Master Thesis Projects
Topics within Agroecology

AGRO Environmental Management & Agrobiology MSc Programmes
2022-2023

Bo Vangsø Iversen - *photographer of above*
Head of MSc Programme
Department of Agroecology
Aarhus University

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Preface

Present catalogue of master thesis projects available in 2022-2023 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**:** www.kandidat.au.dk/en/agro-environmental-management/

Read more about the **MSc in Agrobiology** at www.kandidat.au.dk/en/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. Designing cover crop mixtures to improve nitrogen cycling

Department and main supervisor
Department of Agroecology: Climate and Water, Soil Fertility

Main Supervisor:
Diego Abalos Rodriguez; Tenure Track Researcher, mobile: +45 2085 4336, Email: d.abalos@agro.au.dk
Co-supervisor: Søren O. Petersen, Professor

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

Project start
Anytime. Ideally start between March and May 2022.

Main subject area
Plant biodiversity; climate change mitigation; cover crop mixtures; plant-soil interactions; nitrogen

Short project description
Agriculture is one of the greatest contributors to air and water pollution due to over-application of synthetic fertilizers. Current fertilization techniques aim to increase plant yield through application of mineral nitrogen (N) fertilizer, but plants retain only 50% of fertilizer N. The remaining N can be lost in the form of nitrous oxide, a potent greenhouse gas that contributes to ozone depletion, and as nitrate leaching, causing eutrophication of water bodies and dead zones. In this project, we will address this problem by identifying cover crop mixtures that reduce N losses while enhancing the provision of ecosystem services. The synergistic effect between different cover crop species (grasses, legumes, and brassicaceae) will be investigated in a field experiment. We will reveal the best cover crop mixtures, and explain why these specific mixtures reduce N losses based on their leaf and root traits. Measurements will include quantification of N losses (in air and water), N fixation, soil mineral N, and plant biomass and traits above- and below-ground. Ultimately, the student will propose a promising strategy to steer the biological processes that underpin N losses and plant N retention in agroecosystems.

This is a great opportunity for a young researcher to be involved in a project that will provide experience in the field and in the lab, aiming for discovering new ways to reduce our impact on the environment by making agriculture more efficient. Active guidance from the main supervisor as well as from the PhD student in charge of the experiment will be provided in a collaborative environment. This increases the possibilities of making a scientific paper in connection with the MSc thesis.

Extent and type of project
45 ECTS: Experimental theses; responsible for collection and analysis of own original data
60 ECTS: Experimental theses; responsible for planning, trial design and collection and analysis of own original data

Additional information
[1] Abalos, D., De Deyn, G. B., Kuyper, T. W., & van Groenigen, J. W. (2014). Plant species identity surpasses species richness as a key driver of N_2O emissions from grassland. *Global Change Biology*, *20*, 265–275. [2] 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*, 248–258. [3] 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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

7. 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.

8. 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.

9. Improved phosphorus (P) use efficiency for sustainable production of vegetables

Department and supervisor
Department of Food Science
Assistant Professor Dennis Konnerup, dennis.konnerup@food.au.dk, +45 22512261
Associate Professor Hanne Lakkenborg Kristensen

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, nutrient uptake, fertilizer, sustainability

Short project description
Phosphorus (P) is an essential element for plant growth and is involved in the composition of many macromolecules, such as nucleic acids, phospholipids and ATP. Today, P is mostly obtained from mined rock phosphate, which is a non-renewable resource. Therefore, in this project we focus on how to improve and optimize the fertilization of vegetable crops. This will be done by setting up experiments, where we will test several fertilizers and fertilizing techniques to achieve optimal P uptake and allocation in the plants. We will choose different vegetable species and measure physiological parameters such as photosynthesis, P uptake rates and the plants' ability to acidify the soil in order to release soil-bound P. Application of biostimulants to increase the P uptake can also be tested.

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
Students are welcome to contact one of the supervisors regarding other ideas for projects about vegetables and we can discuss an experimental design.

10. 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.

11. 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

12. 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-Foulum. 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.

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

Department and Supervisors:
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Mette Vestergaard Odgaard, email: Mette.vestergaardodgaard@agro.au.dk, phone +45 22908256
Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone +45 2891 3656
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone +45 25645560

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

Project start
Spring 2022 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/

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

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Mette Vestergaard Odgaard, email: Mette.vestergaardodgaard@agro.au.dk, phone +45 22908256
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-Foulum

Project start
Spring 2022 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.

15. Second Homes in Danish rural areas: taking stock of rural change

Department and supervisors
Department of Agroecology

Main supervisors:
Chris Kjeldsen, Senior Scientist, email Chris.Kjeldsen@agro.au.dk, phone +45 6174 7357
Co-supervisors:
Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone +45 2891 3656
Morten Graversgaard, Researcher, email Morten.Graversgaard@agro.au.dk, phone +45 8715 7751

Physical location of the project and students work
AU-Foulum

Project start
Spring 2022 and onwards

Main subject area
rural development; rural sociology; rural geography

Short project description
Second homes is a recurring theme in debates on rural development. It has been discussed as both a blessing and a curse with regards to how it affects rural development. It is an approach to maintaining the quality of the built environment in rural areas, but it can be argued to be a poor substitute for permanent settlement in terms of community development. The extent and form of second home ownership provides important insights with regards to rural settlement and thus rural development. Understanding and monitoring the extent of second home ownership is important for policy development, but studies dealing with the issue in Denmark is scarce. However, the department has recently acquired a national dataset which will enable a comprehensive mapping of second home ownership in Denmark. Important methods utilized in the project will be GIS, which might need to be supplemented with methods such as surveys and qualitative interviews.

