Master Thesis Projects
Topics within Agroecology

AgroEnvironmental Management
& Agrobiology MSc Programmes
2019-2020

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March 2019

Preface

This catalogue of master thesis projects available in 2018-2019~~7-2018~~ was prepared to help students in their decisions selecting a topic for their thesis project. A number of project proposals are presented in detail, together with contact addresses and other practical information's.

The project proposals presented in this catalogue are primarily intended for students of the **Master's Degree Programme in AgroEnvironmental Management**, and in **Agrobiology** but will also be available for students of Biology, Geography, Geology and other master degree programmes within Natural Sciences, and for bachelor thesis students as far as the students have the scientific prerequisites needed to accomplish a specific project.

If you intend to make a master or bachelor thesis project on a topic not mentioned in this catalogue, please contact and discuss it with one of the course lecturers.

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 this 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 http://agro.au.dk) 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**:** http://kandidat.au.dk/en/agro-environmental-management/

Read more about the **MSc i Agrobiology** at http://kandidat.au.dk/en/agrobiology/, and the MSc thesis catalogues from Department of Animal Science and Department of Food Science.

Contents

1. Bioactive molecules in Agroecology

Main supervisor:
Associate professor Inge S. Fomsgaard,
Inge.Fomsgaard@agro.au.dk, Tlf. 87 15 82 12 or 22 28 33 99
http://pure.au.dk/portal/en/inge.fomsgaard@agro.au.dk

Physical location of the project:
Department of Agroecology, Flakkebjerg, 4200 Slagelse

Project start:
Can be decided individually

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

Main subject area:
Thousands of molecules influence the biological interactions in ecological systems, - also in agroecological systems. Team Natural Product Chemistry and Environmental Chemistry perform projects on a broad range of bioactive molecules – molecules such as plant secondary metabolites (phytochemicals), microbial secondary metabolites, pesticides.

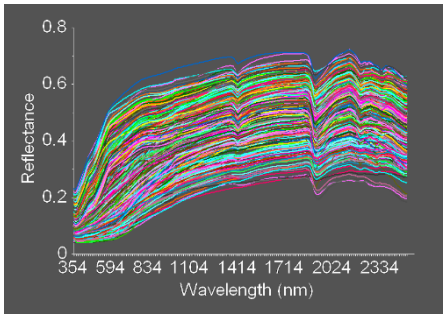
Any project idea is welcome that deals with explaining how the structure of a compounds determines its uptake in neighbouring biological organisms, their possible beneficial or negative effects as well as their transformation in soil or biological organisms.

The master student will be tutored by experienced lab technicians and PhD-s postdoc in the use of our instruments such as LC-MSMS, LC-MSQTRAP, LC-TOF, GC-TOF and LC-MS-DAD.

Short project description:
A master project can be defined any of the research areas that are covered by the Team Natural Product Chemistry and Environmental Chemistry (http://pure.au.dk/portal/en/persons/inge-s-fomsgaard(286ea173-7565-4768-86a7-c97182c4081f)/more.html) and could preferably be linked directly to one of our on-going research projects (see http://pure.au.dk/portal/en/inge.fomsgaard@agro.au.dk)

Relevant literature:
See recent publications IFO**:** http://pure.au.dk/portal/en/inge.fomsgaard@agro.au.dk

2. Sensing phosphorus binding in soils



Main supervisor, co-supervisor:
Associate Professor Goswin Heckrath, Researcher Maria Knadel
Department of Agroecology
goswin.heckrath@agro.au.dk

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

Project start:
Summer 2019

Extent and type of project:
60 ECTS: Two experimental theses in which the student is largely responsible for data collection and analysis. Optionally, the project could be arranged corresponding to 45 (or 30) ECTS.

Main subject area:
Near infrared spectroscopy (NIRS), soil chemistry, Environmental Sciences, GIS.

Useful reading :
Soriano-Disla et al. 2014. Applied Spectroscopy Reviews, 49: 139-186

Short project description:
Background. On the intensively farmed land in Europe and elsewhere large amounts of phosphorus (P) have accumulated in soils due to decades of surplus P additions. In the past, this P accumulation was seen as a resource to agriculture. Today it has become a source for the P-induced eutrophication of surface waters. In Denmark P leaching to drains is a major pathway of P transfer from soil to water, which is controlled by P binding reactions in soils. To devise effective and targeted mitigation we need to map high-risk areas of P leaching. Therefore, a research initiative at AU aims at modelling the risk of P leaching on much of the agricultural land in Denmark. A major challenge is obtaining the necessary spatially distributed data for describing P binding in soils. Currently this is done in laborious and expensive laboratory studies, severely limiting the data available for model parameterization. Recent developments in soil sensing technology suggest that Near Infrared Spectroscopy (NIRS) allows for the rapid, inexpensive measurement of key soil properties controlling P binding. We offer two related MSc projects whose overall goals are to explore the feasibility of a NIRS approach to characterizing a soil's P binding behavior.
Aim. The aims of the MSc projects are i) to obtain and analyze NIR spectra from a range of soils; ii) to conduct P sorption experiments and determine chemical properties related to P binding in these soils, iii) to develop relationships for predicting key P binding parameters from NIR spectra.
Approach. One project focusses on P sorption behaviour and involves contributing to infinite sink P sorption experiments in the laboratory. The other project deals with GIS, spatial analysis and mapping P binding capacity. Both, a large number of NIR spectra and data linked to P binding will be made available to the projects. Experts in NIRS and proximal sensing at the department will guide and support students in the data analysis and building prediction models. This work is linked to and supported by the FOSFORKORTLÆGNING project funded by the Danish Environmental Agency. Students will thus be introduced to cutting-edge research that explores new avenues for predicting soil environmental processes.

3. Pollination and red clover seed production

Department and supervisor:
Birte Boelt
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:
From June 2019

Main subject area:
Crop production and pollination

Short project description:
Seed production of red clover is currently challenged due to low seed yields – in particular in tetraploid varieties. The reason for the low yields are not fully understood but one suggestion is a lack of successful pollination.

The project aims at studying how we can improve seed yields by better managing pollination by bumble- and/or honeybees. We are doing field experiments in diploid and tetraploid varieties of red clover and further we will use the LIDAR-technique to characterize bumblebee species.

We are also very interested to monitor the effect of flower-strips to attract pollination insects to the clover seed production fields.

You can be part of those experiments and perform your studies in this set-up.
In case you want to do 30 ETCS study we can provide you with small data-sets.

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:
Boelt, B., Julier, B., Karagić, D and and Hampton, J. 2015. Legume seed production meeting market requirements and economic impacts. Critical Review ín Plant Sciences 34:412-427.

4. Seed production and plant genetic ressources

Department and supervisor:
Birte Boelt, Department of Agroecology
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 proposed project aims to 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 2019-2021 we are growing various vegetable species for seed production 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/

5. 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:
Any time, 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 process gives a dataset with combinations of percentage germination at different temperatures. From the dataset models describing germination according to temperature sums can be fitted. Such models are available for a number of important weed and crop species. Interested students can select their own favourite species for the investigation. The study could include investigation of interaction between sowing depth, seed size, seed vitality and temperature, which is of great importance for successful establishment of seed crops.

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

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

6. Loline a possible plant protectant agent

Department and supervisor:
Henrik Topbjerg, post doc, Department of Agroecology, E-mail: topbjerg@agro.au.dk, 87158253
Annie Enkegaard, senior scientist, Department of Agroecology, E.mail: annie.enkegaard@agro.au.dk, 87158223
Birte Boelt, senior scientist, Department of Agroecology, E-mail: bb@agro.au.dk, 87158276

Physical location of the project and students work:
Experimental work at AU-Flakkebjerg

Project start:
As soon as possible. Summer 2019

Main subject area:
Endophyte, plant protection

Short project description:
As the availability of pesticides are reduced, plant protection needs to be reconsidered.
Loline is an insecticidal alkaloid produced by certain fungi of *Epichloë* (anamorph *Neotyphodium*), which form symbiosis with grass species particular *Lolium* and *Festuca*.
Plants harbouring the endophyte seems to have a potent chemical defence against insect herbivory. Loline can readily be found in high concentrations in leaves and in roots, although in lower concentrations.
In a current project loline produced by *Neotyphodium uncinatum* isolates are evaluated in planta. Work will focus on insect herbivory behaviour on leaves and/or roots of *Lolium perenne* (L.) and *Festuca pratensis* (Huds.).

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:
You are welcome to contact the supervisor if you have any questions, suggestions etc.

Blankenship et al. 2001. Production of loline alkaloids by the grass endophyte, Neotyphodium uncinatum, in defined media. Phytochemistry, 58, 395-401

7. Functional response of the parasitoid *Bathyplectes curculionis*

Department and supervisor:
Henrik Topbjerg, post doc, Department of Agroecology
E-mail: topbjerg@agro.au.dk
phone 87 15 82 53

Physical location of the project and students work:
Experimental work at AU-Flakkebjerg

Project start:
Preparations needs to be initiated prior to the beginning of project (October to November 2019) as cocoons of *B. curculionis* has to be obtained from commercial seed sorting facilities winter 2019 and stored until use.
Project start up early spring 2020.

Main subject area:
Augmented biological control, functional response, parasitation

Short project description:
Bathyplectes curculionis (Thomson) is a solitary koinobiont endoparasitoid on various *Hypera* weevil species. Under Danish conditions, the parasitoid has recently been found to influence the Clover Head Weevil (*H. meles* Fabricius) populations. Previously the parasitoid has been introduced to the USA as a classical biological control agent against the alfalfa weevil (*Hypera postica* Fabricius).
Information on the functional response of the parasitoid would greatly benefit the evaluation of the parasitoid as a biological control agent.

The project is to be conducted as laboratory experiments evaluating the response of the parasitoid to host larvae densities and temperature.

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 experimental part of the project can be carried out at AU-Flakkebjerg. However, this is not mandatory and it can be envisioned carried out closer to Aarhus. If you have any questions feel free to contact the supervisor.

