. 2. Distribution and speciation in soil. Environ Sci Technol, 45, 4300-4306

5. Phenotyping root mucilage traits of maize varieties from different agroecological zones

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Emmanuel Arthur, Meisam Nazari

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Root exudates, soil-plant-climate interactions, soil physics

Short project description
Adequate soil water content for plant functioning under drought is very important for sustaining crop production. Therefore, understanding which plant traits support soil water availability for plants under drought conditions is crucial. Root mucilage has been proposed to support water availability for plants under drought conditions. Mucilage is a gel-like substance produced at the root tip of plants. Many studies suggest that mucilage alters the soil hydraulic and physical properties (e.g., maintains available soil water during drying) and increases plant water uptake under drought. To investigate the role of mucilage in plant-soil hydraulics, the use of plants contrasting in mucilage traits, (i.e., mucilage production amount, saturation water content, viscosity, surface tension, and hydrophobicity) is necessary. The goal of the proposed project is to test several maize varieties from different countries and select the ones with significantly different mucilage traits. This important step will provide a unique opportunity to disentangle the role of root mucilage in plant-soil hydraulics using plants in more realistic future experiments.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extent of the study and on the number of maize varieties to be tested.

Additional information
Nazari, Meisam, Sophie Riebeling, Callum C. Banfield, Asegidew Akale, Margherita Crosta, Kyle Mason-Jones, Michaela A. Dippold, and Mutez Ali Ahmed. "Mucilage Polysaccharide Composition and Exudation in Maize from Contrasting Climatic Regions." *Frontiers in Plant Science*, 2020. https://doi.org/10.3389/fpls.2020.587610.

Nazari, Meisam. "Plant Mucilage Components and Their Functions in the Rhizosphere." *Rhizosphere*, 2021a. https://doi.org/10.1016/j.rhisph.2021.100344.

Carminati, Andrea, and Mathieu Javaux. "Soil Rather Than Xylem Vulnerability Controls Stomatal Response to Drought." *Trends in Plant Science*, 2020. https://doi.org/10.1016/j.tplants.2020.04.003.

6. Impact of mucilage on soil water retention under dry conditions

Department and supervisor
Emmanuel Arthur, senior scientist, emmanuel.arthur@agro.au.dk, +45 8715 7734
Co-supervisors: Mathieu Lamandé, Meisam Nazari

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil physics, soil hydraulic properties, soil microorganisms

Short project description
Knowledge of soil water retention under dry conditions (matric potential <–1.5 MPa) is important for understanding of vadose zone processes such as water vapor movement in arid regions, volatilisation of organic compounds and pesticides, and microbial processes. Mucilage is a gelatinous substance produced at the root tip of plants. It has several important functions for plant and soil including lubrication of roots for easing their penetration, a source of energy for soil microorganisms, and alleviation of heavy metal toxicity in plants. However, one of the most known and important functions of mucilage is to improve soil water content under drought conditions, which may have positive outcomes for plant water uptake. To date, studies have focused on the impact of mucilage on the soil water content from the wet part of the soil water retention curve (matric potential > –1.5MPa). There is a need to investigate the effect of mucilage on the dry part of the soil water retention curve. Thus, this project aims at understanding how mucilage affects soil water content under very dry conditions and discuss the outcomes for relevant soil and microbial processes.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extent of the study and on the number of soil types to be tested.

Additional information
Carminati, Andrea, Ahmad B. Moradi, Doris Vetterlein, Peter Vontobel, Eberhard Lehmann, Ulrich Weller, Hans Jörg Vogel, and Sascha E. Oswald. "Dynamics of Soil Water Content in the Rhizosphere." *Plant and Soil*, 2010. https://doi.org/10.1007/s11104-010-0283-8.
Nazari, Meisam. "Plant Mucilage Components and Their Functions in the Rhizosphere." *Rhizosphere*, 2021a. https://doi.org/10.1016/j.rhisph.2021.100344.
Nazari, Meisam, Samuel Bickel, Pascal Benard, Kyle Mason-Jones, Andrea Carminati, and Michaela A. Dippold. "Biogels in Soils: Plant Mucilage as A Biofilm Matrix That Shapes the Rhizosphere Microbial Habitat." *Frontiers in Plant Science*, 2022. https://doi.org/10.3389/fpls.2020.587610.

7. Does root mucilage affect soil mechanical properties?

Department and supervisor
Mathieu Lamandé, senior scientist, mathieu.lamande@agro.au.dk, +45 2224 0870
Co-supervisors: Emmanuel Arthur, Meisam Nazari

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Soil mechanics, soil structure, soil physical properties.

Short project description
Roots grow mainly through existing pores but will need to deform the soil to penetrate peds or horizons that lack voids. Consequently, root growth in the field is often impaired by a too high mechanical impedance of dense soil. Root mucilage is a gel-like substance produced by root tips of plants. Mucilage is mainly composed of polysaccharides but also proteins, minerals, and lipids. Several studies have indicated that mucilage changes the soil physical properties related to water such as water content, liquid-phase connectivity, hydraulic conductivity, etc. Soil mechanical properties (friction, cohesion, compressibility) are directly influenced by soil water content and are key soil parameters with regard to requirements for tillage operation, risk of soil compaction during traffic in the field and root growth. Therefore, the proposed project aims to investigate the role of mucilage in altering cohesion and friction of soil.

Extent and type of project
30 ECTS, 45 ECTS, or 60 ECTS: The student will be able to decide on the extend of the study and on the number of soil types to be tested.

Additional information
Nazari, Meisam. "Plant Mucilage Components and Their Functions in the Rhizosphere." *Rhizosphere*, 2021. https://doi.org/10.1016/j.rhisph.2021.100344.
Carminati, Andrea, Pascal Benard, Mutez Ali Ahmed, and Mohsen Zarebanadkouki. "Liquid Bridges at the Root-Soil Interface." *Plant and Soil*, 2017. https://doi.org/10.1007/s11104-017-3227-8.
Bengough AG, Bransby F, Hans J, Mckenna SJ, Roberts T, Valentine TA. Root responses to soil physical conditions; growth dynamics from field to cell. Journal of Experimental Botany, 2006. https://academic.oup.com/jxb/article/57/2/437/489931?login=true
Barley KP, Greacen EL. Mechanical Resistance as a Soil Factor Influencing the Growth of Roots and Underground Shoots. Advances in Agronomy, 1967. https://doi.org/10.1016/S0065-2113(08)60731-2

8. Carbon stabilization of cover crops

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, Phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
April or August

Main subject area
Soil Science, Soil microbiology

Short project description
Cultivation of cover crops (CCs) to replace bare fallow during autumn and winter period has been suggested as a way of climate change mitigation by sequestering atmospheric carbon dioxide into soil. Yet, such potential largely depends on microbial mineralization and fate of carbon inputs from CCs, which may be affected by factors such as cropping system management, soil type, and initial carbon content of soil. The master project thus aims at examining the loss of CCs-derived carbon, and hereafter stabilization potential in soil of interests using mesocom approach under controlled lab condition.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional Information
The master project are linked to ongoing projects "CatCap" and "CCrotate", and will be conducted under supervision of Senior Scientist, Jim Rasmussen, with co-supervision from post doc Zhi Liang (zhi.liang@agro.au.dk). The student will also work together with a group of researchers and technical staff. The outcome of the master thesis may also include one scientific article.

Relevant articles to read
Cotrufo, M.F., Wallenstein, M.D., Boot, C.M., Denef, K., Paul, E., 2013. The Microbial Efficiency-Matrix Stabilization (MEMS) framework integrates plant litter decomposition with soil organic matter stabilization: do labile plant inputs form stable soil organic matter? Global Change Biology 19, 988-995.
Kaye, J.P., Quemada, M., 2017. Using cover crops to mitigate and adapt to climate change. A review. Agronomy for Sustainable Development 37, 4.
Liang, C., Schimel, J.P., Jastrow, J.D., 2017. The importance of anabolism in microbial control over soil carbon storage. Nature Microbiology 2, 17105.
Lützow, M.V., Kögel-Knabner, I., Ekschmitt, K., Matzner E., Guggenberger G., Marschner B., Flessa, H., 2006. Stablization of organic matter in temperate soils: mechanisms and their relevance under different soil conditions – a review. European Journal of Soil 57, 426-445.

9. Combined effect of secondary plant metabolites and beneficial microbes on mycotoxin production of Fusarium

Department and supervisor
Department of Agroecology – Crop Health
Inge S. Fomsgaard, Professor, email: Fomsgaard@agro.au.dk
Landline phone: +45 8715 8212
Mobile: +45 2228 3399

Physical location of the project
AU Flakkebjerg and the Plant Health research department of Chr. Hansen located in Tåstrup.

Project start time
No specific time

Extent and type of project
45 or 60 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.

Main subject area
Biopesticide, plant pathology, HPLC-MS/MS

Additional information
The master student will be conducting the project under supervision of AU and a scientist from Chr. Hansen

Short project description
Fusarium graminearum is a plant pathogen which is responsible for huge global yield losses in cereals. In addition, it produces mycotoxins which are of concern for animal and human health upon consumption.

It has been shown that a group of secondary plant metabolites, called benzoxazinoids, have a suppressive effect on the production of mycotoxins by *Fusarium graminearum*. The focus of this thesis work is to develop a method for quantification of selected mycotoxins in plant material and to quantify mycotoxin and benzoxazinoid levels in biological systems with cereals, the fusarium and a beneficial bacterial strain from Chr. Hansen. The ultimate goal will be to elucidate the relation between plant benzoxazinoids and mycotoxins in presence/absence of the beneficial bacterial strain from Chr. Hansen.

10. N cycling in grain legume cropping systems

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
August-September

Main subject area
Agronomy, soil science, environmental science

Short project description
Grain legumes are expected to increase in cultivated area in the coming years to meet the demand both for meat replacement protein sources and reduce the import of soy for fodder. Cultivation of grain legumes introduces N into the cropping system via N_2-fixation, which increases the N fertility for subsequent crops, but also increase the risk of N losses (N_2O emission and N leaching) if not managed e.g. via use of cover crops during autumn and winter. Thus, increasing cropping of grain legumes offers both opportunities and challenges for our cropping systems. The master project aims at examining the N flows in grain legume based cropping systems using data from ongoing experiments including potential measurements of cover crop growth, N uptake and effects on N_2O emission and N leaching.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The master project will be connected to the GrainLegsGo project led by Jim Rasmussen and will involve co-supervision by postdocs Chiara De Notaris and Kirsten Lønne Enggrob.

Relevant articles to read
De Notaris, C., Rasmussen, J., Sorensen, P., Olesen, J.E., 2018. Nitrogen leaching: A crop rotation perspective on the effect of N surplus, field management and use of catch crops. Agriculture Ecosystems & Environment 255, 1-11.
Zander, P., Amjath-Babu, T.S., Preissel, S., Reckling, M., Bues, A., Schläfke, N., Kuhlman, T., Bachinger, J., Uthes, S., Stoddard, F., Murphy-Bokern, D., Watson, C., 2016. Grain legume decline and potential recovery in European agriculture: a review. Agronomy for Sustainable Development 36, 26.

11. Productivity, species complementarity and carbon deposition in diversified grasslands

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
April or August/September

Main subject area
Agronomy, Soil and Plant Science, Environmental Science

Short project description
Grasslands have the potential to produce high levels of biomass compared to many annual crops, as they are able to utilize the incoming radiation from the sun a higher proportion of the year. Grasslands have benefits to both reduce nitrate leaching and enhance carbon storage in soils. The dependence on nitrogen fertilization can be lowered by species mixtures including legumes while other species may results in other benefits for biodiversity. This master project aims at investigating how diversified grasslands and species mixtures may benefit both the productivity of the cropping system and at the same time the ecological services such as nitrate leaching and carbon storage in soils. There is possibilities for both field work and lab work as part of the project.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional Information
The master project will be connected to the GrassTools project and be under supervision of Senior Reseacher, Jim Rasmussen, with co-supervision from Researcher Diego Abalos. The student will also work together with a group of researchers and technical staffs.

Relevant articles to read
Abalos, D., van Groenigen, J.W., De Deyn, G.B., 2018. What plant functional traits can reduce nitrous oxide emissions from intensively managed grasslands? Global Change Biology 24, E248-E258.
Abalos, D., van Groenigen, J.W., Philippot, L., Lubbers, I.M., De Deyn, G.B., 2019. Plant trait-based approaches to improve nitrogen cycling in agroecosystems. Journal of Applied Ecology 56, 2454-2466.
Brophy, C. *et al.*, 2017. Major shifts in species' relative abundance in grassland mixtures alongside positive effects of species diversity in yield: a continental-scale experiment. Journal of Ecology 105, 1210-1222.

12. What is the backbone of soil organic matter?

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
August-September

Main subject area
Soil science, chemistry

Short project description
The new soil organic matter paradigm offers an opportunity to advance our knowledge of the chemical constitutes of our soils and how soil chemistry interacts with plants and microorganisms to produce sustainable agroecosystems. The underlying key to soil functionality is the organic matter bound to the soil mineral particles, where knowledge of the basic constitutes of this organic matter can tell us about soil quality and how this may be improved. The master project aims at investigating the chemical characteristics of soil focusing on the organic matter compounds constituting the backbone for soil abiotic functionality. This will be done either through a literature study or by conducting lab analysis and experimentation of soil organic matter chemistry involving the use of basic and advanced analytical tools.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The master project will be connected to the 'CatCap' project with co-supervision from postdoc Kirsten Lønne Enggrob and Leanne Peixoto.