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
The project will be afiliated with the SUSTAINSCAPES project, as it concerns the quality of rural spaces.

Useful reading could include:
Coppock, J. T. ed. 1977. *Second Homes: Curse or blessing?* Oxford: Pergamon Press.
Gallent, N. 2007. Second homes, community and a hierarchy of dwelling. *Area* 39 (1):97-106.
Hoogendoorn, G., and G. Visser. 2015. Focusing on the 'blessing' and not the 'curse' of second homes: notes from South Africa. *Area* 47 (2):179–184. http://dx.doi.org/10.1111/area.12156

Jansson, B., and D. K. Müller. 2004. Second home plans among second home owners in Northern Europe's periphery. In *Tourism, mobility and second homes: Between elite landscape and common ground*, eds. C. M. Hall and D. K. Müller, 261-272. Clevedon: Channel View Publications.
Kaae, B. C., T. S. Nielsen, and E. B. Karlsen. 2007. *Udredningsprojekt om "second homes" i danske yderområder*. København: Center for Skov, Landskab og Planlægning, Københavns Universitet. Available from http://www.folketinget.dk/samling/20072/almdel/MPU/Bilag/289/547201.PDF .
Kjeldsen, C., D. S. Kromann, N. C. Nielsen, and F. Just. 2009. *Dobbeltbosætning/sekundære boliger - en undersøgelse af mulige veje til udvikling i Vejen og Langeland Kommuner*. Esbjerg: Institut for Forskning og Udvikling i Landdistrikter, Syddansk Universitet. Available from https://www.sdu.dk/da/om_sdu/institutter_centre/c_clf_centerlanddistriktsforskning/nyheder_fra_clf/dobbeltbosaetning .

16. Marketizing farm- and landscape level ecosystem services in the agro-food value chain

Department and Supervisors:
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone +45 8715 7746
Chris Kjeldsen, Senior Scientist, email Chris.Kjeldsen@agro.au.dk , phone: +45 6174 7357
Co-supervisors:
Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone +45 2891 3656
Sara Iversen, Postdoc, email: sara.iversen@agro.au.dk, phone: +45 5020 7311

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

Project start
Spring 2022 and onwards

Main subject area
Agricultural ecology; landscape ecology; ecosystems services; valorization of externalities; value chains

Short project description
The Danish food sector is losing jobs, and primary producers face a long-term trend of income problems. In addition, agriculture is challenged with regards to compliance with the EU habitat- and water directives, which indicate the need for differentiation and a significant economic, societal and environmental potential in agricultural diversification through developing food systems that combine food production with the delivery of various ecosystem services. To do so, there is a need to improve market access for producers who engage in enhancing and developing ecosystem services and provide incentives for additional efforts. This project should analyze the value-chain and document successful strategies for the valorization and communication of ecosystem services and the coordination of these effects in the value-chain across different market spaces.

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
Alarcon, M., P. Marty, and A. C. Prévot. 2020. Caring for vineyards: Transforming farmer-vine relations and practices in viticulture French farms. *Journal of Rural Studies* 80:160-170. http://www.sciencedirect.com/science/article/pii/S0743016719311349

Bossy, S. 2014. The utopias of political consumerism: The search of alternatives to mass consumption. *Journal of Consumer Culture* 14 (2):179-198. http://joc.sagepub.com/cgi/content/abstract/14/2/179

Boström, M., and M. Klintman. 2019. Can we rely on 'climate-friendly' consumption? *Journal of Consumer Culture* 19 (3):359-378. https://journals.sagepub.com/doi/abs/10.1177/1469540517717782

Liere, H., S. Jha, and S. M. Philpott. 2017. Intersection between biodiversity conservation, agroecology, and ecosystem services. *Agroecology and Sustainable Food Systems* 41 (7):723-760. https://doi.org/10.1080/21683565.2017.1330796

Wezel, A., H. Brives, M. Casagrande, C. Clément, A. Dufour, and P. Vandenbroucke. 2016. Agroecology territories: places for sustainable agricultural and food systems and biodiversity conservation. *Agroecology and Sustainable Food Systems* 40 (2):132-144. https://doi.org/10.1080/21683565.2015.1115799

17. The changing nature of being a "good farmer" in the modern agro-food system – implications for ownership, finance and policy

Department and Supervisors:
Department of Agroecology

Main supervisor:
Chris Kjeldsen, Senior Scientist, email Chris.Kjeldsen@agro.au.dk , phone: +45 6174 7357
Co-supervisors:
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-Foulum

Project start
Spring 2022 and onwards

Main subject area
Rural sociology; farming styles; financialization; rural development

Short project description
Traditionally, the family farmer had a multifaceted role, performing all tasks on the farm, including fieldwork, managing livestock and labour, negotiating sales contracts, as well as attracting investments. However, in the past 40 years Danish agriculture has changed substantially. Today 50% of farms and 40% of the farmland is now under tenure, as much as 75% of fieldwork is carried out by external contractors, Danish farmers are the most indebted in Europe and it is difficult to see how generational change can be organized on the large enterprises. However, policies, financial and market institutions, like banks and cooperatives are still organized around the farmer as an independent decision-maker. Therefore, the role of the farmer has changed from traditionally being about obtaining and demonstrating agronomic skills to now being about demonstrating other types of skills, including financial skills, communicational skills and management skills. This project could analyze how conflicting notions of the good farmer is negotiated and given meaning by famers and other stakeholders and discuss the implications for farmers, the value-chain and supporting policies.