8. Seasonal temperature dependence of microbial denitrifying population in woodchip bioreactors

Department and supervisor:
Department of Agroecology
Lara Elsgaard, Associate professor, lars.elsgaard@agro.au.dk , +45 87157674
Arnaud Jéglot, PhD student, arnaud.jeglot@agro.au.dk, +45 50117549
Maja Hørning Skjødt, Agricultural Technologists, mahs@agro.au.dk, +45 93509013

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

Project start:
June 2019 or September 2019 (or contact supervisors)

Main subject area:
Biofilter; Drainage water; Denitrification; Microbial analysis; Nitrate; Psychrophilic anaerobic conditions.

Short project description:
Nitrate losses via agricultural drainage water contribute to eutrophication, potentially endangering the ecosystem balances in the recipients. Woodchip bioreactors in the landscape is a promising technology for microbial nitrate removal in agricultural drainage water. However, empirical data show that the microbial denitrification efficiency during cold season is not optimal. Therefore, this study aims at analyzing the denitrifying microbiome in samples from woodchip bioreactors and especially to look at the temperature response and temperature sensitivity of the denitrifiers. Literature review, on-site sampling and measurements as well as laboratory experiments will be required to successfully conduct 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 student will be interested in contributing to preventing eutrophication in the environment. The work will be conducted in collaboration with a PhD student and a technician. There is a great potential to develop valuable skills such as: measurements and sampling methods, experimental designs and scientific writing skills.
Literature:
King and Nedwell, 1984. Changes in the nitrate-reducing community of an anaerobic saltmarsh sediment in response to seasonal selection by temperature. Journal of General Microbiology, 130, 2935-2941.

9. Use of biochar to optimize the composition of woodchip biofilters for removal of nitrate an related nutrients from agricultural drainage water

Department and supervisor:
Department of Agroecology
Lara Elsgaard, Associate professor, lars.elsgaard@agro.au.dk, +45 87157674
Finn Plauborg, Senior Scientist, finn.plauborg@agro.au.dk, +45 22181809
Arnaud Jéglot, PhD student, arnaud.jeglot@agro.au.dk, +45 50117549

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

Project start:
2020

Main subject area:
Agricultural wastewater treatment; Denitrification; Biochar; Phosphorous removal.

Short project description:
Woodchip bioreactors are promising for nitrate removal in agricultural drainage water. However, the composition of the filter material may need to be optimized to achieve the best environmental performance, for example related to efficiency of N removal, but also P retention. To optimize the performance of woodchip biofilters, the use of biochar as an admixture will be tested at pilot scale in the laboratory. The student will be conducting the experiments on woodchip bioreactors at pilot scale and will measure the efficiency of processes removing contaminants to determine the optimal use of biochar for the prevention of nutrient release in the environment.

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:
This study is important to prevent eutrophication in the environment because of high phosphorous concentrations. The work will be conducted in collaboration with a PhD student. There is a great potential to develop valuable skills such as: measurements and sampling methods, experimental planning and scientific writing.
Example of literature on biochar:
Bock et al., 2014. Enhanced Nitrate and Phosphate Removal in a Denitrifying Bioreactor with Biochar. Journal of Environmental Quality, 44, pp 605-613.

10. ~~MSc project:~~ Impact of bio-subsoiling crops on soil structure and root growth

Department and supervisors:
Department of Agroecology
Lars J. Munkholm, lars.munkholm@agro.au.dk, phone 8715 7727
Mansonia Pulido-Moncada, Mansonia.pulido@agro.au.dk

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

Project start:
Summer/Autumn 2019

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

Main subject area:
Biological tillage, Soil pore characteristics, root growth, X-ray CT image analysis

Short project description:
Soil compaction is a major threat to soil quality in Denmark. There is a strong need to find cost-efficient measures to mitigate especially subsoil compaction. The used of deep rooted crops/cover crops has been proposed as such a measure. There is, however, a paucity of knowledge on the effects of potentially bio-subsoiling on severely compacted subsoil. The project aims to evaluate the effect of different potential bio-subsoiler crops on the soil pore characteristics and root growth. The experimental activity will take offset in a semi-field experiment at Research Centre Foulum where different annual and perennial crops are tested. Soil cores (Ø=20 cm, h=50 cm) will be X-ray CT scanned and then subjected to destructive sampling for root growth evaluation and soil pore characteristics.

Additional information:
The project will be linked to the COMMIT project (Soil compaction mitigation for productivity and sustainability), which focus on soil compaction and effect of cover crops as a means to mitigate soil compaction.

Useful reading:
Chen, G. and Weil, R.R., 2010. Penetration of cover crop roots through compacted soils. *Plant and Soil*, *331*(1-2), pp.31-43.
Löfkvist, J., Whalley, W.R. and Clark, L.J., 2005. A rapid screening method for good root -penetration ability: comparison of species with very different root morphology. *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science*, *55*(2), pp.120-124.
Williams, S.M. and Weil, R.R., 2004. Crop cover root channels may alleviate soil compaction effects on soybean crop. *Soil Science Society of America Journal*, *68*(4), pp.1403-1409.

11. ~~MSc project:~~ Are lime and gypsum effective means to improve soil structural quality and reduce risk of P loss on degraded soil?

Department and supervisor:
Department of Agroecology
Lars J. Munkholm, lars.munkholm@agro.au.dk, phone 8715 7727

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

Project start:
Summer/Autumn 2019

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

Main subject area:
Degraded soils, Soil structural quality, Soil physical properties, Soil friability, Wet stability.

Short project description:
The aim of this project is to quantify the long-term effect of liming on soil physical quality. Under Danish conditions poor topsoil structure is considered 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 e.g. P and pesticides). Soil will be sampled in long-term trials with different lime rates run by the Danish advisory service, SEGES. This may be supplemented with short-term controlled experiments with gypsum application. There will be special focus on soil friability and wet stability. The former will be determined in the field (visual assessment, drop shatter) and in the laboratory (tensile strength).

Additional information:
Experiments will be carried out using long-term Danish liming experiments. The activities will be carried out 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.
Materechera,S.A., 2009. Aggregation in a surface layer of a hardsetting and crusting soil as influenced by the application of amendments and grass mulch in a South African semi-arid environment. Soil and Tillage Research, 105, 251-259.
Obour, P.B., Jensen, J.L., Lamandé, M., Watts, C.W., Munkholm, L.J., 2018. Soil organic matter widens the range of water contents for tillage. Soil and Tillage Research 182, 57-65.

12. Improved weaning strategy in outdoor pig production

Department and supervisor:
Dept. Agroecology, Blichers Allé 20, 8830 Tjele.
Heidi Mai-Lis Andersen, HeidiMai-Lis.Andersen@agro.au.dk, phone: 8715 4781

Physical location of the project and students work:
AU-Foulum, Blichers Allé 20, 8830 Tjele. Data collection on private farm.

Project start:
Flexible

Main subject area:
Outdoor pig production systems, weaning strategies, feeding strategies, animal behaviour.

Short project description:
A number of problems are associated with weaning of piglets including diarrhoea, decline in growth and a risk of unwanted behaviour. The problems are seen in both indoor and outdoor production systems and is due to the abrupt change in the piglets' environment, nutrient and social group at weaning. In order to reduce weaning problems, zinc is often added to the weaning feed. Which, from an environmental point of view, is a problem and not in line with the ecological principles. Hence, alternative measures are needed to reduce the risk of weaning problems. This project focus on reducing the changes around weaning in the ecological systems, whit main focus on weaning strategy (indoor versus outdoor) and the feed composition around weaning. However, the project is also open for students interested in a more detailed literature study regarding the issue.

Extent and type of project:
The master project can be tailored 30, 45 or 60 ECTS.

Additional information:
The experiment is part of the GUDP project 'Intensiv mobil svineproduktion integreret i markdriften' (SV-AR). You can read/see more about the SV-AR project here (In Danish): https://okologi.dk/landbrug/projekter/svin/intensiv-mobil-svineproduktion

13. Mapping of artificially drained agricultural areas using satellite imagery

Department and supervisor:
Dept. Agroecology
Associate Professor Bo Vangsø Iversen, +45 93508045, bo.v.iversen@agro.au.dk

Physical location of the project and students work:
Aarhus University Foulum, Blichers Allé 20, 8830 Tjele

Project start:
Any time.

Main subject area:
Remote sensing; Machine learning; Digital soil mapping (DSM)

Short project description:
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. In Denmark, almost 50% of the agricultural areas are tile drained and enhanced leaching of nutrients and pesticides through these artificial drainage systems causes contamination of groundwater and coastal ecosystems. While proximal geophysical sensors show promising results, the success often depends on various parameters such as the soil type, hydrological conditions, choice of the sensor, and type (clayware/PVC) of tile drain installed to name a few. Often, these geophysical surveys are expensive and should only be used when we are certain that the agricultural area is potentially tile drained. Hence, reconnaissance surveys need to be performed as an initial step to successfully deploy the proximal sensors. The goal of this master's project will be to investigate readily available satellite imagery for mapping drainage practice intensity over agricultural landscapes. The images can be combined with national maps of soil types, geology, etc. The rationale behind the study is – after a significant rainfall event, greater water removal is observed in artificially drained areas compared to naturally drained areas. A report by Thayn et al., 2011 provides an overview of the workflow using short wave infrared (SWIR) band of Landsat 5 satellite imagery as this band is closely related to soil moisture conditions. In this project, the aim is to analyze Landsat 8 and Sentinel 2 imagery using a similar approach and possibly more covariates.

Extent and type of project:
Master thesis 45 or 60 ECTS

Additional information:
Thayn, J. B., Campbell, M., & Deloriea, T. 2011. Mapping tile-drained agricultural lands. Institute for Geospatial Analsyis and Mapping (GEOMAP). Illinois State University.
Contact supervisor for a briefing.