Relevant articles to read
Frey, S.D., 2019. Mycorrhizal Fungi as Mediators of Soil Organic Matter Dynamics. Annual Review of Ecology, Evolution, and Systematics 50, 237-259.
Lavallee, J.M., Soong, J.L., Cotrufo, M.F., 2020. Conceptualizing soil organic matter into particulate and mineral-associated forms to address global change in the 21st century. Global Change Biology 26, 261-273.
Discovering the drivers for carbon stabilization in agricultural soils

13. Discovering the drivers for carbon stabilization in agricultural soils

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
August-September

Main subject area
Soil science, plant science

Short project description
Danish agriculture face a majestic challenge to become carbon-neutral by 2050. In order to reach this goal our agricultural soil needs to be transformed from carbon sources to carbon sinks. In order to achieve this transformation we need to deepen our understanding of how different plant derived compounds cycle into the soil organic matter pools across the whole root zone soil profile and how plant residues and exudates contributes to the formation of stable carbon and emissions of N, e.g. N_2O. The master project aims at investigating cycling organic compounds of increasing molecular size into the soil microbial biomass – by conducting lab scale experiments with molecular size fractionation of legume and non-legume derived compounds and subsequent incubation in soils with different histories.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
The master project will be connected to the 'Stable or Fertile' project with co-supervision from postdoc Kirsten Lønne Enggrob and Leanne Peixoto.

Relevant articles to read
Enggrob, K.L., Larsen, T., Peixoto, L., Rasmussen, J., 2020. Gram-positive bacteria control the rapid anabolism of protein-sized soil organic nitrogen compounds questioning the present paradigm. Scientific Reports 10, 9.
Peixoto, L., Elsgaard, L., Rasmussen, J., Kuzyakov, Y., Banfield, C.C., Dippold, M.A., Olesen, J.E., 2020. Decreased rhizodeposition, but increased microbial carbon stabilization with soil depth down to 3.6 m. Soil Biology & Biochemistry 150, 10.

14. C and N cycling in legume rhizospheres

Department and supervisor
Department of Agroecology
Jim Rasmussen, Senior Scientist, email: jim.rasmussen@agro.au.dk, phone: +45 8715 7418

Physical location of the project and students work
Blichers Alle 20, Tjele, 8830-DK

Project start
August-September

Main subject area
Soil science, plant science

Short project description
Organic N cycling around legume roots may be a key to increased sustainability of our cropping systems. We now know that most crops have the capacity for uptake of organic N sources like amino acids – where C and N are coupled in the same molecules. Presently we lack estimates of the importance of such organic N uptake for crop N nutrition. Also exudation of organic N from legumes root may be a key to high incorporation of C into microbial biomass leading to stabilization of C in the soil pool, as C and N are coupled when microorganisms assimilate the compounds. Therefore studies are needed on the small scale cycling of organic N compounds in legume rhizospheres. The master project aims at investigating micro-scale cycling in and out of legume roots – i.e. organic N flows in legume rhizosphere – by conducting lab scale experiments with legume organic N uptake and exudation.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
The master project will be connected to the 'Stable or Fertile' project with co-supervision from postdoc Kirsten Lønne Enggrob.

Relevant articles to read
Buckley S, Brackin R, Näsholm T, Schmidt S, Jämtgård S, 2017. Improving in situ recovery of soil nitrogen using the microdialysis technique. Soil Biology & Biochemistry 114, 93-103.
Enggrob KL, Jakobsen CM, Pedersen IF, Rasmussen J, 2019. Newly depolymerized large organic N contributes directly to amino acid uptake in young maize plants. New Phytologist 224, 689-699.

15. Intercropping between legumes and cereals: Do plants help each other by sharing defense compounds?

Department and supervisor
Department of Agroecology
Main supervisor: Inge S. Fomsgaard, Professor, Inge.Fomsgaard@agro.au.dk, phone 2228 3399
Co-supervisors: Jawameer Hama, Postdoc; Mette Vestergård, senior scientist

Physical location of the project and students work
AU Flakkebjerg, DK-420 Slagelse

Project start
No specific time

Main subject area
Natural product chemistry, LC-MS/MS, Agro-ecological interactions between plants

Short project description
Intercropping between legumes and cereals has shown to be beneficial for both crops in terms of yield and nitrogen-fixation. The chemical communication and exchange of defense compounds between legumes and cereals in such an intercropping setup has only been studied to a minor extent. Liquid chromatography-mass spectrometry is the optimal tool for analysing secondary metabolites responsible for the communication. In this project the student will investigate the content of known bioactive compounds in a legume (soybean) and a cereal crop (wheat) when grown alone and when co-cropped, and will evaluate if – and to which extent – defense properties against plant parasitic nematodes are enhanced in both crops.

Extent and type of project
45 or 60 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

Additional information
Hazrati, H.; Fomsgaard, I. S.; Kudsk, P., Root-Exuded Benzoxazinoids: Uptake and Translocation in Neighboring Plants. *Journal of Agricultural and Food Chemistry* **2020,** *68* (39), 10609-10617.
Hazrati, H.; Fomsgaard, I. S.; Kudsk, P., Targeted metabolomics unveil alteration in accumulation and root exudation of flavonoids as a response to interspecific competition. *Journal of Plant Interactions* **2021,** *16* (1), 53-63.

16. Exploration of soybeans' potential and the importance of flavonoids

Department and supervisor
Department of Agroecology – Crop Health
Main supervisor: Inge S. Fomsgaard, Professor, Inge.Fomsgaard@agro.au.dk, phone 22283399
Co-supervisor: Ida K. L. Andersen, PhD Student

Physical location of the project and students work
AU Research Center Flakkebjerg
Forsøgsvej 1, DK-4200 Slagelse

Project start
No specific time

Main subject area
Plant science, bioactive molecules (flavonoids), HPLC-MS/MS

Short project description
Soybeans (*Glycine max* (L.) Merrill) is of the species 'legume' and is a globally important crop with several uses, including edible beans, in soymilk and tofu. Increasing the production of soybean in Danish agriculture will be beneficial for the environment and the climate, as soybeans can be used as an alternative to meat as well as the plant's ability to fertilise the soil.

Flavonoids are secondary metabolites and phytochemicals found in a variety of plants, including soybeans. Their function in plants include acting as signalling molecules and as protection against abiotic and biotic stresses, and analysing flavonoid content in soybean is relevant for investigating these functions.

This project focuses on the development of an HPLC-MS/MS method for identification and quantification of selected flavonoids in soybean plant material: Green beans, mature beans, roots and rhizosphere soil. The aim is 1) To provide knowledge regarding the flavonoid content over time by comparing green and mature beans. In addition, this is valuable knowledge when discussing the potential of green beans for human consumption, 2) To gain knowledge on the exudation of flavonoids from the roots to the rhizosphere soil.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information - *Useful reading*:
Panche, A., Diwan, A., & Chandra, S. (2016). Flavonoids: An overview. Journal of Nutritional Science, 5, E47. doi:10.1017/jns.2016.41
Gómez JD, Vital CE, Oliveira MGA, Ramos HJO (2018) Broad range flavonoid profiling by LC/MS of soybean genotypes contrasting for resistance to *Anticarsia gemmatalis* (Lepidoptera: Noctuidae). PLOS ONE 13(10): e0205010. https://doi.org/10.1371/journal.pone.0205010

17. Prioritizing the Danish landscape – sharing or sparring land?

Department and Supervisors:
Department of Agroecology

Main supervisor:
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Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone +45 25645560

Physical location of the project and students work
Department of Agroecology, AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Nature protection, trade-offs between agriculture and biodiversity, landscape planning,

Short project description
Denmark is dominated by agriculture, which covers 62% of the terrestrial land surface. One of the biggest threats towards biodiversity and nature is lack of space and large connected nature areas. Still, there is a need to sustain or even increase the current food production on a global scale. This raise the question whether an area should be prioritized as an integration ("land sharing") or separation ("land sparing") of nature and agricultural production. Finally, barriers and opportunities related to the implementation of land sharing versus land sparing at landscape scale could be assessed, considering the multifunctional landscape functions and links with national and European policies.

In this project, the aim is to define and map areas where nature and production can coexist and areas, which should be prioritized only for nature or only production. A national map can be produced showing these relationships. For the analysis the student can use various geographical data handled in GIS such as land use, biodiversity, soil, production, historical maps etc.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
It will be an advantage, if the student has experience or interest in working with GIS and spatial geographical statistics.
- Grass I, Batáry P, and Tscharntke T. 2020. Combining land-sparing and land-sharing in European landscapes. Advances in Ecological Research
- Center for Sustainable Landscape under Global Change https://bio.au.dk/forskning/forskningscentre/center-for-sustainable-landscapes-under-global-change/

18. Scenarios for land-use change of carbon rich soils – benefits for biodiversity, climate, environment, and the farmer?

Department and supervisor
Department of Agroecology

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Co-supervisors:
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Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone +45 2891 3656

Physical location of the project and students work
Department of Agroecology, AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Landscape planning; trade-offs between agriculture and alternative land-uses

Short project description
The carbon rich soils in Denmark comprise 171.000 ha of arable land. Politically, it has been suggested to change land use on some of these cultivated soils to enhance biodiversity, reduce nitrogen leaching, and lower greenhouse gas emissions. However, these areas often share ownership between farmers complicating large scale and integrated solutions.

In this project, the student will define scenarios for land-use change that exempt to take carbon rich soils out of production while gaining benefits for nature and biodiversity, climate, the surrounding environment, and the farmer. The student could explore opportunities using geographical data – such as biodiversity, soil organic carbon%, land ownerships, etc. - in combination with data documenting stakeholders perception of solutions and policy implications.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
- Odgaard MV, Knudsen MT, Hermansen JE & Dalgaard T. 2019. Targeted grassland production A Danish case study on multiple benefits from converting cereal to grasslands for green biorefinery. Journal of cleaner production.
- Tybirk K, Odgaard MV, Dalgaard T. 2020. Mange hensyn i ny jordfordeling. Aktuel Natur videnskab: https://aktuelnaturvidenskab.dk/find-artikel/nyeste-numre/3-2020/jordfordeling/
- Center for Sustainable Landscape under Global Change: https://bio.au.dk/forskning/forskningscentre/center-for-sustainable-landscapes-under-global-change.

19. Historical Agroecology – assessing historical data to understand present challenges and solutions for agroecological development

Department and supervisors
Department of Agroecology

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Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone: +45 2891 3656
Nele Lohrum, PhD student, email nija@agro.au.dk

Physical location of the project and students' work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Changes in agri-food systems, historical geography, food studies, rural studies, landscape changes; GIS

Short project description
Denmark have for centuries utilised much of the land for production of food, fiber and feed. In this project, the aim is to use different historical agricultural and geographical data (agricultural censuses on parish level, historical maps, orthophotos etc.), to (1) map past historical agroecological landscapes, and (2) analyse pre-industrial farming systems in the perspective of agroecology and sustainability. Methods for the project could include GIS, systems analysis, archival research, and qualitative interviews.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The project will be thematically linked and embedded within the SUSTAINSCAPES project. It will be an advantage for the student to have some knowledge on agroecological theory and methods, particularly with regards to analyzing farming systems.

Useful reading
Bayliss-Smith, T. P. 1982. *The Ecology of Agricultural Systems*. Cambridge: Cambridge University Press.
Darnhofer, I., D. Gibbon, and B. Dedieu eds. 2012. *Farming Systems Research into the 21st century: The-New Dynamic*. New York: Springer.

20. Stakeholder perspectives on woodland creation

Department and supervisor
Department of Agroecology

Main supervisors
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Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students' work
Department of Agroecology, AU Viborg

Project start
2023/2024

Main subject area
Land use; woodland creation; National Parks; social science; participatory processes; communication; Q-methodology

Short project description
DK forestry policy aim to increase woodland cover by 20 – 25 % by the end of the century, keeping in line with international climate mitigation targets, agro-environment schemes in national and international policy and an increasing public awareness of the ecosystem service benefits woodland landscapes can deliver for society. Creating new woodlands is challenging, partly due to concerns of the potential impacts from a change in land use and also due to stakeholder perspectives. The objective of this project is to add a much needed qualitative element to the overall understanding of this complex topic within the context of an agroecology view and the multiple services provided by agricultural landscapes. This is carried out by a Q-methodology investigation of stakeholder perspectives of woodland creation, using an already existing Q-set. Stakeholder perspectives are a powerful influence and understanding emotions, attitudes and perceptions is a vitally important part of the challenge of creating new woodlands.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The project will be thematically linked and embedded within the SUSTAINSCAPES project and the PhD project 'Forest and Tree Nature Based Solutions. The data collected as part of this study can be linked with already an existing study from a National Park in the UK to assess communalities and divergence between culture and policy between the UK and DK.

Useful reading
Watts S, Stenner P. 2005. *Doing Q methodology: theory, method and interpretation*. Qualitative Research in Psychology **2**:67-91. Iversen, S. 2020. Impacts & Perspectives on Woodland Creation in Upland Cumbria, UK. PhD thesis. P. 207-266. http://insight.cumbria.ac.uk/id/eprint/5179

21. Landscape ecology, habitat connections and corridors

Department and supervisor
Department of Agroecology

Main supervisor:
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Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Connectivity, habitat protection and habitat quality, nature and biodiversity, Habitat fragmentation, hedgerows and corridors,

Short project description
Biodiversity is globally and in Denmark declining at a rapid pace. Habitat fragmentation and physical barriers in the landscape are crucial factors to the ongoing decline in biodiversity. To mitigate the barrier effect of for example roads and traffic, fauna crossings can be implemented to allow species to cross without exposure to traffic. Besides these man-made constructions a better habitat connectivity is needed. This project aims to map and assess the current fauna crossings in Denmark and analyse the potential for a better habitat connectivity through hedgerow management.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Vogt, P., Riitters, K.H., Iwanowski, M., Estreguil, C., Kozak, J. and Soille, P., 2007. Mapping landscape corridors. Ecological indicators, 7(2), pp.481-488.
Hilty, J.A., Lidicker Jr, W.Z. and Merenlender, A.M., 2012. Corridor ecology: the science and practice of linking landscapes for biodiversity conservation. Island Press.
Beier, P. and Noss, R.F., 1998. Do habitat corridors provide connectivity?. Conservation biology, 12(6), pp.1241-1252.