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
Burns, L. 2021. Challenges to habitus: scruffy hedges and weeds in the Irish countryside. *Sociologia Ruralis* 61 (1):2-25. https://onlinelibrary.wiley.com/doi/abs/10.1111/soru.12307
Burton, R. J. F. 2004. Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist' Behaviour. *Sociologia Ruralis* 44 (2):195-215. https://doi.org/10.1111/j.1467-9523.2004.00270.x

Thorsøe, M. H., and E. B. Noe. 2019. Fremtidens virksomhedskonstruktioner i dansk landbrug: Ejerskifter, finansiering og robusthed! Opsamling fra debatmøde på Axelborg, 23. januar 2019. Esbjerg: Center for Landdistriktsforskning, Syddansk Universitet. Available from https://www.sdu.dk/-/media/files/om_sdu/institutter/iful/udgivelser/clf_report_73_+fremtidens_virksomhedsk_dk_landbrug.pdf

18. Impact of climate change on soil readiness in Northern Europe

Department and supervisor
Mathieu Lamandé, Senior Scientist, mathieu.lamande@agro.au.dk, +45 22240870
Co-supervisors: Lars J Munkholm, Professor & Emmanuel Arthur, Tenure Track Researcher

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

Project start
Anytime

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 Nothern 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.

19. Consequences of soil deformation on soil physical propeties

Department and supervisor
Mathieu Lamandé, Senior Scientist, mathieu.lamande@agro.au.dk, +45 22240870
Co-supervisors: Emmanuel Arthur, Tenure Track Researcher

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

Project start
Anytime

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.

20. 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 22240870
Co-supervisors: Emmanuel Arthur, Tenure Track Researcher

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

Project start
Anytime

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.

21. Carbon sequestration in agricultural soils assessed from repeated analyses of soil during 1986-2018

Department and supervisor
Department of Agroecology
Lars Elsgaard, Associate Professor, lars.elsgaard@agro.au.dk, phone 87157674
Laura Sofie Harbo, PhD student - lauraharbo@agro.au.dk,

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

Project start
After summer 2022

Main subject area
Soil organic carbon, statistical analysis and modelling

Short project description
Estimations the soil organic carbon (SOC) stock in mineral agricultural soils is associated with relatively high uncertainties, stemming from the sampling method, sampling frequency and analytical procedures. Currently, Danish national sampling campaigns are done approximately every 10 years, and the data are used for estimating the potential for carbon sequestration and losses in arable soil, as well as modeling the impact of agricultural management on SOC. However, as a consequence of the low sampling frequency, it remains difficult to verify if the observed changes are robust or if they are compromised by random effects.

Soil samples have been collected across Denmark more frequently (between 9 and 13 times since 1986) for other purposes, and have been dried and stored. Re-analyzing these samples can give insight into how a more frequent sampling can improve the estimations of potential carbon sequestration and losses in relation to agricultural management.

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

Additional information
The project is an excellent opportunity to acquire or enhance statistical, modelling and analytical skills. The student will be actively supported in regards to learning statistics and programming in R, if needed. Such supervision can be provided both in Foulum and in Aarhus.

Example literature
A. Taghizadeh-Toosi,J. E. Olesen,K. Kristensen,L. Elsgaard,H. S. Østergaard,M. Lægdsmand,M. H. Greve,B. T. Christensen (2014) "Changes in carbon stocks in Danish agricultural mineral soils between 1986 and 2009" https://doi.org/10.1111/ejss.12169
Poeplau, C, Don, A. Flessa, H. *et al.* (2020) "First German Agricultural Soil Inventory" https://doi.org/10.3220/DATA20200203151139
M. Schrumpf, E. D. Schulze, K. Kaiser, and J. Schumacher (2011) "How accurately can soil organic carbon stocks and stock changes be quantified by soil inventories" https://doi.org/10.5194/bg-8-1193-2011

22. Micro plastics effects on soil organisms

Department and supervisor
Mette Vestergård Madsen, Senior Reseacher, mvestergard@agro.au.dk, 41593003
Jesper Liengaard Johansen, Postdoc, jljohansen@plen.ku.dk

Physical location of the project and students work
Department of Agroecology, Flakkebjerg; Forsøgsvej 1, 4200 Slagelse

Project start
Spring - autumn 2022

Main subject area
Soil Ecology, Eco-toxicology, Recycling and Sustainability

Short project description
Recycling of the waste products household compost and sewage sludge as fertilizers in agriculture, particularly organic agriculture is a challenge because they contain microplastic. The effects of microplastic in soil are largely unknown, and studies on these effects are essential to assess if recycling of these waste products impose environmental risks. In the project RECONCILE, we study the effects of micro plastics on soil organisms and health.

For this master project, we propose a laboratory experiment to study the effects of microplastics on the bacterial feeding soil nematode, and eco-toxicological model organism, *Caenorhabditis elegans*. We plan to use the dose-response method traditionally used in eco-toxicology, where we treat soil with many different concentrations of microplastics, and measure the growth and reproduction of the nematode. In addition, we may include treatments with co-occurring pollutants that might influence the effects and toxicity of microplastics.

Master students will have great influence on the final experimental approach and setup. Therefore, we encourage you to contact us, to have an exchange of ideas, and talk about the project possibilities.

Extent and type of project
45 or 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 reading
Johansen, J. L., et al., 2019. Wood ash decreases cadmium toxicity to the soil nematode Caenorhabditis elegans. Ecotoxicology and environmental safety. 172**,** 290-295. https://doi.org/10.1016/j.envpol.2018.08.034

Johansen, J. L., et al., 2018. Toxicity of cadmium and zinc to small soil protists. Environmental Pollution. 242**,** 1510-1517. https://doi.org/10.1016/j.ecoenv.2019.01.092

Rillig, M. C., Microplastic in terrestrial ecosystems and the soil? ACS Publications, 2012. https://doi.org/10.1021/es302011r

23. 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, Tenure Track Researcher, Emmanuel.arthur@agro.au.dk, 871 57734
Co-supervisor:
Trine Nørgaard, Postdoc, Assistant Professor, Trine.norgaard@agro.au.dk, 871 57635

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

Project start
Anytime

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

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

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

Project start
Anytime

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

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

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

Project start
Anytime

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.