14. The nitrogen footprint of Denmark – using the N-footprint as an awareness tool

Department and supervisor:
Main supervisor: Morten Graversgaard, PhD, Research Assistant, Morten.Graversgaard@agro.au.dk
Telephone: +45 25645560
Co-supervisor: Tommy Dalgaard, PhD, Section Manager, Professor, Tommy.Dalgaard@agro.au.dk

Physical location of the project and students work:
Department of Agroecology, AU Foulum and/or Aarhus University, Aarhus

Project start:
2019 or any time

Main subject area:
Nitrogen footprint, virtual nitrogen loss factors, crop production and animal production, nitrogen and carbon cycles

Short project description:
The aim of the thesis project is to track and calculate the nitrogen footprint of Denmark by the use of data derived from diverse statistical sources (agronomic, energy, transportation data). As part of the project an aim is to develop nitrogen crop loss factors (virtual nitrogen factors) for crops and animal products in Denmark. This could entail field experiments but are not mandatory, as data can be derived from literature or official reportings. The project can be written in both English and Danish depending on the student's choice.

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 Department of Agroecology, and research carried out at the department and in collaboration with international networks on footprint analysis.
Useful reading:
Leach AM, Galloway JN, Bleeker A, et al. 2012. A nitrogen footprint model to help consumers understand their role in nitrogen losses to the environment. Environ Dev 2012;1:40-66.
Shibata H. Galloway JN, Leach AM, Cattaneo LR, Noll LC, Erisman JW, Gu B, Liang X, Hayashi K, Ma L, Dalgaard T, Graversgaard M, Chen D, Nansai K, Shindo J, Matsubae K, Oita A, Ming-Chien Su, Shin-Ichiro Mishima and Bleeker A (2016). Nitrogen footprints: Regional realities and options to reduce nitrogen loss to the environment AMBIO.

15. The nitrogen and carbon footprint of Aarhus University – Co-developing a sustainable agricultural research environment at AU Foulum

Department and supervisor:
Main supervisor: Morten Graversgaard, PhD, Research Assistant, Morten.Graversgaard@agro.au.dk, Telephone: +45 25645560
Co-supervisor: Tommy Dalgaard, PhD, Section Manager, Professor, Tommy.Dalgaard@agro.au.dk

Physical location of the project and students work:
Department of Agroecology, AU Foulum and/or Aarhus University, Aarhus

Project start:
2019 or any time

Main subject area:
Nitrogen and carbon footprint, sustainable development goals, nitrogen loss factors, meat consumption, virtual nitrogen factors, nitrogen and carbon cycles

Short project description:
The aim of this thesis project is to track and calculate the nitrogen and carbon footprint of AU Foulum at Aarhus University by the use of data derived from diverse sources (agronomic, energy, transportation data). Specific issues which could be explored by the student in the project period include calculation of virtual nitrogen factors for different crops, issues of scenario development for reducing the nitrogen footprint and integration of carbon, water footprint in the nitrogen footprint work. The project can be written in both English and Danish depending on the student's choice.

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 Department of Agroecology, and research carried out at the department and in collaboration with international networks on footprint analysis.
Useful reading:
Leach AM, Galloway JN, Bleeker A, et al. 2012. A nitrogen footprint model to help consumers understand their role in nitrogen losses to the environment. Environ Dev 2012;1:40-66.
Leach AM, Majidi AN, Galloway JN, et al. 2013. Toward institutional sustainability: A nitrogen footprint model for a university. Sus J Record 2013;6:211-219.
Leach AM, Galloway JN, Castner EA et al. 2017. An integrated tool for calculating and reducing institution carbon and nitrogen footprints. Sus J Record 2017;10:140-148.

16. Public perceptions of agriculture, food and environmental protection

Department and supervisor:
Morten Graversgaard, PhD, Research Assistant, Morten.graversgaard@agro.au.dk, +45 25645560
Co-supervisors: Chris Kjeldsen, Chris.Kjeldsen@agro.au.dk and Martin Hvarregaard Thorsøe, martinh.thorsoe@agro.au.dk

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

Project start:
2019 or later

Main subject area:
Agricultural development, sociology; mixed methods; survey data; public perceptions; agriculture; landscape planning; communication

Short project description:
The use of rural landscapes is increasingly contested as different stakeholder-groups have conflicting visions regarding the function of space. For instance, farmers associations argue in favor of increasing intensification and specialization of farming, while different stakeholder groups and EU directives on the other hand raise demand for lower environmental impact, better nature protection, organic production or increasing public access. This conflict is exemplified in the recent controversy concerning the "agricultural agreement", the implementation of the Buffer zone act and lawsuits from the agricultural associations against the Danish government. The growing conflict coincides with a number of changes in the relations between urban and rural areas such as, increasing agricultural intensification, specialization, urbanization, globalization of commodity chains. Hence, Danish farmers are in a precarious position between the growing world market demand for cheaper products and public demands for environmental protection. Public perceptions of agriculture and its environmental impacts are among the most important drivers of policy interventions. For this reason, a deeper understanding of the different factors that influence the division between rural and urban space is needed to manage the conflict and to formulate agri-environmental policies that are efficient and perceived legitimate by different stakeholder groups. The objective of this project is to explore stakeholder perceptions of farming by the use of qualitative and quantitative survey data derived from a previous research project in a mixed method analysis. Specific issues which could be explored by the student in the project period includes issues of knowledge, power relations, communication, landscape planning and management etc.

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 project will furthermore be informed by research carried out in various projects at the Department of Agroecology.

17. Biological nitrogen fixation in legume-based cover crops

Department and supervisor:
Main supervisor: Jim Rasmussen, Department of Agroecolgy, jim.rasmussen@agro.au.dk
Co-supervisor: Chiara De Notaris, Department of Agroecology, cdn@agro.au.dk

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

Project start:
Any time

Main subject area:
Legumes, cover crops, Biological N_2 fixation

Short project description:
Biological N_2 Fixation (BNF) is an important source of N in organic arable systems. For this reason, inclusion of legumes in crop rotations is an important strategy to sustainably intensify agricultural production. Legume-based cover crop (CC) mixtures can provide several ecosystem services, including provision of N to the following main crop. The amount of N accumulated in CC biomass is a combination of N taken up from the soil and BNF. BNF is determined by legume biomass, N content and proportion of fixed N_2. The proportion of fixed N_2 (N derived from the atmosphere, Ndfa) is generally considered as a constant, even though it is not. The lack of studies on the variation in Ndfa compromises the accuracy of models and predictions, hindering the goal of reaching highly efficient systems. The aim of this project is to investigate variations in Ndfa in legume-based cover crop mixtures, identifying the main factors involved. Three years of raw data from a long-term crop rotation experiment will be available to the student, including isotopic labelling for an accurate calculation of Ndfa, or the student can conduct experimental work.

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

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

18. Somatic recombination in the yellow rust pathogen *Puccinia striiformis*

Department and supervisor:
Researcher Chris K. Sørensen, chris.sorensen@agro.au.dk, 87154773
Professor Mogens S. Hovmøller (mogens.hovmoller@agro.au.dk)

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

Project start:
Anytime

Main subject area:
Population genetic and epidemiology

Short project description:
The fungal pathogen *Puccinia striiformis* causes the yellow rust disease on cereals and grasses and is currently the most important disease on wheat worldwide. *Puccinia striiformis* has a complicated life cycle with five spore types and alternation between different hosts for asexual and sexual reproduction. It only reproduces asexually on its cereal host species but in 2010 barberry was discovered as an alternate host for sexual reproduction. Some experiments have however indicated that new genetic diversity can be generated from somatic recombination were nuclei are exchanged between dikaryotic mycelia of different genotype that coexist on the cereal host. The objective of this project is to generate new genotypic variation from somatic recombination under greenhouse conditions and to understand the implications for the pathogens ability to infect host varieties with different resistance genes and for pathogen aggressiveness. Previous experiments performed at AU Flakkebjerg have shown that somatic recombinants can be generated in field trials.

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:
Park, R., Wellings, C.R., 2012. Somatic Hybridization in the Uredinales. *Annual Review of Phytopathology*. 50 (1): 219-239.

Rodriguez-Algaba, Julian, Walter, Stephanie, Sørensen, Chris K., Hovmøller, Mogens S. Justesen, Annemarie F. Justesen, 2014. Sexual structures and recombination of the wheat rust fungus *Puccinia striiformis* on *Berberis vulgaris*. *Fungal Genetics and Biology* 70: 77-85.

Hovmøller, Mogens S., et al., 2015.Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region. *Plant pathology* 65 (3): 402-411.

19. Weed dynamics in non-inversion tillage systems

Department and supervisor:
Bo Melander, Associate professor
Department of Agroecology
bo.melander@agro.au.dk
22 28 33 93

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

Project start:
Whenever it suits the student

Main subject area:
Weed science

Short project description:
The student will extract data from two running field experiment with four different crop rotations combined with four primary tillage schemes: 1. Mouldboard ploughing, 2. Non-inversion tine tillage and 3. Direct drilling. The data are from a long-termed cropping history and can help explaining the weed dynamics associated with the omission of inverting tillage. There are many more data (crop yield, crop stand, soil physics, nitrogen and pesticide inputs etc.) to work with in addition to the weed related data. Conservation agriculture is very topical and the student will get a deeper insight into the cropping issues related to this practice.

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 student should have an interest in statistics and the analyses of data. The work can mostly be done from Aarhus and will only require a few trips to Flakkebjerg

20. The soils of Greenland

Main supervisor: Professor Lis Wollesen de Jonge, lis.w.de.jonge@agro.au.dk, 24940550 or Senior researcher Mogens H. Greve, mogensh.greve@agro.au.dk, 20726734
Co-supervisor: Researcher Maria Knadel, maria.knadel@agro.au.dk and post doc Trine Nørgaard trine.norgaard@agro.au.dk

Physical location of the project and students work:
Department of Agroecology, AU Foulum, Blichers Allé 20, 8830 Tjele. Possibility for participating in excursion to southern Greenland

Project start:
The optimal start is August where the Greenland expedition takes place

Main subject area:
We have a number of possible thesis topics: 1. Mapping of carbon stock of soils in Greenland, 2. Soil water retention and plant available water of Greenlandic soils, 3. Micro and macro nutrient content, pH and CEC in Greenlandic soils, 4. Water repellency of Greenlandic soils, 5. Physical and chemical effects of adding glacier flour to Greenlandic soils, 6. Landuse mapping using drone images (requires good technical, software and hardware skills), and 7. You may formulate your own project idea within the described frame

Short project description:
The rapid climate change taking place in Greenland has serious repercussions for animal and plant life throughout the country. The rising temperatures can, however, offer better conditions for a future agricultural production in Greenland. The natural soil resources available for such a production in South Greenland are scantily mapped. Hitherto, our investigations in parts of South Greenland have shown that soils are typically sandy with wind-blown silt (loess) and high organic matter contents that have, as yet, not resulted in a well-developed soil structure. This is most likely because of the influence of temperature on biological activity and the tendency of organic matter to induce hydrophobicity in certain drought conditions. In addition, the soil profile down to the rock base is in many places quite thin, which together with said hydrophobicity is likely to make plant-availability of water the most limiting factor for good and healthy plant growth. Besides these pilot studies, the terrestrial resource is completely uncharted territory with regard to characteristics and suitability for agricultural production.