22. Literature review of drivers and barriers to shelter belts in the DK landscape

Department and supervisor
Department of Agroecology

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Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Landscape ecology and analysis; policy, economic incentives; shelter belts; farm management;

Short project description
Shelter belts of shrubs and trees within the landscape has shown to provide multiple beneficial services to individual farms, in terms of production, animal welfare, water management and soil protection. But on a larger landscape scale, such shelterbelts provide important services to society in terms of carbon storage and conservation of biodiversity. In this project, the student will carry out a systematic literature review to assess the agri-environment policy and subsidy framework, and thereby provide insight into what drives and supports the establishment and management of shelter belts in the DK landscape.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

Additional information
Yang, Carolina. 2020. "The potentials of agroforestry systems in Denmark and southern Sweden.". https://stud.epsilon.slu.se/16285/3/yang_c_201112.pdf
Harkness, Caroline, et al. 2021. "Stability of farm income: The role of agricultural diversity and agri-environment scheme payments." Agricultural Systems 187.

23. Landscape ecology – mapping the historic and current extent of shelter belts in DK landscape

Department and supervisor
Department of Agroecology

Main supervisor:
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Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Landscape ecology and analysis; connectivity, shelter belts; GIS; farm management; conservation

Short project description
Shelter belts of shrubs and trees within the landscape has shown to provide multiple beneficial services to individual farms, in terms of production, animal welfare, water management and soil protection. But on a larger landscape scale, such shelterbelts provide important services to society in terms of carbon storage and conservation of biodiversity. In this project, the student will map and assess the present and historic extent of shelter belts in the DK landscape, by the use of geographical land-use data (GIS). Further analysis can be carried out, with a focus dependent on the student's wishes.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

Additional information
Dhillon, Gurbir Singh, and Ken CJ Van Rees. "Soil organic carbon sequestration by shelterbelt agroforestry systems in Saskatchewan." Canadian Journal of Soil Science 97.3 (2017): 394-409.
Webb, Bid, et al. "Investigating the impact of shelterbelts on landscape hydrology." EGU General Assembly Conference Abstracts. 2017.

24. Climate-accounts at landscape scale – while gaining local benefits

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
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Sara Iversen, Postdoc, email, sara.iversen@agro.au.dk

Physical location of the project and students work
Department of Agroecology, AU Viborg

Project start
2023/2024

Main subject area
Land use; climate regulating services; spatial geographical modelling; multifunctional landscapes

Short project description
One of the solutions to counteract the current climate crises is to capture more carbon in soils. For example natural forest stores more carbon/ha in the soil as compared to agriculture. In this project, we will dive into carbon storage of various land-use and soil types - e.g. agriculture, forest, grassland, and wetlands and the effect of converting from on land-use to another. If done intelligent, these specific land-use changes are likely to deliver positive side-effects in the surrounding landscape by boosting local biodiversity and decreasing nitrogen leaching, where the latter is one of the main pollutants in costal environments. In this project the student will calculate scenarios for future land-use based on climate-accounting at landscape scale, based on how much land is converted and where it should be converted to gain highest effect. The data used can be existing geographical land-use data (GIS) assisted by IPCC conversion factors and the Toolkit for Ecosystem Service Site-specific Assessment (TESSA).

Extent and type of project .
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
- Odgaard MV, Knudsen MT, Hermansen JE & Dalgaard T. 2019. Targeted grassland production e A Danish case study on multiple benefits from converting cereal to grasslands for green biorefinery. Journal of cleaner production.
- Alonso i, Weston, k., Gregg, r. & Morecroft. 2012. Carbon storage by habitat - Review of the evidene of the impacts of management decisions and condition on carbon stores and sources., Natural England Research Reports - Number NERR043.
- Bachelet D, Ferschweiler K, Sheehan T, Baker B, Sleeter BM, Zhu Z. 2017. Human footprint affects US carbon balance more than climate change. http://dx.doi.org/10.1016/B978-0-12-409548-9.09770-0

25. Participatory approaches to land management: inquiring aspects of farmer involvement and participation in regulatory processes

Department and supervisors
Department of Agroecology

Main supervisors:
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Morten Graversgaard, Researcher, email Morten.Graversgaard@agro.au.dk, phone +45 8715 7751

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Participatory approaches; Farm management; food production; nitrogen losses to the environment; planning; social learning; communication

Short project description
The objective of this project would be to explore aspects of stakeholder involvement and – participation in the context of land management. Debates regarding the regulation of Danish agriculture has in recent years emphasized the need for involving stakeholders such as farmers in future regulation of agriculture's impact on the aquatic environment. One of the assumptions behind this is that further progression in terms of regulation is contingent on the degree to which local stakeholders can be involved in addressing environmental issues in a practical setting. The rationale for participatory is also found in European regulations such as the Water Frame Directive. Specific issues which could be explored by the project includes issues of social learning, communication, power, planning, targeted regulation etc.

Extent and type of project
All the variants below can be supervised:
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
It will be an advantage, if the student has been participating in courses such as 'Agricultural Policy and Agro-Environmental Regulation', and 'Communication, Knowledge and Food Systems', as they provide introductions to issues concerning communication, learning, policy and regulation.

Useful reading could include:
Blackmore, C. ed. 2010. *Social Learning Systems and Communities of Practice*. London: Springer. Collins, K., and R. Ison. 2009. Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. *Environmental Policy and Governance* 19 (6):358-373. http://dx.doi.org/10.1002/eet.523

Dalgaard, T., S. Brock, B. Hansen, B. Hasler, O. Hertel, N. J. Hutchings, B. H. Jacobsen, L. S. Jensen, C. Kjeldsen, B. Kronvang, J. E. Olesen, J. K. Schjørring, T. Sigsgaard, M. Graversgaard, F. Hashemi, K. Turner, H. Vejre, W. de Vries, and I. A. Wiborg. 2020. DNMARK: Danish Nitrogen Mitigation Assessment: Research and Know-how for a Sustainable, Low-Nitrogen Food Production. In *Just Enough Nitrogen: Perspectives on how to get there for regions with too much and too little nitrogen*, eds. M. A. Sutton, K. E. Mason, A. Bleeker, W. K. Hicks, C. Masso, N. Raghuram, S. Reis and M. Bekunda, 363-376. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58065-0_25

26. The Effects of Aeolian Dust on Soil Functions in South Greenland

Department and supervisor

Supervisor:
Lis Wollesen de Jonge, Professor, Dept. of Agroecology, lis.w.de.jonge@agro.au.dk, 24940550

Co-supervisors:
Trine Nørgaard, Assistant professor, Dept. of Agroecology, trine.norgaard@agro.au.dk, 93521059
Charles Pesch, Postdoc, Dept. of Agroecology, cp@agro.au.dk
Peter Weber, Postdoc, Dept. of Agroecology, plw@agro.au.dk

Physical location of the project and students work

Department of Agroecology, AU Viborg, 8830 Tjele.

Project start

Start in August at the earliest.

Main subject area

Aeolian dust source tracking, plant biomass and species, soil water repellency, soil dispersibility, organo-mineral complexation.

Short project description

The rapid warming, which is taking place in Greenland, presents an opportunity for improved agricultural production. Large areas of the agricultural soils in Greenland suffer from nutrient deficiency, coarse particle size distributions, and extremely low pH, resulting in a very unfertile and unproductive landscape. Aeolian transport of dust from periglacial landscapes is widely known in Greenland. The fine dust-sized material forms when glaciers crush underlying rocks and stones to very fine particle sizes. It is transported down the valley to pastures and cultivated areas in South Greenland. Aeolian dust deposition could be an important external source of essential nutrients to soils and strongly influence soil quality and functions to improve grassland productivity. The deposition of aeolian dust and its effect on soil functional properties will be addressed in four specific projects and can be shaped according to specific ideas in a fifth:
Project 1: This project aims to track the source of aeolian dust in a subarctic ecosystem in South Greenland. Material from the glacial source will be analyzed (for e.g. availability of plant-essential mineral elements and particle-size distributions) and compared to dust material in soil profiles further down the valley representing areas with high, less, and no dust deposit loads. Additionally, the effect of dust on micro- and macronutrient status, pH and cation exchange capacity can also be evaluated.
Project 2: Here, we utilize the gradient in dust deposition to investigate how aeolian dust affects the above-ground biomass production, the plant community, and the below-ground microbial diversity. Plant biomass and species will be determined in situ, and the bacterial community can be analyzed.
Project 3: In this project, we aim to investigate the effect of dust on soil water repellency. Soil samples from the above-mentioned dust gradient will be analyzed for soil water repellency and evaluated on the basis of, e.g. particle size distribution, organic carbon, plant community and pH.
Project 4: In this project, we aim to investigate the effect of dust on soil structure and soil stability. A low-energy end-over-end dispersibility method will be carried out on 100 cm^3 intact soil cores sampled from the above-mentioned dust gradient. The soil dispersibility potential will be related to organo-mineral complexation through analyses of particulate organic matter and mineral-associated organic matter, and further linked to e.g., particle size distribution, organic carbon, plant community and pH.
Project 5: Within the scope of Aeolian dust transport as presented in the introduction above, you are encouraged to put together your own project. You can select from the other project ideas or contribute with other interesting ideas, and we will assist with what is possible.

Extent and type of project
We encourage a 45 or 60 ECTS thesis (preferably 60 ECTS) where:

45 ECTS is an experimental thesis in which the student is responsible for collection and analysis of his/her own original data, and

60 ECTS is an experimental thesis in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
There is the potential opportunity to join for the sampling excursion in Greenland in August 2023. We expect the student to try to apply for a scholarship to cover the expenses for the trip.
References:

- N. Kingo Jacobsen. Studies on soils and potential for soil erosion in the sheep farming area of South Greenland. Arctic and Alpine Research, 19(4):498–507, 1987.
- Chatrina Caviezel, Matthias Hunziker, and Nikolaus J. Kuhn. Bequest of the Norseman-The potential for agricultural intensification and expansion in southern Greenland under climate change. Land, 6(4):1–20, 2017.
- Charles Pesch, Peter L. Weber, Per Moldrup, Lis W. de Jonge, Emmanuel Arthur, and Mogens H. Greve. Physical characterization of glacial rock flours from fjord deposits in South Greenland-Toward soil amendment. Soil Science Society of America Journal, 86(2):407–422, 2022.

27. Biodiversity and solar panels

Department and supervisor
Department of Agroecology - Entomology and Plant Pathology (PATENT)
Claus Rasmussen, Tenure-Track Assistant Professor, email: claus.rasmussen@agro.au.dk, Mobile: +45 2259 7679

Physical location of the project and students work
AU Flakkebjerg or AU Viborg. Location depend on laboratory needs and available field sites.

Project start
If fieldwork in Denmark is planned, it will require time during season (April-September). Theoretical thesis or fieldwork abroad may provide more flexibility.

Main subject area
Agriculture, Insects, Pollinators, Biodiversity, Ecosystem Services

Short project description
As a response to the ongoing environmental and energy crises, solar panels are increasingly being installed on farmland in Denmark and Europe. This development has taken place despite the fact that agricultural land is a scare resource needed for increasing food demand. An important next step in this development is AgriPhotoVoltaic systems that benefit from dual use of farm land areas by combining electricity production with agricultural production. A potential project relates to the effect of such systems on insect and plant biodiversity, as well as natural pest control, and how such dual use impact the agricultural production between the panels. Designing appropriate monitoring (or using monitoring data from the past), collecting and analysing data are needed to optimize design towards these multiple goals for the land use.

Extent and type of project
All the variants below can be supervised:

30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Additional ideas in relationship to biodiversity and solar panels can be discussed.
Relevant articles to read
H. Blaydes, S.G. Potts, J.D. Whyatt, A. Armstrong (2021) Opportunities to enhance pollinator biodiversity in solar parks, Renewable and Sustainable Energy Reviews, 145, 111065, https://doi.org/10.1016/j.rser.2021.111065

28. Biodiversity and green biomass

Department and supervisor
Department of Agroecology - Entomology and Plant Pathology (PATENT)
Claus Rasmussen, Tenure-Track Assistant Professor, email: claus.rasmussen@agro.au.dk, Mobile: +45 2259 7679

Physical location of the project and students work
AU Flakkebjerg or AU Viborg. Location depend on laboratory needs and available field sites.

Project start
If fieldwork in Denmark is planned, it will require time during season (April-September). Theoretical thesis or fieldwork abroad may provide more flexibility.

Main subject area
Agriculture, Insects, Pollinators, Biodiversity, Ecosystem Services

Short project description
Biomass is an important raw material for renewable energy production where biorefinaries can use perennal grass and legumes to produce regional energy and high value protein for feed. While there are both climate and environmental benefits in regionally grown grasslands harvested and processed to sustainable energy and high value feed, we still know little about the potentially positive impact of different seed mixes on biodiversity. In a combination with an already established experimental setup with different mixtures, the flower resources available for pollinators and the presence of pollinators and other insects will be assessed in order to optimize the yield while at the same time supporting a high diversity of pollinators.