26. Teabag index as a proxy for organic matter decomposition: quantifying the effect soil density, burial method, and crop type

Department and supervisor
Department of Agroecology, Soil Physics and Hydropedology Section
Supervisor: Emmanuel Arthur, Tenure Track Researcher, Emmanuel.arthur@agro.au.dk, 871 57734

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

Project start
Anytime

Main subject area
Soil organic matter, TeaBag Index, Soil properties

Short project description
Soil organic matter decomposition is an essential component of the nutrient cycle. Trditionally, self-made litter bags were used as a proxy for the extent of decomposability of organic material in different ecosystems. This made comparison across studies challenging. Recently, a standardized method based on teabags has been proposed and several studies have used it in different ecosystems and biomes. The project will combine different soil types that are prepared to different densities and assess the impact of burial method, soil packing density, and crop type on the tea bag index, and hence organic matter decomposition.

Extent and type of project
60 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
Keuskamp et al (2013). Tea Bag Index: A novel approach to collect uniform decomposition data across ecosystems. Methods in Ecology and Evolution, 4, 1070–1075.
Djukic et al. (2018). Early stage litter decomposition across biomes. Science of the Total Environment, 628–629, 1369–1394.
Becker, J. N., & Kuzyakov, Y. (2018). Teatime on Mount Kilimanjaro: Assessing climate and land-use effects on litter decomposition and stabilization using the Tea Bag Index. Land Degradation & Development, 29, 2321–2329
Toleikiene et al. (2020). The decomposition of standardised organic materials in loam and clay loam arable soils during a non-vegetation period. Soil and Water Research, 15, 181–190.

27. Transgene free CRISPR-Cas9 edited plants by transient T-DNA expression

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

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
Anytime

Main subject area
Plant biotechnology, new breeding technologies

Short project description
Current protocols for generation of CRISPR-Cas mutants in crop plants typically rely on stable transformation of the target plant with a construct encoding the Cas enzyme, guide RNA and selectable marker expression cassettes. Thus, at least the first generation will be transgenic in addition to having the desired mutations. Alternative approaches using viral vectors or Cas ribonucloproteins have been reported but they have not seen widespread adoption. The proposed project will seek to modify the well-established and efficient *Agrobacterium* mediated transformation method to obtain CRISPR-Cas mutations without transgenes. It is known that agrobacterium derived T-DNA exist in free form in the nucleus for some time before stable integration in the genome or degradation. It is also know that this free T-DNA is transcriptionally active. A CRISPR-Cas construct can therefore be expressed transiently from free T-DNA and cause a mutation before or without stable integration. Indeed, some reports suggest that approximately 10% of mutated plants lack T-DNA integration if plant regeneration is performed without selection for T-DNA integration. The project will stand on two pillars. 1) It will develop a digital droplet PCR based method to find mutated plants among the many wild type plants that result from regeneration without selection. 2) It will explore ways to block T-DNA integration. As for point two, it is the hypothesis that this may be accomplished by targeting polymerase θ, a key enzyme for T-DNA integration. Chemical inhibitors of human polymerase θ are known, but it needs to be investigated whether or not they will work in plants. Alternative strategies to suppress polymerase θ are RNAi or Cas13 mediated mRNA inactivation.

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
van Kregten, M., de Pater, S., Romeijn, R. *et al.* T-DNA integration in plants results from polymerase-**θ**-mediated DNA repair. *Nature Plants* **2,** 16164 (2016).

28. Targeted N measure to reduce nitrate leaching from agriculturqal soils

Department and supervisor
Department of Agroecology, AU Foulum
Christen Duus Børgesen, Senior Researcher, Christen.borgesen@agro.au.dk

Physical location of the project and students work
AU Foulum

Project start
Anytime

Main subject area
Soil hydrology, crop science, soil chemistry, Crop and N modelling,

Short project description
A need exists of targeted solutions for effectively reducing the nitrate leaching from the root zone of agricultural soils to the aquatic environment. The project includes use of nitrate leaching measurements (data) from field trials in an existing database (NLES5), but can also include new field measurements. The projects can include use of GIS for planning of optimal placement of N measures. N measures includes both drain measures and field N measures.
The project proposal is fairly open, which means that the student have high degree of freedom on the specific subjects

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
https://dcapub.au.dk/djfpdf/DCArapport174.pdf

29. Modelling of water, crop, and nitrogen in agricultural soils

Department and supervisor
Department of Agroecology, AU Foulum
Christen Duus Børgesen, Senior Researcher, Christen.borgesen@agro.au.dk
Bo Vangsø Iversen, Associate Professor, bo.v.iversen@agro.au.dk

Physical location of the project and students work
AU Foulum

Project start
Anytime

Main subject area
Soil hydrology, crop science, soil chemistry, Crop and N modelling,

Short project description
A need exists of targeted solutions for effectively reducing the nitrate leaching from the root zone of agricultural soils to the aquatic environment. The project includes use of nitrate leaching models as (NLES5) or the Daisy model. The project can also include new field measurements. The projects use basic soil hydraulic properties from a database but can also include soil hydraulic measurements from specific soils. The project proposal is fairly open, which means that the student have high degree of freedom on the specific subjects

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
None

30. Converting soil with contrasting fertility and quality to semi-natural grassland: changes in carbon storage and pore charasteristics

Department and supervisors:
Department of Agroecology
Lars J. Munkholm, Professor, lars.munkholm@agro.au.dk, phone +4525152716
Johannes L. Jensen, Postdoc, jlj@agro.au.dk, phone +4522193421

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

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 demand us to 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 exploit 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 how soils with different soil fertility and quality levels respond to grassland conversion.