We will map key soil properties for the sustainable use of the land for growing crops and for grazing livestock for South Greenland. We will focus on an area located in Vatnahverfi, one of the two major agricultural catchment areas in South Greenland, in the direction from Igaliku down to Qaqortoq. We will examine the soil (organic matter, texture and soil depth), water conditions (bound water, plant-available water and how particularly the more organic soils repel water during drought) as well as nutrient content, pH and CEC. The scientific survey will be carried out by remote sensing complemented by a massive field and laboratory campaigns of sampling and measurements on soil samples. We use a number of newly developed, fast and accurate soil

physics methods for water, texture and carbon measurements (such as water adsorption methods and near-infrared spectroscopy).

By measuring and mapping key soil properties we can contribute to estimating the extent and location of the most suitable, robust and sustainable soil resources for summer grazing for livestock and specialty crop productions in South Greenland.

To improve the productivity of the soils we test the effects of adding glacier flour to the soils. Glacial flour is formed by the glaciers crushing the underlying rocks and stones to a particle size of very fine sand and silt. The material is washed out under the glacier and is then deposited in lakes and fjords. The material is available near the cultivated fields in South Greenland. Some of the world's most fertile soils have a high content of silt hence the grain size of glacial flour may result in much higher fertility and content of plant-available water if it is added to the coarse soils in Greenland. Glacial flour contains a wide range of minerals and a spectrum of trace elements. Glacial flour may help to neutralize acidity, improve soil structure, promote microbial activity, and slow down soil depletion. The material can be a ready source of calcium, iron, magnesium and potassium as well as other trace elements. This material is present in the fjords of South Greenland, and it can relatively cheaply be pumped up from coastal areas. The effect of glacial flour on soil-water retention, plant available water, nutrient content, pH, CEC and more can be investigated.

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.*

21. Manual and automatic chamber measurements of carbon fluxes important for assessment of the total greenhouse gas balance of annual and perennial cropping systems

Department and supervisor:
Department of Agroecology, section Climate and Water
Main supervisor: Poul Erik Lærke, poule.laerke@agro.au.dk, +45 8715 7692
Co-supervisor: Postdoc Johannes (Jeroen) Pullens, jwmp@agro.au.dk
Co-supervisor: Ji Chen, ji.chen@agro.au.dk

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

Project start:
Preferably Spring 2019, at latest June 2019

Main subject area:
Carbon cycling, climate change and chamber measurements

Short project description:
To study the greenhouse gas emissions of different crops, transparent and dark chambers can be used to measure crop photosynthesis and net ecosystem respiration in the field. Normally, this is carried out mid-day at weekly or biweekly intervals by using temperature controlled manual chambers and shrouding for light control. This measurement scheme makes it difficult to get a full (monthly/annual) greenhouse gas balance. Therefore, we have setup automatic chambers, that measure CO_2 fluxes every 15 minutes over different types of crops, ranging from highly fertilized perennial grass, annual grain crop (triticale) and unfertilized grass-clover. These automatic chambers are state of the art for measurement of CO_2 fluxes in larger agricultural crops but the method needs further comparison with the current manual chamber method. The student will perform the manual chamber measurements to cover field variation. Special focus should be given to the effect of temperature and light control of the manual and automatic chambers as well as the effect of root-shoot ratios of the different crop types on net ecosystem carbon balance. The field site where the chamber measurements will be performed are located at AU Foulum (Foulumgård). The student will work closely with people in the Climate section of Department of Agroecology.

Extent and type of project:
Depends on the student, both 45 or 60 ECTS is possible.

22. Genetic analysis of a sexual recombinant population of the wheat yellow rust fungus *Puccinia striiformis*

Department and supervisors:
Professor Mogens S. Hovmøller, mogens.hovmoller@agro.au.dk, +4587158129
Senior scientist Annemarie Fejer Justesen, annemariefejer.justesen@agro.au.dk, +4587158135
Postdoctoral researcher Julian Rodriguez-Algaba, julianr.algaba@agro.au.dk, +4587158138

Physical location of the project and students work:
Department of Agroecology, Flakkebjerg Research Center, Forsøgsvej 1, 4200-Slagelse

Project start:
Any time

Main subject area:
Plant Pathology, genetics

Short project description:
The life cycle of the fungus *Puccinia striiformis,* the causal agent of yellow (stripe) rust on cereals and grasses has historically been a mystery and the search for the alternate (sexual) host was unsuccessful until the recent discovery of *Berberis* spp. as an alternate host of *P. striiformis*. This discovery opened new opportunities to study the genetics of the fungus at both the genotypic and phenotypic level. Subsequent studies demonstrated segregation of molecular markers and important pathogenic traits such as virulence, in progeny isolates resulting from selfings of particular *P. striiformis* isolates. Additional studies using isolates of other genetic lineages and virulence phenotypes would enable a broader understanding of the genetics of virulence with regards to specific avirulence genes.
The objective of the project is to analyze a pre-established progeny population derived from a selfing of an important *P. striiformis* race originating from the pathogen's center of diversity in the Himalayan region, but in recent years prevalent in Europe. Microsatellite markers will be used to study segregation of neutral markers in the yellow rust fungus. In addition, the application of phenotypic markers will allow studying how these progeny isolates segregate with respect to virulence and potentially to other traits. The outcome of the project would potentially add additional information about the genetics of one of the world's most damaging crop pathogens.

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. We recommend 60 ECTS project in case virulence phenotyping will be part of the project

Additional information:
Useful references:
Hovmøller, M.S., Sørensen, C.K., Walter, S., Justesen, A.F., 2011. Diversity of *Puccinia striiformis* on cereals and grasses. *Annu. Rev. Phytopathol.*, 49:197–217.
Jin, Y., Szabo, L.S., Carson, M., 2010. Century-old mystery of *Puccinia striiformis* life history solved with the identification of *Berberis* as an alternate host. *Phytopathology*, 100:432-435.
Rodriguez-Algaba J., Walter S., Sørensen C.K., Hovmøller M.S., Justesen A.F., 2014. Sexual structures and recombination of the wheat rust fungus *Puccinia striiformis* on *Berberis vulgaris*. *Fungal Genet. Biol.*, 70: 77-85.

23. Botanical composition of organic clover-grass

Department and supervisor:
Department of Agroecology
Troels Kristensen, Senior scientist - troels.kristensen@agro.au.dk
Jørgen Eriksen, Professor - jorgen.eriksen@agro.au.dk

Physical location of the project and students work:
Research center Foulum as daily working place and field registration at a commercial dairy farm located 45 minutes drive from Foulum.

Project start:
Preferably may 2019 – alternative at the latest end of June 2019.

Main subject area:
Pasture, grazing, herbage intake, herbage composition, animal preference

Short project description:
In an on-going research and development project "Grassmilk" http://agro.au.dk/forskning/projekter/graesmaelk/ the aim is to produce organic certified milk from cows that are feed entirely with clover-grass, either as pasture during summer or as silage during the winter season. This raise the question, which botanical composition of the clover-grass mixture can balance the nutritional needs of the cows and at the same time insure a high dry matter net production per area over the season and over years maintain both botanical composition and productivity.

The aim of this MSc project is therefore to investigate how different clover-grass mixtures develop in productivity and quality over a grazing season and in addition to investigate the variation between the mixtures in intake preference when grazing with dairy cows.

The empirical material is one field (9 ha), with five different clover-grass mixtures established in 2018 with three replicates, in total 15 field plot. The herd of 100 dairy cows will be grazing the field – as part of other field – in a rotation grazing system with 3 to 5 weeks interval.

This gives possibilities for looking at productivity and botanical composition during a season, potentially in combination with difference frequency of grazing. The planning of this and the registration is part of the MSc project in close cooperation with the supervisor.

We expect that you can work intensively during the summer season with registrations in the field and during the following period make data analysis and literature review with focus on persistency of different clover-grass mixtures and the effect on livestock productivity.

Extent and type of project:
45 or 60 ECT point

Additional information:
(E.g. perquisites, conditions, useful reading, etc.....)

24. Bioreactors for reducing nitrates from drained agricultural fields

Department and supervisor:
Department of Agroecology
Finn Plauborg, Senior Scientist, finn.plauborg@agro.au.dk, +45 22181809
Maja Hørning Skjødt, Agricultural Technologists, mahs@agro.au.dk, +45 93509013
Arnaud Jéglot, PhD student, arnaud.jeglot@agro.au.dk,

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

Project start:
June 2019

Main subject area:
Collective measures for reducing N load to coastal waters

Short project description:
Woodchips bioreactor is a promising treatment filter for denitrification of nitrates in agricultural drain water. Data from six treatments plants across Denmark is available and there is a need for comparisons of measured N reduction efficiencies with estimates calculated with an existing model. The model predicts the N reduction efficiency as a function of water retention time (how long the water stayed in the filter) and water temperature.

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 work will take place in Foulum

25. Mobile systems to improve nutrient efficiency in outdoor pig production

Department and supervisor:
Dept. Agroecology, Blichers Allé 20, 8830 Tjele.
Anne Grete Kongsted, senior researcher, anneg.kongsted@agro.au.dk, phone: +45 87157993

Physical location of the project and students work:
Experimental activities at AU-Foulum, Blichers Allé 20, 8830 Tjele.