Extent and type of project
All the variants below can be supervised:

30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Additional ideas in relationship to biodiversity can be discussed.
Relevant articles to read
Rachel N. Nichols, John M. Holland, Dave Goulson (2022) Can novel seed mixes provide a more diverse, abundant, earlier, and longer-lasting floral resource for bees than current mixes? Basic and Applied Ecology, 60, 34-47, https://doi.org/10.1016/j.baae.2022.02.002

29. Dissolved organic nitrogen as a nitrogen source for wheat plants

Department and supervisor
Department of Food Science
Associate Professor Ivan Paponov, ivpa@food.au.dk, +45 209 86 016

Physical location of the project and students work
Department of Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Plant physiology, plant growth, nitrogen-use efficiency, organic farming

Short project description
The soil nitrogen (N) pool that is available for plant nutrition consists of inorganic (e.g., nitrate and ammonium) and soluble organic (e.g., amino acid [AA]) forms. Our aim is to investigate the contribution of organic N to plant nutrition, as this aspect has not been extensively studied. We hypothesize that the cultivation of plants that can take up AA more efficiently will revolutionize crop production by substantially reducing N losses to the environment. These N losses occur as inorganic forms (emission of nitrogen oxides and ammonium emission and leaching of nitrate); therefore, cultivation of plants that can efficiently absorb AAs will reduce the conversion of soil AAs into inorganic N, thereby reducing N release into the environment. As a part of this project, you will have the chance to work with a variety of wheat genotypes and conduct experiments under carefully controlled conditions. Using state-of-the-art analytical and molecular techniques, such as metabolite and gene expression analysis, you will gain a mechanistic understanding of the physiological mechanisms underlying plant response to different forms of organic nitrogen.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Näsholm T, Kielland K, Ganeteg U. (2009) Uptake of organic nitrogen by plants. New Phytol. 2009;182(1):31-48. doi: 10.1111/j.1469-8137.2008.02751.x.
Ichihaslie et al (2020) Multi-omics analysis on an agroecosystem reveals the significant role of organic nitrogen to increase agricultural crop yield. PNAS. doi: 10.1073/pnas.1917259117.
Khan, S. et al. (2019) Exogenous Application of Amino Acids Improves the Growth and Yield of Lettuce by Enhancing Photosynthetic Assimilation and Nutrient Availability. Agronomy. 9. 266. 10.3390/agronomy9050266.

30. Identification of key plant traits and mechanisms contributing to lettuce growth under organic cultivation

Department and supervisor
Department of Food Science
Associate Professor Ivan Paponov, ivpa@food.au.dk, +45 209 86 016

Physical location of the project and students work
Department of Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Plant physiology, plant growth, nitrogen-use efficiency, organic farming

Short project description
We know that under organic cultivation, soluble organic (e.g., amino acid [AA]) nitrogen forms play an important role in plant N nutrition. However, the effects of different AA on plant growth and the presence of significant differences between genotypes in uptake and utilization of AA are poorly investigated. We hypothesize that the cultivation of plants that can take up AA more efficiently will revolutionize organic crop production. Moreover, the cultivation of plants that can efficiently absorb AAs will reduce the conversion of soil AAs into inorganic N, thereby reducing N release into the environment. You perform experiments under control conditions with the aim of obtaining a mechanistic understanding of the plant adaptation to organic nitrogen supply. You will work with contrasting lettuce accessions and related wild species. In this study, various analytical and molecular approaches (e.g., metabolite and gene expression analysis) will be used to gain insight into the physiological mechanisms underlying plant response to different forms of organic N.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Ichihaslie et al (2020) Multi-omics analysis on an agroecosystem reveals the significant role of organic nitrogen to increase agricultural crop yield. PNAS. doi: 10.1073/pnas.1917259117.
Khan, S. et al. (2019) Exogenous Application of Amino Acids Improves the Growth and Yield of Lettuce by Enhancing Photosynthetic Assimilation and Nutrient Availability. Agronomy. 9. 266. 10.3390/agronomy9050266.

31. The hormone modulation induced by Ri-technology triggers nutrient and light use efficiency

Department and supervisor
Department of Food Science
Associate Professor Ivan Paponov, ivpa@food.au.dk, +45 209 86 016

Physical location of the project and students work
Department of Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Plant physiology, plant growth, nitrogen-use efficiency, Ri-technology, Agrobacteria rhizogenes

Short project description
This project implements the Ri (root-inducing) technology for ornamental plants. The Ri technology is based on plant inoculation with Agrobacteria rhizogenes, which has a large Ri plasmid and induces hairy root disease, causing root proliferation from the infection site. The transformation of this plasmid in the plant genome can improve plants with traits; however, how these traits affects plant adaptation to different environmental stresses is unknown and requires investigation. You perform experiments under control conditions with the aim to obtaining a mechanistic understanding of modulation induced by Ri transformation to low nitrogen supply. You will work with contrasting Kalanchoe plants (control and Ri-transformed). In this study, various analytical and molecular approaches (e.g., metabolite and gene expression analysis) will be used to gain insight into the physiological mechanisms underlying the effect of Ri transformation in nitrogen use efficiency.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Ibrahim Ilker Ozyigit I.I. et al (2013) Agrobacterium rhizogenes-Mediated Transformation and Its Biotechnological Applications in Crops, K. R. Hakeem et al. (eds.), Crop Improvement, DOI 10.1007/978-1-4614-7028-1_1

32. The effects of different Levels of Shading on Grain Crop Growth, Development, Yield, and Quality in Agri-photovoltaic Systems

Department and supervisor
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René Gislum, Associate Professor, rg@agro.au.dk, Phone: +45 20542092

Physical location of the project and students work
Department of Agroecology - Crop Health (CROP), AU-Flakkebjerg

Project start
If fieldwork is planned, it will require time during season (April-September).

Main subject area
Agriculture, Crop Production, Agri-photovoltaic Systems, Remote Sensing

Short project description
Objective: This study aims to evaluate the effects of different levels of shading on growth, development, yield, and quality of grain crops as wheat, barley, pulses, and buckwheat, in AgriPhotoVoltaic systems (APVs). The project will also use remote sensing technology and non-destructive methods to measure Leaf Area Index (LAI).
Methodology:

1. The project could involve conducting experiments with different grain crops under different levels of shading in APVs, and a control crop grown under full sunlight conditions.
2. Measurements of several variables such as LAI, photosynthesis, carbon assimilation, grain yield, and quality parameters such as protein content. LAI could be measured using non-destructive methods such as remote sensing technologies.
3. Remote sensing technology to obtain information about crop growth, development, and health parameters such as LAI, vegetation indices, and canopy temperature.
4. Data analysis using statistical methods to evaluate the effects of shading on grain crop growth, development, yield, and LAI.
5. Optimizing shading strategies to maximize grain crop yield and quality in APVs, taking into account the effects of shading on LAI and remote sensing data.

Potential outcomes and impact:
This study could provide valuable insights into the effects of shading on grain crop growth, development, yield, and LAI in a multi-crop study in APVs. The results could develop more efficient and sustainable APVs for grain crop production, and provide data to draw conclusions about the potential benefits and drawbacks of using APVs.

Extent and type of project
30, 45 or 60 ECTS

Additional information
You are welcome to contact the supervisors to discuss the opportunities for designing the project to fit your ideas.

33. Exploring impact of climate change on germination of weed and/crop species

Department and supervisor
Johannes Ravn Jørgensen, Associate Professor, jrj@agro.au.dk. Tlf.: 8715 8314
Peter Kryger Jensen, Senior Scientist, PKJ@agro.au.dk. Tlf: 8715 8195

Physical location of the project and student work
Department of Agroecology, AU Flakkebjerg, Forsøgsvej 1, 4200 Slagelse

Project start
Anytime, experimental work can also be conducted at any time.

Main subject area
Weed/crop/seed biology

Short project description
Changes in the climate and new management practices influences sowing time of the cereals. However, a good establishment of cereals is an important starting point both for a high yield and a high level of competitiveness against weeds. With the restrictions to control weeds, all relevant options to prevent and reduce the weed development utilized. The foremost possibility to prevent weeds is a fast germinating and developing crop to restrict the weeds chance to germinate and become established. Moreover, the desire to increase cereal yield have in recent years lead to great focus on exploiting the optimum growing season. This has led to renewed focus on timely and optimal establishment of spring as well as winter cereals.

A temperature gradient table is available at AU Flakkebjerg. The temperature gradient table allows the germination of seeds at 8 different temperatures. The temperature can either be kept constant or with a daily cycle. Counting germinated seeds regularly during the germination pro-cess gives a dataset with combinations of percentage germination at different temperatures. From the dataset models describing germination according to temperature sums can be fitted. Such models are available for a number of important weed and crop species.
Interested students can select their own favourite species for the investigation. The study could include investigation of interaction between sowing depth, seed size, seed vitality and temperature, which is of great importance for successful establishment of seed crops.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
You are welcome to contact one of the supervisors to discuss the opportunities for designing the project to fit your ideas.

34. Biological solution agains late blight (Phytophthora infestans) in patato

Department and supervisor
Department of Agroecology, Crop Health section, Forsøgsvej 1, 4200 Slagelse
Main supervisor: Isaac Kwesi Abuley, ikabuley@agro.au.dk

Physical location of the project and student work
Department of Agroecology, AU Flakkebjerg, Forsøgsvej 1, 4200 Slagelse

Project start
From April 2023, but a different start date can be arranged.

Short project description
Late blight caused by *Phytophthora infestans* is a devastating disease in potatoes globally. Fungicides are the major means of controlling the disease. Given the potentially negative impact of pesticides on the environment, problems of reduced efficacy due to increased pathogen resistance and the de-listing of many fungicides under the EU Pesticide Directive (2009/128/EC), there is an urgent need for a more sustainable long-term integrated pest management strategy. An eco-friendly way to manage late blight is by using biological control agents (BCAs). Several BCAs (e.g. *Bacillus spp.)* for controlling late blight have emerged in the past decades. However, these BCAs are considered risky and seldom used by growers due to their poor efficacy in the field. This poor efficacy is largely due to the poor understanding of what makes these BCAs successful antagonists. For these BCAs to live up to their expectation we need research to acquire this knowledge (e.g. timing). In this project, we seek to understand the optimal conditions that make BCAs effective. This will be done via a growth chamber and greenhouse experiment. The results from this study will be integrated into a Decision Support System for managing late blight.

Extent and type of project
45 ECTS or 60 ECTS

35. Phenotyping pathogenicity traits of novel *Phytohthora infestans* genotypes

Department and supervisor
Department of Agroecology, Crop Health section, Forsøgsvej 1, 4200 Slagelse
Main supervisor: Isaac Kwesi Abuley, ikabuley@agro.au.dk

Physical location of the project and student work
Department of Agroecology, AU Flakkebjerg, Forsøgsvej 1, 4200 Slagelse

Project start
From April 2023, but a different start date can be arranged.

Short project description
Phytophthora infestans (*Pi*) has been problematic since 1840, causing an economically important disease (Late blight, LB) in potatoes and tomatoes on a global scale. While *Pi* is endemic in many potato-growing areas (e.g., Denmark), the high evolutionary capacity of the pathogen means novel genotypes with unpredictable consequences to control measures continually emerge. In 2018, a novel *Pi* genotype (i.e., EU43) emerged in Denmark and is currently widely distributed in the country. This project seeks to understand the pathogenicity traits of this novel genotype. The project will involve: (1) the use of microsatellite markers to determine the genotype of the *Pi* isolates, (2) detached-leaves and whole-plant experiments to determine aggressiveness and virulence of Pi isolates to potato varieties with different resistant genes (i.e., differential sets).

Extent and type of project
45 ECTS or 60 ECTS

36. Forecasting systems for controlling downy mildew (*Peronospora destructor*) in onion

Department and supervisor
Department of Agroecology, Crop Health section, Forsøgsvej 1, 4200 Slagelse
Main supervisor: Isaac Kwesi Abuley, ikabuley@agro.au.dk

Physical location of the project and student work
Department of Agroecology, AU Flakkebjerg, Forsøgsvej 1, 4200 Slagelse

Project start
Ideally from April 2023, but a different start date can be arranged.

Short project description
Onion production is threatened by epidemics of downy mildew (*Peronospora destructor*). To control the disease, fungicides are sprayed repeatedly (8-10 times) in a season. However, this excessive use of a fungicide is unsustainable and counterproductive to the green agenda. There is thus the need to reduce the use of fungicides. One way of regulating the use of a fungicide is via disease forecasting systems/models. These forecasting models predict when conditions favorable for infection by a pathogen are present, and thus recommend the application of fungicide. Currently, there are no forecasting models for timing the application of fungicides in onions in Denmark. However, there are existing models (e.g. MILLIONCAST, DOWNYCAST) that have proven useful in other countries. The objective of this project is to evaluate different forecasting models from the literature for timing fungicides and biological control agents for controlling downy mildew in onions.

The project is part of the InnovateIPM project (https://agro.au.dk/forskning/projekter/innovate-ipm)

Extent and type of project
45 ECTS or 60 ECTS

References
ARAÚJO, E. R., ALVES, D. P. & KNOTH, J. R. 2017. Weather-based decision support reduces the fungicide spraying to control onion downy mildew. *Crop Protection,* 92**,** 89-92.
ARAÚJO, E. R., RESENDE, R. S., ALVES, D. P. & HIGASHIKAWA, F. S. 2019. Integrating cultivar resistance and disease warning system to control downy mildew of onion. *Australasian Plant Disease Notes,* 15**,** 1.
GILLES, T., PHELPS, K., CLARKSON, J. P. & KENNEDY, R. 2004. Development of MILIONCAST, an Improved Model for Predicting Downy Mildew Sporulation on Onions. *Plant Disease,* 88**,** 695-702.
JESPERSON, G. D. & SUTTON, J. C. 1987. Evaluation of a forecaster for downy mildew of onion (Allium cepa L.). *Crop Protection,* 6**,** 95-103.
PALTI, J. 1989. EPIDEMIOLOGY, PREDICTION AND CONTROL OF ONION DOWNY MILDEW CAUSED BY PERONOSPORA-DESTRUCTOR. *Phytoparasitica,* 17**,** 31-48.
VAN DER HEYDEN, H., BILODEAU, G. J., CARISSE, O. & CHARRON, J.-B. 2020. Monitoring of Peronospora destructor Primary and Secondary Inoculum by Real-Time qPCR. *Plant Disease,* 104**,** 3183-3191.