Extent and type of project:
30/45/60 ECTS: Experimental theses in which the student is responsible for collection and analysis of his/her own original data

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

Useful reading:
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.

31. Are soil physical conditions limiting root growth and nutrient uptake in phosphorus responsive sandy soils

Department and supervisor
Department of Agroecology
Lars J. Munkholm, Professor, lars.munkholm@agro.au.dk, phone +4525152716
Ingeborg Frøsig Pedersen, Postdoc, ifp@agro.au.dk

Physical location of the project and students work
Department of Agroecology, Research Centre Foulum

Project start
Flexible

Main subject area
Soil fertility, soil structure, phosphorus, cereals

Short project description
For some Danish sandy soils, placement of mineral phosphorus fertilizer near the seed at sowing can result in significant yield increase in spring barley despite a high content of labile phosphorus (measured as Olsen P). Adverse soil physical conditions may restrict root growth and thus hinder phosphorus uptake from the soil phosphorus reserve. Field experiments with spring barley have been conducted in 2020 and 2021 on soils with high Olsen P content and yield increase to P fertilizers. The field experiments will be repeated in 2022. Soil temperature and physical conditions (porosity, penetration resistance) and early season root growth will be evaluated. The project will include data analysis and synthesis of data gathered in 2020-22. The student will also have the chance to be involved in lab work related to other relevant measurements such as micro-penetration on soil cores.
The study is related to Post-doc project funded by SEGES, a farmers owned agricultural knowledge and innovation centre in Denmark.

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
Arvidsson J (1999) Nutrient uptake and growth of barley as affected by soil compaction. Plant and Soil 208:9-19

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

Department and supervisor
Department of Agroecology
Lars J. Munkholm, Professor, lars.munkholm@agro.au.dk. phone +45 25152716
Goswin Heckrath, Associate Professor, goswin.heckrath@agro.au.dk, phone +45 51435035

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

Project start
Autumn 2022

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 "hardsetting" soils that are very difficult to manage. Hardsetting 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 field experiment in 2020 and follows up on measurements carried out in 2020/21. 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.

Useful reading
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.

33. 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.

34. Biomass yield and soil organic carbon and total nitrogen swquestration with land conversion from annuals to perennials

Department af supervisor
Department of Agroecology, AU Foulum
Ji Chen, Tenure Track Researcher, ji.chen@agro.au.dk
Uffe Jørgensen, Professor, uffe.jorgensen@agro.au.dk
Kiril Manevski, Researcher, kiril.manevski@agro.au.dk

Physical location of the project and students work
AU Foulum, field and lab work

Project start
Anytime

Main subject area
Agroecology, agronomy, ecology

Short project description
How much can we increase biomass yield by promoting land conversion from annual to perennial crops? Will increased biomass extraction for biorefineries reduce soil organic carbon (SOC) and total nitrogen (TN) stock? Which cropping system is more stable for biomass production over time? To our knowledge, no study has concurrently investigated the effects of land conversion from annual to perennial crops on biomass yield, yield stability, and changes in SOC and TN stock, which limits the understanding and application of sustainable agroecosystems producing biomass for biorefineries. In 2012, we established an experimental platform at Aarhus University Foulum to systematically compare the effects of annual and perennial crops on biomass yield for biorefineries and SOC and TN stock. The experimental platform is well managed until now and will be continued. In this project, the student will investigate the relationships between biomass production and changes in SOC and TN stock. We will together explore how we can increase biomass production without compromising SOC and TN stock. The student is flexible to focus on either biomass or soil aspects and the degree for their linkage. The student is also expected to be involved in both field soil sampling, lab and data analysis with good supervision.

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
J. Chen, P. E. Lærke, U. Jørgensen, Land conversion from annual to perennial crops: A win-win strategy for biomass yield and soil organic carbon and total nitrogen sequestration. Agriculture, Ecosystems & Environment 330, 107907 (2022).
J. Chen, P. E. Lærke, U. Jørgensen, Optimized crop rotations increase biomass production without significantly changing soil carbon and nitrogen stock. Ecological Indicators 117, 106669 (2020).
K. Manevski, P. E. Lærke, X. Jiao, S. Santhome, U. Jørgensen, Biomass productivity and radiation utilisation of innovative cropping systems for biorefinery. Agricultural and Forest Meteorology 233, 250-264 (2017).

35. Yield stability under both conventional and organic farming

Department and supervisor
Department of Agroecology, AU Foulum
Ji Chen, Tenure Track Researcher (ji.chen@agro.au.dk)
Jørgen Eivind Olesen, Head of Department, (jeo@agro.au.dk)

Physical location of the project and students work
AU Foulum, field and lab work

Project start
Anytime

Main subject area
Agroecology, agronomy, ecology

Short project description
Global demands on organic agricultural products are substantially increasing over the past decades, leading to the rapid expansion of organic farming. For example, more than 71.5 million hectares of worldwide farmland are under organic management. Will organic farming provide enough food to feed the world population? How can we increase yield production from organic farming by optimizing farming managements? Particularly, will organic farming be more stable compared to conventional farming under the accelerated climate change? Indeed, temporal yield stability has emerged as critical issue in an era of accelerated climate change and agricultural intensification, which indicates the variability in the biomass production from a cropping system over time. In 1997, we established an experimental platform at Aarhus University Foulum to systematically compare the effects of conventional and organic farming on yield, nitrogen leaching, and soil organic carbon and total nitrogen stock. The experimental platform is well managed until now and will be continued. We will together explore how do yield and yield stability change over the past 25 years and what are the underlying mechanisms? The student is expected to be involved in both field and lab analysis with good supervision on data analysis.