Project start:
Flexible

Main subject area:
Outdoor pig production systems, nutrient management, feeding strategies, animal behavior.

Short project description:
Despite clear animal-welfare benefits of outdoor production, growing-finishing pigs on pasture are very rare in Denmark. This relates partly to high feed uses - and therefore high feed costs - and high risk of nutrient losses in current pasture systems. New management strategies to improve nutrient efficiency are important to promote the ecological and economic competiveness of the system.

This project investigates whether a mobile system (daily allocation of new land) combined with a restricted feeding regime and a high-yielding foraging crop (sugar beets) improves the nutrient efficiency of outdoor pig production compared to current stationary pasture systems.

The focus of the master project can be tailored to the student's main interests.

Extent and type of project:
The master project can be tailored 30, 45 or 60 ECTS.

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 is part of the GUDP project 'Intensiv mobil svineproduktion integreret i markdriften' (SV-AR). You can read/see more about the mobile system here (In Danish): https://okologi.dk/landbrug/projekter/svin/intensiv-mobil-svineproduktion;
https://www.youtube.com/watch?v=51ohiCd2Kyg

26. Testing a new methodology for measuring aggregate stability

Department and supervisor:
Mathieu Lamandé, mathieu.lamande@agro.au.dk, +45 8715 7694
Co-supervisors: Emmanuel Arthur

Physical location of the project and students work:
Department of Agroecology, AU Foulum, 8830 Tjele, Denmark
Department of Environment and Natural Ressources, Norwegian University of Life Sciences, 1462 Ås, Norway

Project start:
Any time

Main subject area:
Soil quality, aggregate stability, methodology

Short project description:
Aggregate stability is an important physical property of soils. Soil aggregates are the elemental bricks of the macroscopic structure of soils. Modification of aggregates arrangement or destruction of aggregates have important consequences on soil ecosystem services, as soil aeration, plant available water, root growth, access of nutrients, filtering of pollutants, erosion, etc. Classical methods for determination of aggregate stability require specific equipment, are time consuming, and often need a noticeable amount of soil. A newly developed quick and inexpensive method shows great potential for accurate determination of aggregate stability in the field. However, this method should still be tested against classical methods and for a range of soil conditions. That is what we propose to do in the present project. We intend to determine aggregate stability using the new methodology and a classical rain simulator for a range of soil types and land uses, and to compare results from the new method against the reference method.

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
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

Additional information:
Fajardo M., McBratney A.B., Damien J.Field D.J., Minasny B., 2016. Soil slaking assessment using image recognition. Soil and Tillage Research 163, 119-129.
Amézketa E., 1999. Soil aggregate stability: a review. J. Sustain. Agric., 14, 83-151.

27. Identifying water repellent organic fractions with a combination of heat treatments and NIR spectroscopy

Department and supervisor:
Department of Agroecology
Lis Wollesen de Jonge, professor (lis.w.de.jonge@agro.au.dk)
Maria Knadel, researcher (maria.knadel@agro.au.dk)
Emmanuel Arthur, researcher (emmanuel.arthur@agro.au.dk)

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

Project start:
Any time

Main subject area:
Spectroscopy, organic matter, water repellency, modeling

Short project description:
The aim of the study is to identify different soil organic matter fractions that are responsible for development of soil water repellency (hydrophobicity) in a range of soils from different geographic origins. This will be done by a combination of different heat treatments and visible near-infrared spectroscopy (NIRS) data analyses. Soil water repellency (WR) is a global phenomenon with a huge impact on soil hydraulic properties such as infiltration, evaporation, erosion and preferential flow. The soil texture, water content (WC) and organic matter (OM) are the main factors that affect the occurrence and severity of WR. NIRS represents an alternative technique to conventional wet chemistry analyses of soil. Several soil properties such as soil OM, texture and WC can be analysed simultaneously and in a rapid manner using this technique. The application of NIRS to soil analyses is possible because spectra contain information on the organic and inorganic composition of soil. The student will be responsible for soil sampling, WR and NIRS measurements, as well as qualitative and quantitative analysis of NIR spectra.

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

Reading materials:
Knadel, M. (2016): Assessing soil water repellency of a sandy field with visible Near Infrared Spectroscopy, Journal of the Near Infrared Spectroscopy, 24, 215-224. doi: 10.1255/jnirs.1188

28. Precision farming – use of thermal camera for evaluation of drought stress in potatoes and wheat?

Supervisor:
Professor Mathias N. Andersen, MathiasN.Andersen@agro.au.dk, +4587157739
PhD, Academic employee Kirsten Kørup, KirstenKoerup@agro.au.dk, +4587157752
PhD, Postdoc Kiril Manevski, Kiril.Manevski@agro.au.dk, +4587157795

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

Project start:
June 2019

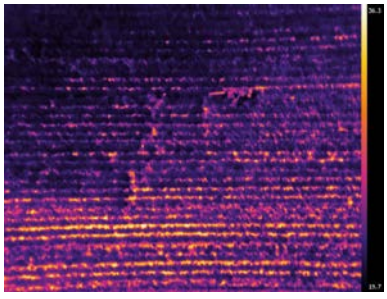
Main subject area:
Potato and wheat production, precision agriculture, drought stress and irrigation.

Short project description:
Drought is a great challenge to biomass production, and even in humid temperate climates, such as in Denmark, drought is intermittent and unpredictable. Therefore, to prevent yield loss it is necessary to irrigate. However, an efficient use of water by the crop is required to minimise excess use and to prevent nutrients leaching out of the soil root zone. The crop water need assessment usually starts with an evaluation of the drought stress level in the crop. Stomatal conductance has been found to be suitable for prediction of drought stress, but manual measurements of crops are tedious and time consuming. Alternatively, indirect measurement using modern thermal infrared imaging cameras mounted on unmanned aerial vehicles – drones - might be a viable option. These novel "telemetry" methods become increasingly popular for scientists and agro-environmental managers, due to their ease for operation and ability to cover larger areas.
In this project, field measurements of crop and soil variables (soil water content and stomatal conductance, among others) will be performed on potato and wheat plants. The correlation of soil processes and plant physiology with thermal infrared imaging data will be analysed in depth.

Extent and type of project:
45 or 60 ECTS according to wishes of candidate.

Additional information:
It is a prerequisite to have a driving license because the experimental field is located 15 km Northwest of AU Foulum. The candidate will be a part of a dynamic international and scientific working environment. The actual project work will be performed together with a team of students, technicians and researchers with great possibilities to work independently.





29. Nitrogen uptake and utilization in grass seed production

Main supervisor:
René Gislum, rg@agro.au.dk, 20542092

Physical location of the project:
Aarhus and Flakkebjerg

Project start:
Anytime

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

Main subject area:
Nitrogen and grass seed production

Additional information:
Results are available from former field experiment and it is also possible to get results from companies/farmers.

The project will be part of the research program '3030 in 2020' where focus is to increase grass seed yield by 30% and reduce input by 30% before year 2020.

Short project description:
Nitrogen uptake and utilization is import from a production and environmental point of view. Nitrogen application strategy in grass seed crops depends on the specie, some species are applied nitrogen in the autumn while others species are only applied nitrogen in the spring. Spring nitrogen application can be optimize by using e.g. the 'critical nitrogen dilution curve' or canopy reflectance, both methods have shown their potential in grass seed production.

The objective of the project is to continue the work on 'critical nitrogen dilution curve' and canopy reflectance as methods to increase seed yield and optimize the utilization of applied nitrogen.

30. The use of Sentinel satellites in practical grass seed production

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

Physical location of the project and students work:
Anywhere

Project start:
Any time

Main subject area:
Satellites images and crop pruduction

Short project description:
The Sentinel 2 satellite images are now available and it is obvious that we need to investigate the possibilities to use these images in practical crop production. This project concern grass seed production and to investigate how to use satellite images to optimize seed yield. There are several important factors for achieving a high seed yield among them are: good establishment, sufficient nitrogen application and the interaction between growth regulation and nitrogen application rate. The purpose of this project is to investigate if and how we can use information from Sentinel 2 in grass seed production. The project will be in close collaboration with the grass seed industry and practical grass seed growers. You will start by learning how to use Sentinel 2 data and make a survey among grass seed farmers and advices to figure out which information are important for them. Next step will be to define the project in details.

Extent and type of project:
Depends on the student, all three types (30, 45 or 60 ECTS) are possible.

Additional information:
http://www.copernicus.eu/

31. When do plants get heat stroke?

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science
Faculty of Science and Technology
Aarhus University
E-mail: coo@food.au.dk,
Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
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:
Photosynthesis, plant adaptation, global change, stress, climate, temperature

Additional information:
The Master student are linked to a group of scientists, technical staff and PhDs, thus the student will make the project in an international working team. The experimental work is linked to ongoing research using state of art equipment for physiological analysis of plant reactions. This increases the possibilities of making a scientific paper in connection with the M.Sc-thesis.

We might be able to provide paid accommodation for a period during your project depending on availability.

Short project description:
Both in the greenhouse and outside plants might be subjected to short and long term stress by temperature. How does different species cope with this stress by changing growth habit, by changing photosynthesis or other methods? Experimental plants can be different cereals or soya or broad beans linked to current phenotyping project. We have a joint project with South African researchers screening for heat tolerance in different bean species.

32. Stress in wheat production under global change

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science
Faculty of Science and Technology
Aarhus University
E-mail: coo@food.au.dk,
Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
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:
Photosynthesis, plant adaptation, global change, stress, climate, temperature

Additional information:
The Master student are linked to a group of scientists, technical staff and PhDs, thus the student will make the project in an international working team. The experimental work is linked to ongoing research using state of art equipment for physiological analysis of plant reactions. This increases the possibilities of making a scientific paper in connection with the M.Sc-thesis.

We might be able to provide paid accommodation for a period during your project depending on availability.

Short project description:
Ongoing studies of wheat aim to select and predict plant performance under various climate change condition especially focusing on high temperature effects linked to water stress of the photosynthesis reaction of plants in different stages of development and whether high CO_2 can make the plant less sensitive or whether combinations of stresses affect the plants differently using state of art technology to monitor plants reactions. The projects are part of an international project ModCarbostress aiming to improve models of plant reactions to climate change.