37. Agronomic and environmental evaluation of nitrogen fertilization strategies at field level

Department and supervisor
Department of Agroecology, Climate and Water

Main Supervisors:
Davide Cammarano, Professor, mobile: +45 93522545, Email: davide.cammarano@agro.au.dk
Diego Abalos Rodriguez; Tenure Track Researcher, mobile: +45 2085 4336, Email: d.abalos@agro.au.dk

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Between April and September 2023 and/or April and September 2024

Main subject area
Plant-soil interactions; nitrogen; spatial variability; agronomy; precision agriculture

Short project description
Precision Agriculture (PA) is "a management strategy that takes account of temporal and spatial variability to improve sustainability of agricultural production" (www.ispag.org). There are several key elements to consider in such definition: the agronomic component which considers the field management, and the economic and environmental sustainability of production aiming at keeping farming highly productive and profitable with lower environmental impacts. PA distinguishes itself from classical agronomic trials because it attempts to consider the spatial (within a field or between fields) and temporal (during a growing season and/or between growing seasons) variability of the factors affecting nutrient dynamics (e.g., topography, soil organic carbon, soil texture). It thus attempts to analyse the multiple factors at play in farmers' fields rather than a few isolated ones.
With this project we will be able to quantify in space and time the plant-soil continuum (e.g., N2O emissions, soil nitrogen, plant biomass/nitrogen, soil water) of different fertilization strategies in a 5 ha field. Ultimately, the aim of this PA-focused project is to understand the best rate and time to apply nitrogen fertilizers to crops, to make informed management decisions that increase the sustainability of agricultural systems.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for the collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

38. The potential of Silicon fertilizers for increasing the performance and physiological response of Potato under drought stress

Department and supervisor
Department of Agroecology, Climate and Water

Main supervisor:
Davide Cammarano, Professor, Phone: +45 93522545, email davide.cammarano@agro.au.dk
Co-supervisor:
Klaus Butterbach-Bahl, Professor, Phone: +45 93508238, email klaus.butterbach-bahl@agro.au.dk

Physical location of the project and students work
Department of Agroecology, AU Viborg

Project start
April 2023

Main subject area
Silicon fertilizers; potato drought tolerance; plant performance; plant physiology

Short project description
Potato (*Solanum tuberosum* L.) is one of the most important crops globally, feeding more than a billion people. However, recently potato yields have been negatively impacted by increased frequency and intensity of drought. Potatoes are highly susceptible to drought due to their small and shallow roots that make the plant unable to take up water and nutrients from deeper soil layers. The application of Silicon fertilizers has the potential to decrease potato susceptibility to drought by increasing the plants' performance and nutrient uptake. The project will be a field experiment that will examine the effect of different Silicon fertilizers (Amorphous silica and Diatomous earth) and their application methods (foliar application or incorporated in soil) on potato performance indicators (above and below ground biomass, tuber production) and physiological responses (photosynthetic gas exchange, chlorophyll fluorescence) during periods of drought.

The student will gain experience in experimental fieldwork methodology, soil and plant sampling and analysis. The student will further collaborate with post doctorate students in change of the project to produce the master's thesis and a scientific article.

Extent and type of project
45 ECTS: Experimental theses where the student is responsible for collection and analysis of own original data and 60 ECTS: Experimental theses where the student is responsible for planning, trial design and collection and analysis of own original data.

Relevant articles to read
Nasir, M. W., & Toth, Z. (2022). Effect of Drought Stress on Potato Production: A Review. *Agronomy*, *12*(3), 635;
Tayade et al. (2022). Silicon as a Smart Fertilizer for Sustainability and Crop Improvement. *Biomolecules*, *12*(8), 1027.

39. Robot-mounted sensors for spatialized weed and crop management

Department and supervisor
Department of Agroecology, Climate and Water

Main Supervisors:
Davide Cammarano, Professor, mobile: +45 93522545, Email: davide.cammarano@agro.au.dk
René Gislum, Associate Professor, mobile: +45 20542092, Email: rg@agro.au.dk

Physical location of the project and students work
Department of Agroecology, AU Viborg and AU Flakkebjerg.

Project start
Between April and September 2023 and/or April and September 2024

Main subject area
Precision agriculture; proximal sensing; weed management.

Short project description
The project involves working with analyzing images from robots and drones for spatial determination of weeds amount at different times during the growing season, and to determine the crop vegetation cover, leaf area index at key physiological states. The robot-mounted sensors will help to improve our understanding of the spatial consistency of the spectral relationship of plant sensing and weeding infestation at field level.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for the collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

40. Do temperature and soil particle size determine the magnitude of water sorption in soils?

Department and supervisor
Department of Agroecology, Soil Physics and Hydropedology Section

Supervisor: Emmanuel Arthur, Senior Researcher, Emmanuel.arthur@agro.au.dk, 871 57734
Co-supervisor: Trine Nørgaard, Assistant Professor, Trine.norgaard@agro.au.dk, 871 57635

Physical location of the project and students work
Department of Agroecology, AU Vibprg, 8830 Tjele

Project start
Any time

Main subject area
Water vapour sorption in soils, temperature effects on soil water movement

Short project description
The advent of sophisticated equipment for measuring soil water vapour sorption (dry-region soil water retention) provides a unique opportunity to investigate how soil temperature and particle size affect the sorption magnitude, sorption hysteresis, and the subsequent influence on the estimation of soil properties from water sorption. The thesis work will involve the use state of the art equipment to measure soil water vapour sorption, and soil samples that differ in clay mineralogy, soil texture, and organic matter content.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The student should have basic knowledge of soil physics/soil science.

Useful Reading
Yeşilbaş, M., Boily, JF. Particle Size Controls on Water Adsorption and Condensation Regimes at Mineral Surfaces. Sci Rep 6, 32136 (2016). https://doi.org/10.1038/srep32136
Arthur, E., Tuller, M., Moldrup, P. and Wollesen de Jonge, L. (2014), Evaluation of a Fully Automated Analyzer for Rapid Measurement of Water Vapor Sorption Isotherms for Applications in Soil Science. Soil Science Society of America Journal, 78: 754-760. https://doi.org/10.2136/sssaj2013.11.0481n

41. Can we predict water retention at low saturation by spectroscopic techniques and empirical modelling?

Department and supervisor
Department of Agroecology, Soil Physics and Hydropedology Section

Supervisor: Emmanuel Arthur, Senior Researcher, Emmanuel.arthur@agro.au.dk, 871 57734
Co-supervisor: Maria Knadel, Tenure Track Assistant Professor, Maria.knadel@agro.au.dk, 871 57736

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Near-infrared spectroscopy modeling, development of pedotransfer functions

Short project description
At low saturations, water is adsorbed onto soil surfaces as water films or gaseous molecules. This process is crucial for modelling water vapour transport, microbial activity, and biological processes such as plant water uptake in the vadose zone. The direct measurement of water retention at such low saturations is time-consuming and can be cumbersome. In this project, the student will utilize available sorption isotherm and near-infrared spectroscopy data for 300+ soil samples. The data will be combined to develop robust models for estimating water retention under dry conditions. Additionally, empirical models will be developed from easy-to-measure soil properties (e.g., clay, silt, organic matter contents). These models will represent a rapid approach to estimating water retention under conditions that are often encountered in arid soils and during summer.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

Additional information
The student should have basic knowledge of soil physics/soil science.

Useful Reading
José M. Soriano-Disla, Les J. Janik, Raphael A. Viscarra Rossel, Lynne M. Macdonald & Michael J. McLaughlin (2014) The Performance of Visible, Near-, and Mid-Infrared Reflectance Spectroscopy for Prediction of Soil Physical, Chemical, and Biological Properties, Applied Spectroscopy Reviews, 49:2, 139-186, DOI: 10.1080/05704928.2013.811081
Pittaki-Chrysodonta, Z., Arthur, E., Moldrup, P., Knadel, M., Norgaard, T., Iversen, B.V. and de Jonge, L.W. (2019), Comparing Visible–Near-Infrared Spectroscopy and a Pedotransfer Function for Predicting the Dry Region of the Soil-Water Retention Curve. Vadose Zone Journal, 18: 1-13 180180. https://doi.org/10.2136/vzj2018.09.0180

42. Applying near-infrared spectroscopy and empirical modelling to determine water retention hysteresis in soils

Department and supervisor
Department of Agroecology, Soil Physics and Hydropedology Section

Supervisor: Emmanuel Arthur, Senior Researcher, Emmanuel.arthur@agro.au.dk, 871 57734
Co-supervisor: Maria Knadel, Tenure Track Assistant Professor, Maria.knadel@agro.au.dk, 871 57736

Physical location of the project and students work
Department of Agroecology, AU Viborg, 8830 Tjele

Project start
Any time

Main subject area
Near-infrared spectroscopy, development of pedotransfer functions

Short project description
Hysteresis, defined as differences in the water content for the wetting and drying branch of the sorption isotherms, exists in the majority of soil types. Consideration of hysteresis is crucial for accurate modelling of water vapour flow in arid regions or during dry summer spells for quantification of soil evaporation and for ensuring the correct estimation of soil properties from water content measurements. The student will quantify sorption hysteresis for a large soil database and develop models to estimate the phenomena from near-infrared spectra and available soil properties.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

Additional information
The student should have basic knowledge of soil physics/soil science.

Useful Reading
Arthur, E, Tuller, M, Moldrup, P, de Jonge, LW. Clay content and mineralogy, organic carbon and cation exchange capacity affect water vapour sorption hysteresis of soil. *Eur J Soil Sci.* 2020; 71: 204– 214. https://doi.org/10.1111/ejss.12853
Lu, N., Khorshidi, M., 2015. Mechanisms for soil-water retention and hysteresis at high suction range. J Geotech Geoenviron 141(8), 04015032.

43. Beer, malt, and grain in prehistory

Department and supervisor
Department of Agroecology, AU Flakkebjerg

Kim Henrik Hebelstrup, Associate Professor, kim.hebelstrup@agro.au.dk

Physical location of the project and students work
AU Flakkebjerg & collaboration with The Danish National Museum

Project start
Anytime

Main subject area
Crop biology and evolution, barley/malt/beer analysis

Short project description
In early prehistory all humans were hunters and gatherers. Humans exploited many species in nature in different ways, and we must assume that the knowledge of animal and plant characteristics was very broad with a significant exploitation of many different animals and plants and a distinct understanding of diversity and biological systematics. Independently at different times in prehistory, agricultural cultures emerged, where a few species gradually became part of the household economy. This process is called domestication. Wild animals became livestock, and wild plants became crops, which were sown, cultivated, harvested, stored and used in the household and in trade. In southern Scandinavia, this process began about 6000 years ago when agriculture with its crops, livestock and associated advanced technology and culture emerged. The first crops in southern Scandinavia were emmer and barley. It has been hypothesized that the production of beer or similar beverages from these cereals may have played a particularly important role for the motivation of crop production in this part of prehistory. This project examines starch from grains and other prehistoric finds as indicators of malt and alcoholic beer/beverage production. Experimental beer brewing is reconstructed based on archaeological finds, to explore how brewing techniques may have been carried out in the past.
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Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of her/his own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of her/his own original data

Additional information
Cordes, A., Henriksen, P. S., Sørensen, L., Blennow A., Hald, M. M., Lund, J., Møller, A. N.,Nielsen, P. O., Nielsen, F. O., Bech, J., H., Sarauw, T., Simonsen, J., Sparrevohn, L., Westphal, J. & K. H. Hebelstrup (2021) Identification of prehistoric malting and partial grain germination from SEM analysis of starch granules in charred barley, Journal of Archaeological Science, 125, 105297.

44. Bread, gluten & diabetes

Department and supervisor
Department of Agroecology, AU Flakkebjerg

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Mobile: +45 50387921

Physical location of the project and students work
AU Flakkebjerg

Project start
Any time

Main subject area
Crop biotechnology

Short project description
A number of different projects are available within field of bread and gluten. We try to develop new varieties of barley using new breeding technologies to increase the quality of barley flour for baking purposes. We analyse gluten structure and molecular composition to understand how it may contribute to celiac disease or other types of gluten insensitivity. We analyse the carbohydrate fraction of flour and use new breeding techniques to increase its health impact. In particularly in relation to relief of glycaemic control in type-2 diabetic patients.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
See more at: https://www.klimafokus.dk/bygbroed-boer-erstatte-rugbroedet-men-der-er-en-hage/
And: https://landbrugsavisen.dk/mark/ny-kornsort-skal-forebygge-diabetes-og-overv%C3%A6gt

45. Breeding towards pesticide-free crop production

Department and supervisor
Department of Agroecology, AU Flakkebjerg

Kim Henrik Hebelstrup, Associate Professor, kim.hebelstrup@agro.au.dk
Mobile: +45 50387921

Physical location of the project and students work
AU Flakkebjerg

Project start
Any time

Main subject area
Crop biotechnology

Short project description
We use new breeding technologies such as CRISPR to breed new types of potatoes and wheat that have higher resistance to fungal pathogens. In potato, we focus on the resistance towards late blight caused by *Phytophthora infestans*, and in wheat, we focus on resistance towards yellow rust caused by yellow rust caused by the biotrophic fungus *Puccinia striiformis*. The ultimate goal is to generate natural resistance to an extent where pesticides will no longer be necessary to control diseases.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
See more at: https://via.ritzau.dk/pressemeddelelse/kan-rotation-i-kartoffelsorter-forlaenge-resistens-mod-skimmel?publisherId=13559834&releaseId=13669713

46. Microbiome-assisted drought resilience in barley

Department and supervisor
Department of Agroecology, AU Flakkebjerg

Mette Vestergård, Senior Researcher, mvestergard@agro.au.dk
Chris Barnes, Tenure Track Assistant Professor, c.barnes@agro.au.dk
Mogens Nicolaisen, Professor, mn@agro.au.dk

Physical location of the project and students work
AU Flakkebjerg, Forsøgsvej 1, 4200 Slagelse

Project start
Any time

Main subject area
Plant/soil microbiology, plant phenotyping, drought resilience

Short project description
With ongoing climatic changes, severe drought is already challenging crop production in Europe and elsewhere, and drought frequency and intensity are only expected to increase during the coming decades. Future crop production therefore depends on solutions that will enhance crop resilience towards drought stress. It is becoming increasingly clear that the microorganisms on and in the plant (the plant microbiome) play a significant role in plant responses to stress, e.g. drought. However, we know little about the identity of stress-alleviating microorganisms and the mechanisms that are involved in plant-microbial interactions.
In this project, you will design and perform experiments to investigate how different barley genotypes interact with soil microbiomes during drought stress. For instance, you could investigate if barley drought-resilience depends on the recruitment or presence of specific plant-beneficial microorganisms, or if previously drought-prone soils have a higher prevalence of drought stress-alleviating microorganisms.
You will gain experience and competencies with controlled plant experiments, plant phenotyping, classical and molecular microbiological methodologies as well as data analysis, graphical presentation, and scientific writing.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The project is affiliated to the Barley MicroBreed project, see: https://agro.au.dk/forskning/internationale-platforme/barleymicrobreed/

The project requires basic knowledge in microbiology.