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

Additional information
J. Chen, P. E. Lærke, U. Jørgensen, Land conversion from annual to perennial crops: A win-win strategy for biomass yield and soil organic carbon and total nitrogen sequestration. Agriculture, Ecosystems & Environment 330, 107907 (2022).
S. Knapp, M. G. A. van der Heijden, A global meta-analysis of yield stability in organic and conservation agriculture. Nature Communications 9, 3632 (2018).
Y. Rui et al., Persistent soil carbon enhanced in Mollisols by well-managed grasslands but not annual grain or dairy forage cropping systems. Proceedings of the National Academy of Sciences 119 (2022).

36. Subsurface drainage mapping using UAV imagery

Department and supervisor

Department of Agroecology
AU Foulum
Bo Vangsø Iversen, Associate Professor, bo.v.iversen@agro.au.dk
Triven Koganti, Postdoc, triven.koganti@agro.au.dk

Physical location of the project and students work

AU Foulum, field work at various places in DK

Project start

Anytime

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.

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

Department and supervisor

Department of Agroecology
AU Foulum
Bo Vangsø Iversen, Associate Professor, bo.v.iversen@agro.au.dk
Triven Koganti, Postdoc, triven.koganti@agro.au.dk

Physical location of the project and students work

AU Foulum

Project start

Anytime

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 noninvasive mapping of their locations. However, a major limitation for this technique is high signal attenuation in highly electrical conductive areas causing limited penetration of the electromagnetic signal. In this project, the student will simulate the GPR forward modeling 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).

38. Driving variables for soil hydraulic properties

Department and supervisor
Department of Agroecology
AU Foulum
Bo Vangsø Iversen, Associate Professor, bo.v.iversen@agro.au.dk

Physical location of the project and students work
AU Foulum

Project start
Anytime

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.

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

Department and supervisor
Department of Agroecology
AU Foulum
Bo Vangsø Iversen, Associate Professor, bo.v.iversen@agro.au.dk
Goswin Heckrath, Associate Professor, goswin.heckrath@agro.au.dk

Physical location of the project and students work
AU Foulum

Project start
Anytime

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

40. Filter systems for removing phosphorus from agricultural drainage water

Department and supervisor
Department of Agroecology

Goswin Heckrath, Associate Professor, goswin.heckrath@agro.au.dk, +45 51435035

Physical location of the project and students work
AU Campus Foulum

Project start
No specific time

Main subject area
Environmental Sciences

Short project description
Background. Nutrients and sediment in agricultural drainage waters contribute to eutrophication of surface waters. A new approach towards mitigating drainage water phosphorus (P) losses focuses on drainage filter systems for high risk areas. Aarhus University and partners setup full-scale pilot systems to develop the technology. While soluble P can be retained by various reactive filter materials through sorption, removal of sediment and particle-bound P from drainage waters remains a practical challenge. Therefore, the overall goal of the MSc project is to explore adaptations to the existing drain filter system to improve sediment retention and overall P retention.

Aim. The aims of this MSc project are i) to study sediment properties in relation to P transport and retention in the filter system and ii) to test the effectiveness of flocculants for sediment retention.
Approach. Drainage water samples are collected continuously and automatically in different units of the drainage filter system during the runoff season. The student will contribute to analyzing the samples for different P fractions and sediment quality at the Department of Agroecology. This involves wet chemical analyses and determination of particle size distributions by laser diffraction. The data is used for investigating the dynamics of P retention and retention efficiency. During autumn, the effect of adding a salt as flocculant to drainage water before it enters the sediment filter will be monitored over several weeks. The project will be actively supported by technical staff at the Department of Agroecology and the student has access to monitoring data from previous years.

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
Vandermoere, S. et al. 2018. Reducing phosphorus losses from drained agricultural fields with iron coated sand filters. Water Research 141, 329-339.

41. Mobilization of assimilate in perennial plants – the root side of the story

Department and supervisor
Department of Agroecology
AU Foulum
Kiril Manevski, Researcher, kiril.manevski@agro.au.dk
Mathias N. Andersen, Professor, mathiasn.andersen@agro.au.dk
Ji Chen, Researcher ji.chen@agro.au.dk /Jim Rasmussen jim.rasmussen@agro.au.dk

Physical location of the project and students work
AU Foulum, field and lab work

Project start
Anytime

Main subject area
Plant physiology, agronomy, plant ecology

Short project description
Perennial herbs are among the most relevant plants for the Green Transitioning in Denmark and globally. Once defoliated, they follow one or a combination of two 'reserve dependent' regrowth strategies, to either photosynthesise with remaining leaves or halt root growth and remobilize stored carbohydrates when defoliation is severe. Studying the remobilization process would shed light on carbon sequestration potentials of perennial herbaceous plants and progress the theory of plant assimilate dynamics.

The scientific problem arises when root turnover, growth and decay is altogether an ongoing process accelerated by defoliation, which shades the remobilization process. However, a well-developed plant will store some carbohydrate reserves in the root, which will be then mobilized for regrowth after defoliation. This is a well-known effect, which should be relatively simple to measure by analyzing the roots for content of soluble carbohydrates (and maybe protein) between defoliated and untreated plants.