33. Cool plants – how do they react to cool conditions?

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science
Faculty of Science and Technology
Aarhus University
E-mail: coo@food.au.dk
Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
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
Photosynthesis, plant adaptation, global change, stress, climate, temperature

Additional information:
The Master student are linked to a group of scientists, technical staff and PhDs, thus the student will make the project in an international working team. The experimental work is linked to ongoing research using state of art equipment for physiological analysis of plant reactions. This increases the possibilities of making a scientific paper in connection with the M.Sc-thesis.

We might be able to provide paid accommodation for a period during your project depending on availability.

Short project description:
This project is dealing with how different plant species react to lower than normal temperatures and the idea to so the aim for the M.Sc. project could be to study effects of shorter or longer periods of lower than normal temperature on growth and physiology of the plants. This can be important to evaluate new crops potential in Denmark due to the sudden spells of cold conditions in the sowing period.

34. How does plant cope with high humidity

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science
Faculty of Science and Technology
Aarhus University
E-mail: coo@food.au.dk,
Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
No specific time

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

Main subject area:
Photosynthesis, plant adaptation, global change, stress, climate, temperature

Additional information:
The Master student are linked to a group of scientists, technical staff and PhDs, thus the student will make the project in an international working team. The experimental work is linked to ongoing research using state of art equipment for physiological analysis of plant reactions. This increase the possibilities of making a scientfic paper in connection with the M.Sc-thesis.

We might be able to provide paid accomodation for a period during your project depending on availability.

Short project description:
This proposed project is dealing with how different plant species react to conditions when the water content of the air is high and we're interested in how the stomata is regulated by both humidity, but we can also include reactions to different spectral light compositions and other climate factors. Using high tech methods we can follow plants reaction to climate – such as humidity and water stress. The project can be done on species that is included in a joint project with commercial growers.

35. Does changes in light composition affect the plants?

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science
Aarhus University
E-mail: coo@food.au.dk, Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
No specific time

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

Main subject area:
Photosynthesis, plant adaptation, global change, stress, climate, temperature

Additional information:
The Master student are linked to a group of scientists, technical staff and PhDs. The experimental work is linked to ongoing research using state of art equipment for physiological analysis of plant reactions. This increases the possibilities of making a scientific paper in connection with the M.Sc-thesis.

Short project description:
Growing plants under different light spectral light composition can affect both plant shape, photosynthesis, growth rate and secondary metabolites, so you can be part of a team that works to improve the taste of herbs, make a more sustainable plant production and trying to developed the future plants production in urban multilayer farming. The Thesis can focus on physiology, plant growth and metabolites.

36. Legumes for the future

Main supervisor:
Professor Carl-Otto Ottosen
Department of Food Science, Aarhus University
E-mail: coo@food.au.dk, Phone: 22903105

Physical location of the project:
Department of Food Science, Årslev (after Nov 1, 2019, AgrofoodPark, Skejby)

Project start:
No specific time

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

Main subject area:
Photosynthesis, plant adaptation, global change, stress, climate, temperature, legumes

Additional information:
The Master student are linked to a group of scientists, technical staff and PhD. The experimental work is linked to on going research using state of art equipment for physiological analysis of plant reactions. This increases the possibilities of making a scientific paper in connection with the M.Sc-thesis if this should be of interest.

Short project description:
One of the challenges in agriculture is to get enough protein crops both for human consumption, so we focus on understanding of how we can find legumes (faba and soya beans) for the Danish climate, but also working on South African bean types adapted to high temperatures in collaboration with several South African universities. This can be done by studies of the physiological responses to cold and high light and nutrient deficiency. Part of the project might be made in South Africa if we can get student grants.

37. Ecological intensification for production of vegetables: double-cropping and nitrogen recycling

Main supervisor and department:
Associate professor Hanne Lakkenborg Kristensen, Department of Food Science, hanne.kristensen@food.au.dk, +45 8715 8354.

Physical location of the project and students work:
Department of Food Science, AU Årslev, Kirstinebjergvej 10, 5792 Årslev
After 1. Nov. 2019, AU-FOOD, AgroFoodPark, 8200 Skejby

Project start:
Any time

Main subject area:
Organic vegetables, new intensive cropping systems, intercropping, nitrogen recycling, root growth

Short project description:
The aim of the project is to study new cropping systems for production of organic vegetables based on diversification and continuous plant cover. This is done by use of intercropping, overlap of growth seasons, autumn-winter crops combined with tight nitrogen recycling in the plant-soil system. A crop rotation experiment is conducted in the field and offers possibilities to study agronomic factors, crop and root growth and nitrogen uptake. An additional field experiment is used for screening of several new and weird cropping systems of several crops and offers possibilities to test your own ideas and study horticulture in new perspective.

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 DoubleCrop 'Increased production by double cropping, plant-based fertilizers and reduced tillage' granted by GUDP (NaturErhvervStyrelsen) under the research program RDD3.

38. Intercropping of cabbage and beetroot and use of plant-based fertilisers for increased biodiversity and soil fertility

Department and supervisor:
Hanne Lakkenborg Kristensen, Associate Professor, Department of Food Science, hanne.kristensen@food.au.dk, +45 8715 8354.

Physical location of the project and students work:
Department of Food Science, AU-Årslev, Kirstinebjergvej 10, 5792 Årslev
After 1. Nov. 2019, AU-FOOD, AgroFoodPark, 8200 Skejby

Project start:
Any time

Main subject area:
Intercropping, soil fertility, root growth, plant-based fertilisers, organic vegetables

Short project description:
If you think new ways for vegetable production are exiting and the future, this may be the master to go for!
The aim of the project is to study the effect of intercropping of cabbage and beetroot combined with the use of plant-based fertilisers on vegetable productivity and soil fertility. A major field experiment is conducted over the summer of 2019. It offers several possibilities for the study of agronomic factors, such as indices for improved soil fertility, nitrogen mineralization, crop uptake and root growth in intercropped and sole-cropped systems. Pot trials for in-depth study of plant-based fertilisers and soil fertility can be added to the experimental plans.

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 European project SureVeg 'Strip-cropping and recycling of waste for biodiverse and resource-efficient intensive vegetable production' granted by CORE organic COFUND and InnovationFund Denmark.

39. High quality compost from recycling of waste – effects on biological soil fertility and plant production

Department and supervisor:
Hanne Lakkenborg Kristensen, Associate Professor, Department of Food Science, hanne.kristensen@food.au.dk, +45 8715 8354.

Physical location of the project and students work:
Department of Food Science, AU-Årslev, Kirstinebjergvej 10, 5792 Årslev.
After 1. Nov. 2019, AU-FOOD, AgroFoodPark, 8200 Skejby

Project start:
Any time

Main subject area:
Organic matter decomposition, soil fertility, plant production, carbon, nitrogen

Short project description:
'Dead' soils from intensive use need addition of stabile organic matter.
The aim of the project is to test high quality compost with defined properties produced from organic waste. The compost is developed by European partners. The project will focus on indices of compost quality and the effects on soil biological fertility and crop productivity in conventional and organic vegetable systems. Pot and field trials are conducted to investigate carbon and nitrogen fractions, microbial activity (enzymes, mineralization) and crop growth and nutrition.

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 European project SOILCOM 'Sustainable soils by quality compost with defined properties' granted by the Interreg North Sea programme.

Study regulations concerning Master Thesis Projects

Text from the study regulation of the Masters Degree Programme in AgroEnvironmental Management

Objective:

The Master's degree programme is concluded with a thesis of 30, 45 or 60 ECTS credits, depending on the extent to which the student prioritizes to plan and carry out his/her own experimental work. The objective of the thesis is to give the students the possibility of colouring their own study programme within a particular area and to enable them to independently uncover, delimit and study a relevant scientific problem.

Learning objectives

Characteristics of the three thesis types:

Thesis 30 ECTS credits
Theoretical thesis based on literature studies and/or analyses of issued data sets.

Thesis 45 ECTS credits
Thesis in which the student is responsible for collection and analysis of original unedited data sets. The quality of the data collection, analysis and editing must be included in the overall assessment.

Thesis 60 ECTS credits
Thesis in which the student is responsible for planning of experiment design and method as well as collection and analysis of original unedited data sets. Quality and independence in design of own experiments, planning of data extraction from original data sources, or development of new theory must be included in the overall assessment. Furthermore, the quality of the data collection, analysis and editing must be included in the overall assessment

In the assessment of the thesis importance will be attached to whether the student can:

- Independently uncover and delimit a problem within the chosen area.
- Arrange a relevant project design for analysis of the delimited question.
- Seek and prioritize relevant literature and be critical of different theoretical views and possibly conflicting results.
- Include, discuss and select relevant theories in relation to problems.
- Discuss and be critical of the relevance and quality of the applied literature, the applied theories/models, methods of analysis and possible data, including trial design and statistical methods.
- Carry out an independent and coherent analysis of the chosen problem and summarize the conclusions of the study.
- Communicate in writing and orally the analyses and conclusions of the project, including the problem, choice of method, analysis, discussion, conclusion and putting into perspective, in a clear and relevant way in relation to a defined target group.

Method of instruction
No instruction as such is connected with the thesis work, but the Board of Studies will assign a supervisor to the student; this supervisor will also act as examiner. A thesis contract must also be drawn up at the time of assigning a supervisor; this contract must be approved by the Head of Studies.

The thesis contract must include information about:

- The extent of the thesis (30, 45 or 60 ECTS credits)
- Formulation of the project, delimitation of the subject
- Supervision plan
- Thesis language (Danish or English)
- Deadline

The thesis contract is signed by the student and the supervisor and submitted to the Director of Studies for approval. Once the thesis contract has been approved and the deadline for submitting the thesis has been determined, the student cannot withdraw from the exam. If the thesis is not submitted by the determined deadline, it will be considered as a spent examination attempt. The Board of Studies then approves a changed project formulation within the same subject area and at the same time determines a new deadline of three months. If the thesis is not submitted by this deadline, the student may have a third examination attempt in accordance with the same regulations that apply to the second examination attempt.