47. Alleviation of climate extremes by conservation agriculture/regenerative practices

Department and supervisors:
Department of Agroecology

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone +4525152716
Loraine ten Damme, ltd@agro.au.dk

Physical location of the project:
Department of Agroecology, Research Centre Foulum, AU Viborg

Project start:
Flexible

Main subject area:
Climate adaptation, Conservation agriculture/regenerative practices, Soil structure Hydraulic properties, Soil mechanical properties

Short project description:
The aim of the project is to evaluate the potential of conservation agriculture/regenerative practices to alleviate impacts of climate extremes on key soil functions. The project will include experimental activities in the field and the laboratory and use the CENTS long-term rotation and tillage field experiment. Measurements include quantification of soil hydraulic and mechanical properties. The work will be integrated into the European SoilX project funded via the EJP Soil programme.

Extent and type of project:
45/60 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

Additional information:
The project will build on data collected in relation to field sampling in spring 2023 in the CENTS experiment at Research Centre Flakkebjerg. The student will supplement these results by targeted soil structure measurements in the field and in the laboratory.

Useful reading:
https://ejpsoil.eu/soil-research/eom4soil/into-dialogue/soilx
Blanchy et al, SOIL, 9, 1–20, 2023 https://doi.org/10.5194/soil-9-1-2023

48. Converting soil with contrasting fertility and quality to semi-natural grassland: temporal changes in carbon storage and soil structural characteristics

Department and supervisors:
Department of Agroecology

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone +4525152716
Johannes L. Jensen, jlj@agro.au.dk, phone +4522193421

Physical location of the project:
Department of Agroecology, Research Centre Foulum, AU Viborg

Project start:
Flexible

Main subject area:
Soil quality, Soil management, Soil recovery, Soil organic carbon, Soil structure, Pore characteristics

Short project description:
Loss of soil organic carbon (SOC) is a major threat to sustained soil functions and services globally. Further, the climate crisis demands a focus on mitigating greenhouse gas emissions in agriculture. One strategy is to sequester CO_2 from the atmosphere by converting arable land to grassland. However, it remains unknown how introduction of grassland will change the SOC storage and pore characteristics depending on the fertility and quality level of the arable land. The project exploits a unique long-term field experiment from Askov starting in 1981 with varying amounts of straw incorporation (0, 4, 8, 12 t/ha/year) and +/- ryegrass as cover crop in a spring barley monoculture. The experiment was terminated in spring 2020 and all plots were converted to semi-natural grassland. The plots hence had contrasting soil fertility and quality levels at the time when they were converted. The **aim** of this project is to quantify the temporal changes in SOC and soil structure for soils with different soil fertility and quality levels converted to grassland.

Extent and type of project:
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information:
The project will build on data on SOC and pore characteristics measured in spring 2020 and autumn 2021, i.e. shortly before and after the conversion to grassland. The student will sample bulk soil and soil cores in the field experiment and carry out soil structural measurements such as soil structural stability and soil pore characteristics (water retention, air-permeability and gas diffusivity).

Useful reading:
Jensen, J. L., Eriksen, J., Thomsen, I. K., Munkholm, L. J., Christensen, B. T. 2022. Cereal straw incorporation and ryegrass cover crops: the path to equilibrium in soil carbon storage is short. European Journal of Soil Science, 73, 10.1111/ejss.13173.

Teng, H., Taghizadeh-Toosi, A., Olesen, J.E., Jensen, M.L., Sørensen, P., Christensen, B.T. 2019. Converting temperate long-term arable land into semi-natural grassland: decadal-scale changes in topsoil C, N, C-13 and N-15 contents. European Journal of Soil Science, 70, 350-360.

Jensen, J.L., Schjønning, P., Watts, C.W., Christensen, B.T., Munkholm, L.J. 2020. Short-term changes in soil pore size distribution: Impact of land use. Soil and Tillage Research, 199, 104597.

Jensen, J.L., Schjønning, P., Watts, C.W., Christensen, B.T., Obour, P.B., Munkholm, L.J. 2020. Soil degradation and recovery – Changes in organic matter fractions and structural stability. Geoderma, 364, 114181.

49. Are lime and gypsum effective means to improve soil structural quality and reduce risk of phosphorus loss and degraded soil?

Department and supervisor
Department of Agroecology

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone +45 25152716
Goswin Heckrath, goswin.heckrath@agro.au.dk, phone +45 51435035

Physical location of the project
Department of Agroecology, Research Centre Foulum, AU Viborg

Project start
Autumn 2023

Main subject area
Degraded soils, Soil structural quality, Phosphorus loss, Soil friability, Wet stability.

Short project description
The aim of this project is to quantify the effect of liming and gypsum amendment on soil physical quality and surface runoff risk. Under Danish conditions poor topsoil structure is a problem on loamy soils with low organic matter content. They may in the worst case develop into so-called "hard- setting" soils that are very difficult to manage. Hard-setting soils display low strength in wet conditions and a large risk of clay dispersion. This may cause problems in crop production (poor seedbed quality and crop establishment) and for the environment (increased loss of phosphorus (P) and pesticides by surface runoff). The effectiveness of lime or gypsum for mitigating the problems remains to be tested under Danish conditions. The work includes sampling and measurements in a field experiment established in 2020. There will be special focus on soil erodibility, structural stability and friability. The latter will be determined both in the field (visual assessment, drop shatter) and in the laboratory (tensile strength).

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Experiments will be carried out in a field experiment established in 2020 in collaboration with the Danish advisory service, SEGES. Builds on results obtained in 2020/21 shortly after establishing the experiment.

Useful reading
Blomquist, J., Berglund, K. 2021. Timing and conditions modify the effect of structure liming on clay soil [Article]. Agricultural and Food Science, 30(3), 96-107. https://doi.org/10.23986/afsci.103422.
Blomquist, J., Simonsson, M., Etana, A., Berglund, K., 2018. Structure liming enhances aggregate stability and gives varying crop responses on clayey soils. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science 68, 311-322.
Ekholm, P. et al. 2012. Gypsum amendment of soils reduces phosphorus losses in an agricultural catchment. Agricultural and Food Science 21, 279-291.

50. Analytics of grass regrowth with statistical and dynamic modelling

Department and supervisor
Department of Agroecology, Aarhus University

Researcher Kiril Manevski, kiril.manevski@agro.au.dk
Professor Uffe Jørgensen, uffe.jorgensen@agro.au.dk
Researcher Ji Chen, ji.chen@agro.au.dk

Physical location of the project and students work
Department of Agroecology, AU Viborg

Project start
Any time

Main subject area
Crop science, data science, mathematical modelling

Short project description
Grass regrowth consists of numerous complex and interacting biological processes that can be modified by management. Understanding and quantifying these regrowth processes are essential for improving grass management for high yield and nutritive value. Modelling (statistical and process-based) is useful tool to integrate these interactive processes and to explore management options that improve grass production. The Danish process-based model Daisy can simulate grass regrowth but is associated with considerable uncertainty as the parameter values are based on data from unknown origin. At the department we have substantial amount of data gathered from various projects describing grass regrowth, which can be used to: 1) conduct univariate and multivariate statistical modelling to investigate and evaluate causal relationships of weather and management variables with grass regrowth, 2) evaluate and improve the accuracy of the Daisy grass module to simulate grass regrowth through calibration, and 3) conduct scenario analysis with the calibrated model to predict biomass accumulation during grass regrowth under different managements and associated soil carbon changes.

The MSc project will focus on extensive computer work for data analysis and results visualization, providing to the student data principles applicable across different fields. The results will also extend the applicability of Daily to simulate more accurately perennial systems. The student can be associated with the newly funded Novonordisk Fonden project AgroEco-HPM - "A high-performance data-driven agroecosystem modelling platform for developing agricultural systems with minimum environmental impact".

Extent and type of project
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
https://doi.org/10.1016/j.ecolmodel.2012.02.016

51. Computer vision-based approach for plant canopy nitrogen estimation

Department and supervisor
Department of Agroecology, Aarhus University

Researcher Kiril Manevski (kiril.manevski@agro.au.dk)
Postdoc Vita Antoniuk (vita.antoniuk@agro.au.dk)
Professor Mathias N. Andersen (mathiasn.andersen@agro.au.dk)

Physical location of the project and students work
Department of Agroecology,t AU Viborg

Project start
Any time

Main subject area
Crop science, remote sensing, agronomy

Short project description
Nitrogen (N) is essential nutrient element required for optimum crop growth. Accurate estimation of N status in crops is momentous to decide the N fertilization but remains difficult with methods other than destructive crop sampling and lab analyses. Finding solutions requires studies that extend across multiple spatio-temporal scales and contexts. Computer systems with digital image analysis might help solve the problem, especially because images from unmanned aerial systems (UASs) provide very high temporal and spatial resolution of sub-cm scale for both pixel-based classification based on the reflectance values and object-based analysis of colour, intensity, texture, and other image properties for different image resolutions.

In this MSc project we will utilize existing high spatial resolution UAV image datasets from potato and wheat crops grown under different micro-environment (drought) and managements (irrigation, nitrogen) to elucidate how well can leaf and canopy nitrogen be estimated by advanced image analysis methods, including object-based classification with fuzzy memberships and rules that we ourselves will develop based on data from potential conditions.
The MSc project will focus on extensive computer work for image analysis and results visualization, providing to the student tools and principles applicable across different fields. We have the needed software (ENVI, eCognition, ArgGIS), no prior knowledge is needed as the software platforms are intuitive and the student can explore themselves with the help of the supervisors.

Extent and type of project
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
https://doi.org/10.1016/j.rse.2020.111758

52. Labile inhibitor restricted xylanases in barley straw for bio-energy

Department and supervisor
Dept. of Agroecology, Crop Genetics and Biotechnology

Claus Krogh Madsen, Tenure Track Assistant Professor, ClausKrogh.Madsen@agro.au.dk
Phone: 87 15 81 04

Physical location of the project and students work
Reseach centre Flakkebjerg, Slagelse

Project start
Any time

Main subject area
Plant biotechnology, Bio-energy.

Short project description
Sustainable and ethical production of biofuels require the use of non-food side-streams mainly in the form lignocellulose biomass. Straw is one such biomass produced in large quantities. Generally, the challenge for utilization of lignocellulose biomass is recalcitrance of the material to enzymatic hydrolysis, i.e. plant cell walls are built to last. One possible solution is to express hydrolytic enzymes (xylanases, cellulases ect.) in the plant, so the cell wall will have a built-in impermanence [1]. This strategy, however, will need some way of restricting premature hydrolytic activity that would be detrimental to plant fitness. Cereals are known to express three families of xylanase inhibitors, XIP, TAXI and TLXI. So far research in these proteins has focused on their role in plant defence or their (undesired) inhibition of technical enzymes, e.g. in feed [2]. There has been little, if any, effort to utilize cereal xylanase inhibitors to – by design - restrict a xylanase.

The proposed project will co-express a heat stabile xylanase and a heat labile xylanase inhibitor in barley straw. The resulting straw will be assayed for xylanase activity with and without activation by heat treatment. The xylanase and inhibitor pair will also be expressed in the yeast *P. pastoris* in a parallel experiment to provide the pure proteins for *in vitro* investigation of their interaction.

Extent and type of project
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Li, Q.; Song, J.; Peng, S.; Wang, J.P.; Qu, G.-Z.; Sederoff, R.R.; Chiang, V.L. Plant biotechnology for lignocellulosic biofuel production. *Plant Biotechnol. J.* **2014**, *12*, 1174–1192.
Krogh Madsen, C.; Pettersson, D.; Hjortshøj, R.; Katholm, A.; Brinch-Pedersen, H. Superior Growth Rates in Broilers Fed Wheat with Low In Vitro Feed-Xylanase Inhibition. *J. Agric. Food Chem.* **2018**, *66*, 4044–4050.

53. Phytase gene regulation in barley and wheat

Department and supervisor
Dept. of Agroecology, Crop Genetics and Biotechnology

Claus Krogh Madsen, Tenure Track Assistant Professor, ClausKrogh.Madsen@agro.au.dk
Phone: 87 15 81 04

Physical location of the project and students work
Research Centre Flakkebjerg, Slagelse

Project start
Any time

Main subject area
Crop plant biology

Short project description
Plants express phytases to mobilize phosphorous from internal storage pools in the form of phytate (inostitol hexakisphosphate)[1]. Typically, seeds express high amounts of phytase during germination. Barley, wheat and their closest relatives have the unusual adaptation of expressing phytase during grain filling and storing it until germination. The mature grains therefore have considerable phytase activity, which is a positive quality for their use in food and feed [2].