We have several field experiments already established at Foulum involving perennial herbaceous plants from the *Poaceae* (true grasses) and the *Fabaceae* (legumes) families and would like to systematically compare the root observations. In this MSc project, the student under good supervision will conduct field sampling of plant and root, determine soluble carbohydrates in roots and investigate statistical differences and relationships with aboveground biomass. We will together explore whether and to which extend the plant remobilize carbohydrates to support aboveground biomass growth and what does it mean for the Green Transitioning.

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

Additional information
https://ucanr.edu/sites/WalnutShortCourse/files/296816.pdf

42. Exploring impact of climate change on germination of weed and/or 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 students 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 tempera-tures. 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.

43. Soil organic carbon stock and under mixed-species systems

Department and supervisor
Department of Agroecology, AU Foulum
Ji Chen, Tenure Track Researcher, ji.chen@agro.au.dk
Diego Abalos, Tenure Track Researcher, d.abalos@agro.au.dk
Diego Grados Bedoya, Postdoc, diegogradosb@agro.au.dk

Physical location of the project and students work
AU Foulum, lab and office work

Project start
Anytime

Main subject area
Agroecology, agronomy, ecology

Short project description
Globally, soil organic C (SOC) stock at one-meter depth is about 1500 Gt (1 Gt = 10^9 t), about three to four times as much C as it in the atmosphere. Thus, even small reductions in SOC stock can significantly increase atmospheric CO_2 concentration and hasten climate change, directly or indirectly threatening agricultural sustainability. Furthermore, SOC stock plays pivotal roles in enhancing soil fertility, soil food web stability, and productivity. However, it remains unclear how and to what extent we could protect or increase SOC stock by optimizing cropping systems and management. Plant diversity promotes key ecosystem functions, including soil fertility, organic matter decomposition and nutrient cycling. Multi-species mixtures can increase SOC compared to pure stands due to several mechanisms, including above- and below-ground niche complementarity and higher root litter inputs because of more efficient exploitation of the soil volume by roots in mixtures. Meta-analysis is one of the most robust tools to summarize the existing results and identify the critical knowledge gaps. In this project, we will explore how do mixed-species systems affect SOC stock using meta-analysis. We will later compare our results from meta-analysis to the existing database from our archived database in the department to deepen our understanding. The student is expected to be involved in data collection and analysis with daily supervision.

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 thesis in which the student is responsible for collection and analysis of his/her own original data

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

Additional information
J. Chen, P. E. Lærke, U. Jørgensen, Land conversion from annual to perennial crops: A win-win strategy for biomass yield and soil organic carbon and total nitrogen sequestration. Agriculture, Ecosystems & Environment 330, 107907 (2022).
J. Chen et al., Soil carbon loss with warming: New evidence from carbon-degrading enzymes. Global Change Biology 26, 1944-1952 (2020).
A. Don, J. Schumacher, A. Freibauer, Impact of tropical land-use change on soil organic carbon stocks – a meta-analysis. Global Change Biology 17, 1658-1670 (2011).

44. Pea cultivars for production of protein for organic food

Department and supervisor
Hanne Lakkenborg Kristensen, Associate Professor, hanne.kristensen@food.au.dk, 20698054

Physical location of the project and students work
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.

45. Biostimulants for improved soil quality and plant development in organic vegetables

Department and supervisor
Hanne Lakkenborg Kristensen, Associate Professor, hanne.kristensen@food.au.dk, 20698054

Physical location of the project and students work
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 conventional and organic farmers. However, effects on crop production have been variable and science-based evidence is needed to document if biostimulants make any difference at all.
In this project the student will take part in conducting field experiments at the research station AU-Auning on Djursland, where several biostimulants are 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/

46. New technology for on-farm production of organic compost and mineral fertilisers

Department and supervisor
Hanne Lakkenborg Kristensen, Associate Professor, Department of Food Science,
hanne.kristensen@food.au.dk, +45 20698054

Physical location of the project and students work
Department of Food Science (AU-FOOD), 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 outphase conventional nutrient sources. However, we lack understanding of the composting process.

The aim of this master project is to investigate the use of the newly invented composting technology. How does biomass quality added to the machine influence the composting processes inside and the resulting quality of compost products and condensed nitrogen fertilisers? The focus will be on carbon and nitrogen mineralisation and microbial processes.

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.

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

Department and supervisor
Hanne Lakkenborg Kristensen, Associate Professor, Department of Food Science,
hanne.kristensen@food.au.dk , +45 20698054

Co-supervisor Otto Nielsen, Trial and Project Manager, Nordic Beet Research
on@nbrf.nu, +45 23617057

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

Field investigations takes 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. Biodiversity may be included in the topic. 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.*

48. Coupling soil geochemistry and biodiversity for peatland restoration

Department and supervisor
Department of Agroecology, AU Foulum
Shubiao Wu, Associate Professor, wushubiao@agro.au.dk
Claudia Nielsen, PhD Student, claudia@agro.au.dk

Physical location of the project and students work
AU Foulum

Project start
Anytime

Main subject area
Ecology, Biogeochemistry

Short project description
The aim of the project is to explore how soil geochemistry can be coupled with biodiversity indicators in order to estimate the renaturation potential, its successes and trade-offs, for peatland and wetland restoration. This will include empirical data collection and analyses of soil chemical and physical properties and biodiversity scores of key wetland species (focus taxa: vascular plants, birds, and arthropods), as well as abiotic environmental factors. The variables will be coupled linking generalised dissimilarity modelling to a survey gap analysis procedure for conservation assessments.

Students will be introduced to a hot topic which links climate and biodiversity in wetland conservation.

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
Rochefort, L., Isselin-Nondedeu, F., Boudreau, S., & Poulin, M. (2013). Comparing survey methods for monitoring vegetation change through time in a restored peatland. Wetlands Ecology and Management, 21(1), 71-85.