METHOD OF EVALUATION

A combined oral and written exam with the participation of an external examiner. The written part of the exam consists of a dissertation of maximum 100 normal pages, written in Danish or English with a summary in English. A normal page for written submissions is 2400 characters. To calculate normal pages, text is included, but not the front page, table of contents, bibliography, appendix, figures and models. The dissertation must be submitted to the supervisor in 4 printed copies. The oral part is public (exemptions from this cf. the Examination Executive Order, section 19, subsections 2 and 3). The supervisor announces the time and place of the examination in agreement with the student.

In the assessment of the thesis dissertation importance will mainly be attached to its scientific content, but the student's spelling and formulating capacity will also form part of the assessment, irrespective of the language of the thesis. At the oral exam the student will have 30 minutes in which to present the project. The examiner and the external examiner may then ask the student questions for up to 30 minutes whereupon the grade will be determined and announced. The thesis dissertation and the oral exam will be assessed jointly, using the Danish 7-point grading scale. The examiner and the external examiner subsequently prepare a written assessment.

See also updated information at http://studerende.au.dk/en/studies/subject-portals/agroecology-food-and-environment/

Master's Thesis Contract

The Board of Studies of Agricultural Sciences
The Faculty of Agricultural Sciences, Aarhus University
(NB: See updated info at http://studerende.au.dk/studier/fagportaler/agrobiologi/ and http://studerende.au.dk/en/studies/subject-portals/agroecology-food-and-environment/)

Agreement on Master's Thesis Project between:

Student:

Name: _____

Student registration number : _____

Address: _____

_____

Telephone: _____

Mail address: _____

Supervisor(s):

Main supervisor

Name: _____

Mail address: _____

Other supervisors:

Name: _____

Mail address: _____

Degree programme: _____

Scope of the thesis in ECTS: _____

Thesis statement: _____

_____

_____

_____

Working title: _____

_____

The project is written in: ☐ Danish

☐ English

The summary is written in: ☐ Danish

☐ English

Physical location of the project: _____

Resource needs/ financing , see instructions article 1

Agreement on the project finances: _____

_____

_____

Specific timetable and plan of supervision, see instructions article 2

Date of project start: _____

Deadline for handing in the thesis: _____

Project plan:

- Outline of the main phases and deadlines
- Extent and structure of the supervision

_____

_____

_____

_____

_____

_____

The thesis can be published at the libraries and homepages of the departments and the faculty.

☐ yes

☐ no

The agreement on publishing has been read and understood, see article 3

☐ yes

The section about patent rights has been read and understood, see article 4

☐ yes

The section about plagiarism has been read and understood, see article 5

☐ yes

Signatures

Student: _____

Main supervisor: _____

Other supervisors: _____

Head of programme: _____

The signed contract must be submitted to The Board of Studies of Agricultural Sciences

Approved by the Head of Studies

Date: Signature: _____

Guidelines for the MSc thesis contract

1) Resource needs/financing
The supervisor commits him-/herself to make the facilities and research resources agreed upon in the project plan available to the project. If completion of the thesis depends on a grant or an agreement with a partner, it is important to mention this. Please note that you as a student must agree to possible risks and their potential consequences (for example that partners can give notice to terminate contracts and that the thesis as a consequence of this has to be redefined).

2) Time frame
The student must begin his/her thesis and submit it within the time frame of the thesis as specified in the academic regulations for each degree programme. When the thesis contract has been approved and the deadline for submitting the thesis has been appointed, you can not withdraw from the exam. If the thesis is not handed in by the appointed time, it counts as an examination attempt. The Board of Studies then approves a revised project formulation within the same subject area and at the same time appoints a new deadline of 3 months. If the thesis is not submitted by this deadline, the student may have a third examination attempt according to the regulations that apply to the second examination attempt.

3) Publication agreement
As regards the **publication of data** obtained during a thesis study, the regulations in force are stipulated in "The Danish Ministry of Education's circular No 169 of 16 July 1973 on the use of students' projects and their ensuing rights"("Undervisningsministeriets cirkulære nr. 169 af 16. juli 1973 om anvendelsen af de studerendes opgaver og deres rettigheder i forbindelse hermed". This means that the student has the right to use and further process original and processed data after finishing the thesis and that the student must give written consent to publication of these data. However, there are exceptions regarding copyright as mentioned in article 4.

Yes, data obtained in connection with my thesis may figure in publications, and I approve the conditions below: _____ (student's signature)

The student is obliged to hand over all original and processed data, including laboratory logs, to the supervisor but is entitled to a copy for his/her own use. The supervisor reserves for him-/herself the right to use these data in the best possible way in collaboration with the student. If the student on signing the thesis contract has accepted that data may be published, and the student achieves results that, in the supervisor's opinion, are suitable for publishing after further processing and possibly supplemented with further data, a manuscript must be prepared. This takes place in collaboration between the student, the supervisor and other co-authors, if any. The author sequence is agreed upon by the student, the supervisor other co-authors, if any, with reference to the Vancouver Protocol (http://www.icmje.org/). If the student's contribution is modest, his or her data can be published in the name of the supervisor.

Or

No, data obtained in connection with my thesis may not figure in publications. I hand over a copy of my original and processed data, including laboratory logs, to the supervisor after the completion of the thesis.

_____ (student's signature)

On signing the thesis contract the student may refuse publication of the thesis data. The main supervisor/project supervisor may in that case revise the suggested thesis project taking this refusal into consideration.

4) Patent rights
The right to the results appearing from a student's thesis, including any immaterial rights, such as patent rights and copyrights to computer programs takes as its starting point "The Danish Ministry of Education's circular No 169 of 16 July 1973 on the use of students' projects their ensuing rights" ("Undervisningsministeriets cirkulære nr. 169 af 16. juli 1973 om anvendelsen af de studerendes opgaver og deres rettigheder i forbindelse hermed").

However, there will often be exceptions to this starting point:

I. If the student in connection with his/her thesis takes part in a research project in which external parties participate, the student must renounce his/her right to any patentable results and any copyrights on computer programs before his/her participation in the project begins.

II. If the student makes an invention or gets the copyright on computer programs in connection with the completion of the thesis in collaboration with his/her supervisor, the student must, provided that the University decides to take over the supervisor's part of the invention, transfer his/her part of the invention to the University in return for becoming covered by Aarhus University's regulations on compensations under section 12 in Danish Act No. 347 of 2 June 1999.

5) Plagiarism
Plagiarism is using another person's text as your own without making precise source references. Plagiarism is considered a very serious offense because it is a theft of another person's work and because you are assessed on work that in actual fact is not yours.

You avoid plagiarism by always making a precise source reference when you use other people's work – this applies to quotations, reproductions, interpretations, translations, figures, illustrations, etc. When you produce a text, it must appear clearly which is the result of your own ideas and which passages are a result of your processing of other people's knowledge.

You must be aware that it is your responsibility: If you plagiarise, the consequences may be quite serious. The regulations at Aarhus University regarding sanctions in connection with plagiarism can be found on the net.

6) Academic regulations as regards the Master's thesis project

The Master's degree programme is concluded with a thesis of 30, 45 or 60 ECTS credits, depending on the extent to which the student prioritises to plan and carry out his/her own experimental work. The objective of the thesis is to give the student the possibility of specialising in a particular area and independently uncover, delimit and study a relevant scientific problem.

Learning objectives:
Characteristics of the three thesis types:

- Thesis 30 ECTS credits: Thesis based on literature studies and/or analyses of issued and edited data sets.
- Thesis 45 ECTS credits: Thesis in which the student is responsible for collection and analysis of original unedited data sets. The quality of the data collection, analysis and editing must be included in the overall assessment.
- Thesis 60 ECTS credits: Thesis in which the student is responsible for planning of experiment design and method as well as collection and analysis of original unedited data sets. Quality and independence in design of own experiments, planning of data extraction from original data sources, or development of new theory must be included in the overall assessment. Furthermore, the quality of the data collection, analysis and editing must be included in the overall assessment.

In the assessment of the thesis importance will furthermore be attached to whether the student can:

- Independently uncover and delimit a problem within the chosen area.
- Arrange a relevant project design for analysis of the delimited question.
- Seek and prioritise relevant literature and be critical of different theoretical views and possibly conflicting results.
- Include, discuss and select relevant theories in relation to problems.
- Discuss and be critical of the relevance and quality of the applied literature, the applied theories/models, methods of analysis and possible data, including trial design and statistical methods.
- Carry out an independent and coherent analysis of the chosen problem and summarise the conclusions of the study.
- Communicate in writing and orally the analyses and conclusions of the project, including the problem, choice of method, analysis, discussion, conclusion and putting into perspective, in a clear and relevant way in relation to a defined target group.

Method of instruction:
No instruction as such is connected with the thesis work, but the Board of Studies will assign a supervisor to the student; this supervisor will also act as examiner. A thesis contract must also be drawn up at the time of assigning a supervisor; this contract must be approved by the Head of Studies.

The thesis contract must include information about:

- The extent of the thesis (30, 45 or 60 ECTS credits)
- Formulation of the project, delimitation of the subject
- Supervision plan
- Thesis language (Danish or English)

- Deadline

The thesis contract is signed by the student and the supervisor and submitted to the Head of Studies for approval. Once the thesis contract has been approved and the deadline for submitting the thesis has been determined, the student cannot withdraw from the exam. If the thesis is not submitted by the determined deadline, it will be considered as a spent examination attempt. The Board of Studies then approves a changed project formulation within the same subject area and at the same time determines a new deadline of three months. If the thesis is not submitted by this deadline, the student may have a third examination attempt in accordance with the same regulations that apply to the second examination attempt.

Method of evaluation:
A combined oral and written exam with the participation of an external examiner. The written part of the exam consists of a dissertation of 100 pages, written in Danish or English with a summary in English. A normal page for written submissions is 2400 characters. To calculate normal pages, text is included, but not
the front page, table of contents, bibliography, appendix, figures and models. The dissertation must be submitted to the supervisor in 4 printed copies.