The responsible genes have been identified and studied at CGB but important questions remain. Specifically, we have some preliminary evidence suggesting that temperature significantly influence phytase activity but it is not known how. We have currently two hypothesis a) the gene which is normally expressed during grain filling (*PAPhy_a*) is further enhanced by heat or b) a second gene normally expressed during germination (*PAPhy_b*) is induced by heat.

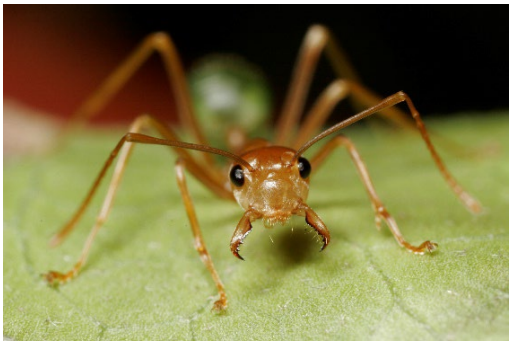
The project will use qPCR and digital droplet PCR to investigate phytase gene expression in barley and (optionally) wheat in response to different temperature treatments. Available to the project are a series of chemically and CRISPR-Cas9 induced mutant lines with modified *PAPhy_a* expression.

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Madsen, C.K.; Brinch-Pedersen, H. Globoids and phytase: The mineral storage and release system in seeds. *Int. J. Mol. Sci.* **2020**, *21*.
Madsen, C.K.; Brinch-Pedersen, H. Molecular Advances on Phytases in Barley and Wheat. *Int. J. Mol. Sci.* **2019**, *20*, 2459.

54. Biological control of plant pests



Department and supervisor
Department of Ecoscience, Terrestrial Ecology
Main supervisor: Joachim Offenberg, Senior Scientist, joaf@ecos.au.dk, mobile 2558 0680

Physical location of the project and students work
Aarhus University campus (building 1120) and greenhouses in Skejby (building 5910).

Project start
Anytime

Main subject area
Biological control, sustainable plant protection, ants as beneficials, antibiotics, microbiomes.

Short project description
"Would you like to help develop sustainable plant protection, that can effectively and cost efficiently replace chemical pesticides?"

We work with sustainable agriculture by researching and developing new methods for biological control of pests in open field crops. Biocontrol is a sustainable alternative to chemical pesticides and has been a major success in greenhouses, where the use of beneficial insects has replaced almost all use of chemical protection – simply because it is cheaper and more efficient.

A similar breakthrough has not yet been made in open field systems, because biocontrol agents easily disperse and leave the system. Therefore, we have focused our research on sedentary agents, which stay. One such example is ants.

We study how ants can be used to control pest insects and plant pathogens in agriculture. The predatory nature of ants makes them excellent at controlling pest insects, while antimicrobial substances produced by the ants and their associated microorganisms have been shown to control various plant pathogens. Additionally, we investigate the use of ant-associated microorganisms against plant pathogens and post-harvest diseases.

Apart from ants, we are exploring other potential beneficials for open field systems. So, if you want to help make the breakthrough, feel free to contact us!"

Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information - *Useful reading*
Offenberg 2015. Ants as tolls in sustainable agriculture. Journal of Applied Ecology. 52: 1197-1205
Jensen et al 2023. Implementing wood ants in biocontrol: suppression of apple scab and reduced aphid tending. Pest Management Science. Early online: DOI 10.1002/ps.742
Offenberg & Damgaard 2019. Ants suppressing plant pathogens: a review. Oikos. 128: 1691-1703.
Offenberg et al 2022. Combating plant diseases with ant chemicals: a review and metaanalysis. Journal of Applied Ecology 59: 25-38

55. Integrating outdoor pigs with agroforestry

Department and supervisor
Department of Agroecology

Anne Grete Kongsted, Senior Scientist, anneg.kongsted@agro.au.dk, phone +45 87157993.

Physical location of the project and students work
AU Viborg. Data collection on commercial farms and/or research stations

Project start
No specific time

Main subject area
Agroforestry, pigs, organic farming, tree and pasture management, nutrient efficiency

Short project description
A key focus is how to adopt agroforestry concepts in organic pig production to improve its suistanability. Denmark has maintained free range production as a distinctive element in organic sow herds. The outdoor image is favourable with the consumer perception of animal welfare but the free-range systems continue to face serious challenges with high risk of nutrient losses. We focus on how to implement (and manage) trees in these pasture-based systems to improve nutrient efficiency while providing multiple benefits related to animal welfare, carbon sequestration and biodiversity. Key points are e.g. to increase crop nutrient removal through harvesting of green tree biomass and to explore the possibility to use the harvested material (ensiled or fresh) as fodder for livestock.

Extent and type of project
All three types are relevant:

30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Experimental work and/or on-farm data collection are linked to the OUTFIT and MIXED (https://projects.au.dk/mixed/) projects on agroforestry and mixed farming systems.

56. Afforestatopm amd biodiversity

Department and supervisor
Department of Ecoscience, AU Aarhus

Beate Strandberg, Senior Scientist, bst@ecos.au.dk, Mobile: 30183151

Physical location of the project and students work
Campus AU (Building 1120) and field localities

Project start
Any time depending on the final project description.

Main subject area
Globally, the World is facing both a climate and a biodiversity crisis. Solutions to both challenges will influence land use and the competition for land. Afforestation is mentioned as a climate change mitigation measure providing carbon capture and storage. However, it has been questioned to what extent afforestation can meet both the climate and biodiversity goals. The focus of the thesis will be on biodiversity in afforested areas.

Short project description
Broadly speaking, five elements determine which species occur in forests: 1) the tree species composition, 2) soil moisture, 3) forest structure (stratification, clearings, forest edges), habitat resources (water, dead wood, litter, flowers etc.) and time. Most tree species have associated specialized insects and fungi, which are completely dependent on the tree species, and they will naturally only appear if the host species is planted.

The thesis will basically have two steps: 1) prediction of which animal and plant species can be expected based on existing knowledge (literature) on associated species, forest's structure, and habitats resources, and 2) studies of how well the prediction holds up in selected forests. The latter will be done using classic collection and species determination techniques.

Extent and type of project
30, 40 and 60 ECTS projects are possible.

Additional information
Good knowledge of associated organisms the project focusses on.

57. Give peas a chance! Cultivars for production of protein for organic foods

Department and supervisor
Department of Food Science

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Thayna Mendanha, co-supervisor, tm@food.au.dk

Physical location of the project and students
Dept. Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Pea cultivars, agronomic performance, plant growth, plant-based protein, organic farming

Short project description
There is a high demand for locally produced plant-based proteins to replace animal protein sources with the aim to reduce climate change impact of food production. Peas are a traditional crop in Denmark, but production is low and knowledge is missing to optimize protein content and cropping performance. In this project, the student make the master study with focus on field trials at the research station AU-Auning, Djursland. The study will include testing of agronomic performance of a number of pea cultivars aimed for high protein yields and further investigation for the food industry and for breeding of new high protein pea cultivars.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The study will be conducted in the frame of the KlimÆPro project 'Klimavenlig produktion af plante-baserede fødevarer fra danske ærter' (Climate-friendly production of plant-based foods from Danish peas) in collaboration with major Danish food, agricultural and seed companies.

58. Biostimulants improve soil quality and plant development in organic vegetables – or don't?

Department and supervisor
Department of Food Science

Hanne Lakkenborg Kristensen, Associate Professor, hanne.kristensen@food.au.dk, +45 2069 8054
Mesfin T. Gebremikael, Tenure Track, mesfin.gebremikael@food.au.dk

Physical location of the project and students
Dept. Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Biostimulants, vegetables, soil fertility, organic farming, plant growth and nutrition

Short project description
In recent years, more farmers have started applying biostimulants with the aim to improve crop growth and increase the resilience of crops towards abiotic stresses. Biostimulants originate from plant extracts, algae extracts, or beneficial fungi and bacteria, and can be applied by conven-tional and organic farmers. However, effects on crop production have been variable and sci-ence-based evidence is needed to document if biostimulants make any difference at all. In this project the student will conduct chemical and data analysis from greenhouse or field experiments at AU, where several biostimulants were tested in vegetable crops. Effects will be investigated in the plant-soil system, including plant growth response and soil microbial activity. Moreover, effects on the nutrient status of the plant and soil will be assessed to address the potential beneficial effects of biostimulants on nutrient availability within the cropping system.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The experiment will be performed in the frame of the Biogrowth project: https://mst.dk/erhverv/groen-virksomhed/groent-udviklings-og-demonstrationsprogram-gudp/gudp-projekter/2020-projekter/biovaekst/

59. Compost and fertilisers produced by new technology for on-farm recycling of carbon and nutrients

Department and supervisor
Department of Food Science

Hanne Lakkenborg Kristensen, Associate Professor, hanne.kristensen@food.au.dk, +45 2069 8054
Mesfin T. Gebremikael, Tenure Track, mesfin.gebremikael@food.au.dk

Physical location of the project and students
Dept. Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Main subject area
Organic fertilisers and composts, plant biomasses, documentation of technology, nitrogen and carbon mineralisation

Short project description
A newly invented farm-scale composting technology enables recirculation of biomass into plant-based compost and mineral fertilizers. The new technology can improve resource use efficiency, soil fertility and carbon storage in organic vegetable production and decrease the use of conventional nutrient sources. However, we lack understanding of the composting process and the effects on the soil-plant system.

The aim of this master project is to investigate the use of the new composting technology and the effects on soil and plant growth. How does biomass quality added to the machine influence the composting processes and the resulting quality of compost products and condensed nitrogen fertilisers? The focus will be on carbon and nitrogen mineralisation and microbial processes, and soil and plant responses.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued/edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
The master project will be linked to the project ComCrop 'New Composting Technology for On-farm Nutrient and Carbon Recycling to Organic Soils and High-Value Crops' granted by the RDD5 programme. The student will collaborate with AU-FOOD staff and the technology company ComFerm ApS on the experimental work.

60. Strip-cropping in organic food production – effects on soil fertility and crop growth

Department and supervisor
Department of Food Science

Hanne Lakkenborg Kristensen, Associate Professor, hanne.kristensen@food.au.dk, +45 2069 8054
Co-supervisor: Otto Nielsen, Trial & Project Manager, Nordic Beet Research, on@nbrf.nu, +45 2361 7057
Mesfin T. Gebremikael, Tenure Track, mesfin.gebremikael@food.au.dk

Physical location of the project and students
Department of Food Science, Agro Food Park 48, 8200 Aarhus N

Project start
Anytime

Physical location of the project and students work
Department of Food Science, Agro Food Park 48, 8200 Aarhus N
Field investigations take place at Nordic Beet Research (NBR) and may be linked to getting a summer job (field registrations etc. in different crops at NBR, Nordic Seed and/or VKST) at the research center at Lolland, address: Højbygårdvej 14, 4960 Holeby.

Project start
Anytime

Main subject area
Strip-cropping systems, production of sugar beets and other field crops, soil fertility, organic farming.

Short project description
Different crop species grown in strips in the field can increase biodiversity and soil fertility. However, competition at the interface between strips may influence crop development and harvest quality. Field investigations of crop growth and soil microbial activity from the interface into the neighbouring strips will increase our understanding of crop-crop and crop-soil interactions in strip-cropping systems. The field trials are run by the Nordic Beet Research staff. The master study will be a combination of field investigations at the research center at Lolland and laboratory work at the Dept. of Food Science at Agro Food Park, Aarhus N. The stay at Nordic Beet Research, Lolland may be combined with a summer job at the research center.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
The master project will be linked to the project StripCrop (https://icrofs.dk/en/research/danish-research/organic-rdd-6/stripcrop/) under the RDD6 research programme Strip-cropping for increased biodiversity and resilience in crops and soil.

61. Biodiversity – Crop tailored flower strips

Department and supervisor
Birte Boelt, Senior Scientist, e-mail: bb@agro.au.dk
Phone: 2228 3328

Physical location of the project and students work
Department of Agroecology, AU Flakkebjerg, 4200 Slagelse

Project start
Autumn 2023 or spring 2024

Main subject area
Agroecology

Short project description
Pollinators and natural enemies of crop pests are of importance in agricultural plant production as well for biodiversity in the agricultural landscape. As part of an IPM-strategy as well as a concern for the decline in insect number, farmers are increasingly establishing flower strips. These are not only considered a food resource for pollinators, but they may also provide food and shelter for natural enemies of crop pests.

Flower strips are diverse and may consist from only 2-3 species to mixtures of >20 species and their longevity range from annual to perennial. Information about the value of single species and how they each contribute to the value of the mixture is very limited. However, this knowledge is required if we in future want to design crop tailored flower strips to increase crop yield and reduce severity of pests.

In autumn 2021 and spring 2022, 25 single flower species and four mixtures were established with the aim to support pollinators and natural enemies of oil seed rape pests.

Potential topics are agronomic aspects of single species and mixtures, their pollen and nectar resource as well as studies of pollinators or various insect species.

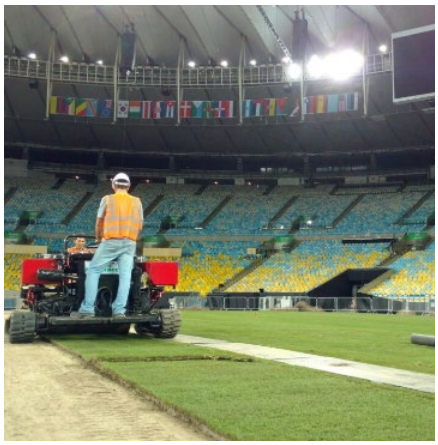
Extent and type of project
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
Two identical field experiments are located in Flakkebjerg and in Foulum (AU Viborg).
The project is carried out in collaboration with Yoko Dupont, ECOS, AU and Vibeke Langer, KU.