Renou-Wilson, F., Moser, G., Fallon, D., Farrell, C. A., Müller, C., & Wilson, D. (2019). Rewetting degraded peatlands for climate and biodiversity benefits: Results from two raised bogs. Ecological Engineering, 127, 547-560.

Minayeva, T. Y., & Sirin, A. A. (2012). Peatland biodiversity and climate change. Biology Bulletin Reviews, 2(2), 164-175

49. Microplastics in the soil

Department and supervisor
Department of Agroecology
AU Foulum
Maria Knadel, Researcher Tenure Track Assistant Professor, maria.knadel@agro.au.dk
Trine Nørgaard, Assistant Professor, (trine.norgaard@agro.au.dk)

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

Project start
Anytime

Main subject area
Soil spectroscopy, microplastic

Short project description
Microplastics in the soil - occurrence, transport, and estimation: Microplastics (MP) present new global environmental challenges. The actual levels, in various soil ecosystems, the type of MP polymers and their transport in the soil are largely unknown. These knowledge gaps will be addressed in two connected projects: **Project 1**, focussing on sampling and MP characterization to estimate MP levels in different soil ecosystems and P**roject 2**, dealing with laboratory experiment to determine MP transport through 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
Literature:
Büks, F. and Kaupenjohann, M. (2020). Global concentrations of microplastics in soils – a review, SOIL, 6, 649–662, https://doi.org/10.5194/soil-6-649-2020.
Paul, A., Wander, L., Becker, R., Goedecke, C., & Braun, U. (2019). High-throughput NIR spectroscopic (NIRS) detection of microplastics in soil. Environmental Science and Pollution Research, 26(8), 7364-7374.

50. Seed Production - Grasses

Department and supervisor
Birte Boelt, Senior Researcher
E-mail: bb@agro.au.dk
Phone: 8715 8276

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 in order 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 from 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 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

51. Plant Genetic Ressources – Characterisation

Department and supervisor
Department of Agroecology
Birte Boelt, Senior Researcher, E-mail: bb@agro.au.dk
Phone: +45 2228 3328

Physical location of the project and students work
AU-Flakkebjerg

Project start
Anytime

Main subject area
Seed production, germination and vigour, seedling robustness, genebank accessions, landraces, plant breeding

Short project description
The interest in preserving and utilizing plant genetic ressources (e.g. old varieties and landraces) is growing and projects focusing on for example agronomic robustness, quality traits, New Nordic Food and cultural heritage has been initiated in recent years. Along with these projects there has been a growing interest to characterise this seed material and make it available for organic and conventional production in both hobbymarkets and at larger scale for commercial sale.This plant material might not fullfill the requirements in the traditional variety testing system in the EU.

The project can be shaped according to your interest for example identify and characterise "exotic" seed material, evaluate germination, vigour and early seedling growth, demonstrate seed production, optimise seed quality or looking into legal aspects for organic production of cultivars with distinct characteristics.

In 2022-2023 we are growing various vegetable species for regeneration in tunnels. You can be part of this or carry out your experiments with some of this material.

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
https://www.nordgen.org/en/

52. Crop tailored flower strips

Department and supervisor
Birte Boelt, Senior Researcher, E-mail: bb@agro.au.dk
Phone: 8715 8276

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

Project start
Spring 2023

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 flowerstrips. These are not only considered a food resource for pollinators, but they may also provide food and shelter for natural enemies of crop pests.

Flowerstrips 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 flowerstrips to increase crop yield and reduce severity of pests.

In autumn 2021 and spring 2022, 25 single flower species and four mixtures are 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 Foulum.
The project is carried out in collaboration with Yoko Dupont, ECOS, AU and Vibeke Langer, KU.

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

Department and supervisors
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560
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-Foulum

Project start
Spring 2022 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.

54. Stakeholder perspectives on woodland creation

Department and supervisor
Department of Agroecology

Main supervisors
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Chris Kjeldsen, Senior Scientist, email Chris.Kjeldsen@agro.au.dk, phone +45 6174 7357
Co-supervisor:
Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

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

Project start
2022/2023

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

55. Landscape ecology, habitat connections and corridors

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560
Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU-Foulum

Project start
Spring 2022 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.

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

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560
Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU-Foulum

Project start
Spring 2022 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.

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

Department and supervisor
Department of Agroecology

Main supervisor:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone: +45 8715 7746
Co-supervisors:
Morten Graversgaard, Postdoc, email Morten.Graversgaard@agro.au.dk, phone: +45 25645560
Sara Iversen, Postdoc, email Sara.Iversen@agro.au.dk

Physical location of the project and students work
AU-Foulum

Project start
Spring 2022 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.

58. Integrating outdoor pigs with agroforestry

Department and supervisor
Department of Agroecology

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

Physical location of the project and students work
AU-Foulum. 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.

59. 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
Co-supervisors:
Mette Vestergaard Odgaard, email mette.vestergaardodgaard@agro.au.dk, phone +45 22908256
Sara Iversen, Postdoc, email, sara.iversen@agro.au.dk

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

Project start
2022/2023

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

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

Department and supervisors
Department of Agroecology

Main supervisors:
Tommy Dalgaard, Professor, email Tommy.Dalgaard@agro.au.dk, phone +45 8715 7746
Chris Kjeldsen, Senior Scientist, email Chris.Kjeldsen@agro.au.dk, phone +45 6174 7357
Co-supervisors:
Martin Hvarregaard Thorsøe, Researcher, email MartinH.Thorsoe@au.dk, phone +45 2891 3656
Morten Graversgaard, Researcher, email Morten.Graversgaard@agro.au.dk, phone +45 8715 7751

Physical location of the project and students work
AU-Foulum

Project start
Spring 2022 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