The oral part is public (exemptions from this cf. the Examination Executive Order, section 19, subsections 2 and 3). The supervisor announces the time and place of the examination in agreement with the student. In the assessment of the thesis dissertation importance will mainly be attached to its scientific content, but the student's spelling and formulating capacity will also form part of the assessment, irrespective of the language of the thesis. At the oral exam the student will have 30 minutes in which to present the project. The examiner and the external examiner may then ask the student questions for up to 30 minutes whereupon the grade will be determined and announced.

The thesis dissertation and the oral exam will be assessed jointly, using the Danish 7-point grading scale. The examiner and the external examiner subsequently prepare a written assessment.

Guidelines for the MSc Thesis Research Proposal

The Research Proposal
Broad agreement exists on the basic scientific standards that apply for a scientific study. Above all, the scientific standards that apply (and thus must be met) are the following:

The thesis must be theory-based.
The research must be verifiable.
The research must be in principle replicable.

To make sure that your research is complying with these rules, you should start by making a research proposal attending to these standards. A proposal consists of the following parts:

Problem statement: This gives the motivation for the selection of the topic and a clear description of the problem field, finally resulting in a concise problem statement. This part includes a review of the theoretical and empirical literature, which is most relevant to the topic and ensures that the topic has not already been exhausted by other researchers.

Theoretical framework: This part gives the background of your topic. Which information is already known from the literature? The theory acts as a base for further investigation and comparison with the (future) results. You must indicate which concepts are important to be looked at in answering the research questions.

Research objective(s) and research questions: This clearly states the scientific objectives of the research. It is important that the objectives of the research are strictly related to the research topic.
Subsequently, the research objective(s) should be translated into research questions. These are the questions that need to be answered in order to fulfill the research objective(s).

Methodology: In this part of the proposal it should be explained how the theory and research questions can be examined and answered empirically. The function of the methodology part within the research proposal (and later in the thesis report) is to specify reliability, validity and replicability of the research.

You need to consider the following points when setting up a sound methodological framework:

Identify the **character of the thesis work.** For instance: is it an explorative, or comparative, or experimental study?

Design the **data collection.** This step requires arguing about, and providing an answer to, the following questions:

What is seen as data and from which sources of information do you obtain these data?

What are the criteria for determining and delineating the sources of information?

What methods are employed to derive the data from the sources of information? Is the case of experimental work: what is the experimental design, which factors do you explicitly test for, how many replicates do you have, etc.?
Which instruments will be used? It is important to think about the instruments you need far in advance, because not all equipment is available, or it can be in use elsewhere.

Design the **data analysis**: It should be pointed out that the description of the methods is necessary for data collection as well as for data analysis. How can the data be processed? Which statistical tests can be applied given the employed data collection methods or experimental design? Note that it is important to think about data analysis before you start to collect data. Certain analyses require certain data formats and experimental set-up.

Working plan and time schedule: The research proposal finally should be completed by a comprehensive working plan, indicating the necessary steps in carrying out the research, as well as their logical order in time, specification of milestones and quarterly status presentations – all to ensure that the workload is realistic and the thesis work is progressing in a sound way.

In some cases you need a **financial plan**. The general necessity of financial means to carry out the thesis work needs to be discussed and agreed between student and supervisor before the actual thesis work starts.

*After you have completed your research proposal, you must provide a **short abstract** of your proposal to the web manager of the institute. This abstract will be published on the web pages of the chair group.*

Guidelines for writing the Thesis Report

The thesis report (max. 100 normal pages), should be written in Danish or English with a summary in English. A normal page for written submissions is 2400 type units (i.e. characters plus spaces). To calculate normal pages, text is included, but not the front page, table of contents, bibliography, appendix, figures and models. Font size 12pt, line spacing 1.5, subtitles, margins, headers, page numbers etc. ...

Writing style: The thesis report should be written in an academic writing style. An academic writing style is in its essence short, clear and unambiguous. You use the terminology of the discipline. When you propose a hypothesis or theory, it must be substantiated. You bring documentation for any methods and postulates in terms of reference to scientific, peer reviewed research (scientific journal papers) or in terms of data. You discuss your actual results in relation to the applied methods and relevant peer reviewed research. You conclude on you hypothesis and on your actual results. For more information concerning writing style, writing process etc, please see the home-page of *The Purdue Online Writing Lab* http://owl.english.purdue.edu/exercises/

Referencing: It is very important that you give proper references when making statements from the literature. References acknowledge the work of others, and provide the reader with information on the sources that you used. Plagiarism is not acceptable and in serious cases students risk to be expelled from the university.

The thesis report consists of the following elements:

- **Front page**: This is the cover of your thesis. It should mention the title of the research, the name of the author, the name of the master's degree programme, year and date. The front page also needs to carry the logo of the university and the name of the Faculty. You are (maybe) free in designing the cover page.
- **Title page**: This page must be in the strict format.
  - The title page contains the following elements:
  - Title of the thesis research
  - Your full name (including all initials)
  - Student registration number
  - Name of the master's degree programme
  - ECTS of the thesis (60, 45 or 30)
  - Year and date of submission
  - Title, name and department of the supervisor(s)
  - A copyright statement – *to be discussed*
  - The proper logo of the university and the name of the Faculty
- **Preface:** Less than one page.
- **Table of content:** Gives an overview of the chapter structure of the thesis with their respective page numbers. It should also include the summary and possible annexes.
- **Abstract:** Maximum of 250 words that describes the research for the general public.

- **Summary:** Provides a short (1-2 pages) but comprehensive summary of all chapters, i.e. the research objectives, the methods used, the most important results and conclusions.
- **Introduction:** This part includes the problem statement, the scientific objectives as well as the research questions that you have formulated in your proposal. You can also give a characterization of the type of work and a short outline of the structure of the subsequent chapters can complete it.
- **Theoretical Framework:** In this section you provide a review of the theoretical and empirical literature and the reconstruction of the used theoretical concepts. The theoretical framework may be completed by a conceptual model, in which the relations of the relevant concepts of the applied theories are presented. Note that this framework may also be part of the introduction instead of being presented as a separate chapter.
- **Methods:** This part reports on the used information sources, as well as the applied methods and instruments for data collection and statistical data analysis. In contrast to the research proposal - where this section is presenting the ambitions/ plan - you must present the situation as it has actually worked (incl. problems that occurred) in the final thesis report. In the case of fieldwork, you should describe the area and sites in which the research was carried out. When you have done experimental work, you should give all relevant details of the followed procedure (protocol). This enables others to evaluate your work, and to reproduce it if needed.
- **Results:** In this section the results should be presented in the most objective and comprehensive manner. Mixing results with subjective interpretation and discussion must be avoided. The challenge is to structure the results in such a way, that the research questions are addressed as best. Where appropriate, the findings should be illustrated or summarized with tables and figures including a statistical data analysis. In any case tables and figures must be drawn in such a way that they can be read on their own, independent from the surrounding text. Do not forget to include measurement units and an explanation of abbreviations. References to tables and figures should be made in the text (e.g., see table 1; cf. figure 2). Note that table captions are given above the table, whereas figure captions are placed below the figure.
- **Discussion:** The discussion section links your own findings, as presented in the result section, with those of others. What do your results mean and imply? The challenge here is to argue for and against the findings and the related theoretical concepts. Literature references are therefore again a requisite in this section. Furthermore, you must discuss your findings in the background of the scientific objective(s) and the research question(s), as well as in the light of the chosen theoretical framework. Last but not least, it should also not be forgotten to discuss to what extent the findings might have been influenced by the chosen methods.
- **Conclusions:** This section brings together the most important consequences of your research. These conclusions normally touch on three aspects: a.) The scientific objec-

tive and the research questions (results); b.) Hints for future research on this topic (theoretical framework and methods); c.) Practical application of the results (consequences in management and policy), however, this last part might also be a separate section named 'Implications' or 'Perspectives'.

- **Bibliography:** In this section a list of all referred literature should be given, sorted in alphabetical order. The style for the different types of publications (articles in journals, books, chapters in books etc.) should be consistent, according to the Harvard style, see also the Harvard online referencing tutorial.
- When you refer to information on the Internet you should give the complete web-address, as well as the date on which the information has last been accessed, e.g.:
- *Ministry of LNV (2002): Forestry on paper. Public brochure, downloadable at http://www.minlnv.nl/morepaper.pdf. Information derived on June 15, 2002.*
- *Royall, C.P., B.L.Thiel, and A. Donald. 2001. Radiation damage of water in environmental* scanning electron microscopy. Journal of microscopy [online]. **204**(3), [Accessed 17 March 2009], pp.185-195. Available from: http://0-www3.interscience.wiley.com.wam.leeds.ac.uk/.
- **Annex/Appendix: The content of the annex/appendix is not evaluated, thus all important and relevant information must be given within the frame of the thesis and its main sections.** The annex should include supplementary information about protocols, observations, calculations, etc. This could mean for example: the inclusion of the original data, further detailed statistical analysis, etc. Note that also the annex pages should be numbered consistently with the general text.

Different types of research (e.g., historical research, a literature review) might require a slightly different chapter structure.

Deadlines concerning Master Thesis Projects

Thesis 30 ECTS – 6 months
Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.
Project start: 1. December 2017 (course registration: November 2017)
Thesis deadline (for examination): 30. June 2018

Thesis 45 ECTS – 9 months
Experimental thesis in which the student is responsible for collection and analysis of original unedited data sets. The quality of the data collection, analysis and editing must be included in the overall assessment.
Project start: 1. September 2017 (course registration: May 2017)
Thesis deadline (for examination): 30. June 2018

Thesis 60 ECTS – 12 months
Experimental thesis in which the student is responsible for planning of trial design and methods as well as collection and analysis of original unedited data sets. Quality and independence in design of own experiments, planning of data mining from original data sources, or the development of new theories must be included in the overall assessment. Furthermore, quality of the data collection, analysis and editing must be included in the overall assessment.
Project start: 1. June 2017 (course registration: May 2017)
Thesis deadline (for examination): 30. June 2018

For all master thesis types: Examination within 4 weeks after delivery of the thesis
For updated information see also: http://studerende.au.dk/en/studies/subject-portals/ and http://studerende.au.dk/en/studies/subject-portals/agroecology-food-and-environment/