62. Seed production - Grasses

Department and supervisor
Birte Boelt, Senior Scientist, e-mail: bb@agro.au.dk
Phone: 2228 3328



Physical location of the project and students work
Department of Agroecology, AU Flakkebjerg, 4200 Slagelse

Project start
Anytime

Main subject area
Seed science and technology.

Short project description
Denmark is globally leading in seed production in temperate grass species. Grass seed is used in forage mixtures or in turf – for private or professional.

The research in AGRO deals with the optimization of management practices to improve seed yield and quality. An important quality parameter is rapid and uniform germination.

The project aims at studying seed yield and quality parameters in grasses and how this may be influenced by different management practices.

Currently we are investigating if the application of various nutrients at sowing can enhance establishment rate and growth in *Poa pratensis*.

The project can be carried out in collaboration with partners in the Danish seed industry.

The benefit of working with seed quality parameters, and as an example germination, is the short duration of project cycle. You will be able to generate your own data to analyze during the thesis.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for the collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

63. Land governance – Integration of climate, nature, and nitrogen

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746

Co-supervisor:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
Governance of natural resources, landscape planning, multifunctionality.

Short project description
Land governance includes rules, institutions, actors, and processes that govern the use, development, and conservation of land resources which are pivotal in delivering green transitions. Governance processes address how land is allocated, managed, and used for various purposes, how measures should be coordinated and implemented, and how effects should be evaluated. In this thesis. key themes to be studied could be: (1) addressing spatial organization of land use supporting multiple functions; (2) updating and improving tenure institutions and associated land administration systems to facilitate efficient land use transitions; (3) strengthening spatially targeted approaches to land use regulation, to accommodate integrated environmental and economic optimization of land use; (4) ensuring policy integration across sectors and issues, and between top-down and bottom-up decision making flows

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

64. Matching top-down and bottom-up rural planning – Systematic prioritization of Denmark

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746

Co-supervisors:
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Mette Vestergaard Odgaard, email: mette.vestergaardodgaard@agro.au.dk, phone +45 22908256

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
GIS analysis, rural planning, spatial planning, local vs national planning, nature,

Short project description
International and national plans and political goals are often developed and implemented based on different rationales and ideas than the local needs and priorities. In this thesis project, the idea is to assess planning and environmental priorities in Denmark and combine this with GIS modelling. Key questions to ask is: Do regional or national plans and political priorities on nature protection match local priorities aimed at ensuring community wellbeing and sustainability.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for the collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

65. Global nitrogen management and governance

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +458715 7746

Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +4525645560
William San Martín

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Global analysis, nitrogen governance, nitrogen pollution

Short project description
For most of the last century, anthropogenic reactive nitrogen has been a critical element of development from a local to a planetary scale. Intergovernmental and scientific organizations, research institutions, farmers, and communities have responded to the global nitrogen challenge as an issue at the intersection of agricultural-energy transitions and sustainable development. Yet, impacts, policy responses, and social demands have grown unequally. The idea is to examine developed and developing nations' responses, challenges, and innovations in Europe, US, Africa, South Asia, and Latin America. Possibilities is to explore the impacts and responses to increasing anthropogenic reactive nitrogen emissions.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
Kanter, D et al. "Gaps and opportunities in nitrogen pollution policies around the world." Nature Sustainability, 3.11 (2020).
Yang, Anastasia L et al. "Policies to Combat Nitrogen pollution in South Asia: Gaps and Opportunities." Environmental Research Letters 17.2 (2022).

66. Implementing multiple purposes in Danish landscapes

Department and supervisor
Department of Agroecology

Main supervisor:
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Co-supervisor:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Rural policies, policy integration, agricultural policies, multifunctionality.

Short project description
The green transition is on everyone's lips: rural landscapes must solve the climate crisis, the biodiversity crisis, provide clean drinking water, secure our coastal waters and marine areas from suffocating in nutrients, provide healthy food, ensure an energy transition based on sustainable forms of energy, etc. National political objectives are set with multiple purposes in the same rural landscapes. There are political goals of having 25% more forest areas, large nitrogen reduction efforts, climate targets and targets for the removal of 100,000 low-lying peatland areas, there are EU targets for 30% more biodiversity. How can these policies be aligned and implemented. And how is this to be ensured in practice out in the rural landscapes. In this thesis, theoretical concepts of policy integration and coherence can be used to better understand these dilemmas in the rural landscapes.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
Jale Tosun & Achim Lang (2017) Policy integration: mapping the different concepts, Policy Studies, 38:6, 553-570, DOI: 10.1080/01442872.2017.1339239Nilsson et al. (2012). Understanding Policy Coherence: Analytical Framework and Examples of Sector–Environment Policy Interactions in the EU. Env. Pol. Gov. 22, 395–423.

67. Terroir in Europe – Why are GIs unevenly distributed?

Department and supervisor
Department of Agroecology

Main supervisor:
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Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560

Physical location of the project and students work
AU Viborg

Project start
Spring 2023 and onwards

Main subject area
terroir, Geographical Indication, geographical distribution, PDO, PGI, food studies

Short project description
Geographical Indications (GIs) are an important tool for guaranteeing the quality of food products to the consumer, while promoting rural development through higher remuneration for farmers with a focus on terroir and the special characteristics of a particular locality. The five countries with the largest number of GIs (Italy, France, Spain, Greece, and Portugal) alone have more than 70% of European GIs. This uneven distribution of GIs across Europe is questionable because it implies that the benefits of this system are not distributed equally between countries. Understanding the reasons for this unequal geographical distribution will therefore allow to refine the rules and policies on GIs and explore ways to promote the system in areas where it is underused.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for the collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Useful readings
Huysmans, Martijn, and Johan Swinnen. 2019. "No Terroir in the Cold? A Note on the Geography of Geographical Indications." Journal of Agricultural Economics 70 (2): 550–59. https://doi.org/10.1111/1477-9552.12328.

68. Subsurface drainage mapping using UAV imagery

Department and supervisor
Department of Agroecology, AU Viborg

Main supervisor: Bo Vangsø Iversen, Associate Professor, email: bo.v.iversen@agro.au.dk
Co-supervisor: Triven Koganti, Postdoc, email: triven.koganti@agro.au.dk

Physical location of the project and students work
AU Viborg, field work at various places in DK

Project start
Any time

Main subject area
Soil physics, soil sensors

Short project description
Advanced processing techniques for mapping artificially drained agricultural areas using UAV Imagery: Artificial drainage installations (popularly known as "tile drains") are a common practice in poorly drained agricultural areas to drain the excess water and enhance crop productivity. Knowledge of the location of the drainage pipes is important for developing eutrophication mitigation strategies as drain lines act as shortened pathways for solute transport to the aquatic environment. In recent years, studies showed that UAV imagery (visible, multispectral and thermal infrared) proved to be a suitable technique for subsurface drainage mapping as drain lines show up as linear features due to differences in spectral reflectance and thermal inertia between dry and wet soil. In this project, the student will investigate advanced processing techniques such as decorrelation stretch, minimum noise fraction and/or principal component transforms on an existing dataset for suppressing the noise components thereby enhancing the drainage pipe response. In addition, supervised machine learning algorithms will be developed and employed to differentiate the drain line response from the linear features produced from field operations. The student is expected to be good at R or Matlab and GIS.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Allred, B., Eash, N., Freeland, R., Martinez, L., & Wishart, D. (2018). Effective and efficient agricultural drainage pipe mapping with UAS thermal infrared imagery: A case study. Agricultural water management, 197, 132-137.

Allred, B., Martinez, L., Fessehazion, M. K., Rouse, G., Williamson, T. N., Wishart, D., Koganti, T., Freeland, R., Eash, N., Batschelet, A., & Featheringill, R. (2020). Overall Results and Key Findings on the Use of UAV Visible-Color, Multispectral, and Thermal Infrared Imagery to Map Agricultural Drainage Pipes. Agricultural water management. Accepted.

69. Predicting the suitability of GPR for agricultural subsurface drainage mapping using gprMax

Department and supervisor
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Main supervisor: Bo Vangsø Iversen, Associate Professor, email: bo.v.iversen@agro.au.dk
Co-supervisor: Triven Koganti, Postdoc, email: triven.koganti@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Soil physics, geophysics, soil sensors

Short project description
Artificial drainage installation (popularly known as "tile drains") is a common practice in poorly drained agricultural areas to drain the excess water and enhance crop productivity. Knowledge of the location of the drainage pipes is important for developing eutrophication mitigation strategies as drain lines act as shortened pathways for solute transport to the aquatic environment. While traditional methods such as tile probing and trenching equipment are time-consuming and exceedingly invasive, GPR proved to be a suitable and effective alternative for non-invasive mapping of their locations. However, a major limitation for this technique is high signal attenuation in highly electrically conductive areas causing limited penetration of the electromagnetic signal. In this project, the student will simulate the GPR forward modelling using gprMax software for a variety of scenarios including different antenna bandwidths, soil electrical conductivities, dielectric permittivities, etc. to determine ideal configuration and conditions for drainage pipe mapping. This project aims at providing a framework for the use of GPR technology for subsurface drainage mapping.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
Koganti, T., Van De Vijver, E., Allred, B. J., Greve, M. H., Ringgaard, J., & Iversen, B. V. (2019). Evaluating the Performance of a Frequency-Domain Ground Penetrating Radar and Multi-Receiver Electromagnetic Induction Sensor to Map Subsurface Drainage in Agricultural Areas. In The 5th Global Workshop on Proximal Soil Sensing (pp. 29-34).
Koganti, T., Van De Vijver, E., Allred, B. J., Greve, M. H., Ringgaard, J., & Iversen, B. V. (2020). Mapping of Agricultural Subsurface Drainage Systems Using a Frequency-Domain Ground Penetrating Radar and Evaluating Its Performance Using a Single-Frequency Multi-Receiver Electromagnetic Induction Instrument †. Sensors, 20(14), 3922.

70. Driving variables for soil hydralic properties

Department and supervisor
Department of Agroecology, AU Viborg

Main supervisor: Bo Vangsø Iversen, Associate Professor, email: bo.v.iversen@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Soil physics, hydrology, vadose zone processes

Short project description
Measurements of soil hydraulic parameters are both expensive and time-consuming and are often practically impossible in modelling studies. It is therefore imperative that the required hydraulic properties can be obtained from other available predictors such as soil texture, bulk density, and other easily measured soil variables. Based on a comprehensive, Danish database on soil hydraulic properties (hydraulic conductivity, soil water characteristics) this study will focus on studying the influence of soil properties (soil texture, organic matter) on soil hydraulic properties. The study can contain different aspects such as developing pedotransfer functions and modelling of water transport in the vadose zone of the soil

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Kotlar, A.M., I. Varvaris, Q. de Jong van Lier, L.W. de Jonge, P. Moldrup, and B.V. Iversen. 2019. Soil hydraulic properties determined by inverse modeling of drip infiltrometer experiments extended with pedotransfer functions. Vadose Zone Journal 18:180215.
Iversen, B.V., M. Lamandé, S.B. Torp, M.H. Greve, G. Heckrath, L.W. de Jonge, P. Moldrup, O.H. Jacobsen 2012. Macropores and macropore transport. Relating basic soil properties to macropore density and soil hydraulic properties. Soil Science 177(9):535-542.

71. Preferential transport of phosphorus (P) in agricultural soils

Department and supervisor
Department of Agroecology, AU Viborg

Main supervisors:
Bo Vangsø Iversen, Associate Professor, email: bo.v.iversen@agro.au.dk
Goswin Heckrath, Associate Professor, email: goswin.heckrath@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Soil physics, hydrology, leaching.

Short project description
A need exists of targeted solutions for effectively reducing the leaching of nutrients from the root zone of agricultural soils to the aquatic environment. Spatial information of soil hydraulic properties (SHPs) and preferential water pathways in the soil must be better understood. This project focuses on macropore flow in combination with the transport of phosphorus in artificial subsurface tile drain system as a driver of P transport to the aquatic environment. Based on a P leaching index, the project should aim at describing P leaching pathways and loads. The project will be based on a dataset of soil hydraulic properties as well as tile drainage data from the Danish Pesticide Leaching Assessment Programme (www.pesticidvarsling.dk).

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data

Additional information
Allaire et al. 2009: https://doi.org/10.1016/j.jhydrol.2009.08.013
Bol et al. 2018: https://doi.org/10.3389/fmars.2018.00276
Eastman et al. 2010: https://doi.org/10.1016/j.agwat.2009.11.010
Kotlar et al. 2020: https://doi.org/10.1016/j.geoderma.2020.114479

72. Phosphorus transport in rewetted lowland areas – Critical processes and risk mapping

Department and supervisor
Department of Agroecology, AU Viborg

Main supervisors:
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Goswin Heckrath, Associate Professor, email: goswin.heckrath@agro.au.dk

Physical location of the project and students work
AU Viborg

Project start
Any time

Main subject area
Soil physics, hydrology, leaching.

Short project description
Rewetting organic lowland soils reduces carbon dioxide emissions significantly and represents an important climate change mitigation. However, rewetting may cause excessive release of iron-oxide bound phosphorus (P) in anoxic soils leading to eutrophication of the aquatic environment. Our understanding of P release from lowland hot spot areas is insufficient and current methodology does not allow locating these areas. The project will focus on our understanding of the geochemical and subsurface hydrological processes in restored wetlands that govern net P release from soils to surface waters. The study can be a combination of literature study, analysis of existing data as well as field- and/or lab work depending on the extent of the project.

Extent and type of project
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
45 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data.
60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data.

Additional information
Bauwe et al. 2019: https://doi.org/10.1016/j.ecohyd.2019.03.003
Guedessou et al. 2020: https://doi.org/10.3389/frwa.2020.608910