

Master Thesis Projects

Topics within Agroecology

*AgroEnvironmental Management & Agrobiolology
MSc Programmes 2017-2018*



*Tommy Dalgaard
Head of MSc Programme,
Department of Agroecology
Aarhus University
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Preface

This catalogue of master thesis projects available in 2017-2018 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.

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1. 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 important from a production and environmental point of view. Nitrogen application strategy in grass seed crops depends on the species, some species are applied nitrogen in the autumn while others species are only applied nitrogen in the spring. Spring nitrogen application can be optimized 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.

2. 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 production

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/>

3. Ecosystem services provided by small undisturbed patches in agricultural landscapes

Department and supervisor

Gabor Lovei, DSc, Senior Scientist, gabor.lovei@agro.au.dk, 871 58224

Physical location of the project and students work

Flexible

Project start

Any time

Main subject area

Ecology/landscape ecology/ biological control

Short project description

(Background and Content)

Stone age burial mounds dot the Danish landscape. They are protected and mostly undisturbed, surrounded by cultivated fields. The project will survey a selection of such sites and assess their role as refuges of beneficial organisms (predatory beetles, bees, etc.), as well as their role in increasing beneficial functions (like pest control and pollination) in cultivated landscapes, using simple, practical experimental manipulative techniques.

Similar small habitat patches are protected for cultural or religious reasons in many countries, and the student can pursue a similar project in her home country, too, if relevant, and evaluate her data in Denmark.

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

This could be developed as a 45 or a 60 ECT project.

Additional information

(E.g. prerequisites, conditions, useful reading, etc.....)

4. Mechanical subsoiling effects on the soil pore system

Main supervisor

Per Schjønning, Per.Schjonning@agro.au.dk, +45 8715 7725

Physical location of the project

Department of Agroecology, AU Foulum, 8830 Tjele

Project start

Optional

Extent and type of project

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

Main subject area

Soil tillage, soil compaction, soil pore system

Additional information

Traffic with heavy machinery in agricultural soils induces compaction of the subsoil, which is detrimental to soil functions, including crop productivity. Mechanical loosening of the soil by deep-reaching tillage implements is frequently used by farmers although studies have indicated that the procedure is problematic. There is a need to elucidate in more detail how mechanical subsoiling affects soil properties.

Short project description

A comprehensive, existing data set on the effects of mechanical subsoiling on soil strength and soil pore characteristics in 3D will support literature studies for better understanding of beneficial as well as unfavourable effects of mechanical subsoiling on plant growth. Data includes penetration resistance, pore size distribution and gas diffusivity in control soil and soil that were loosened by different subsoilers. State-of-the-art models for description of the soil pore system will enable a detailed picture of the implement-soil interaction, which will then be evaluated with respect to soil functions like root growth, aeration and water transport.

The project may be restricted to analysis of the existing data set and a literature review (30 ECTS). OR it may be extended by an experimental part including sampling in and laboratory analyses of soil cores from existing field experiments with mechanical subsoiling (45 ECTS).

The work (even the 30 ECTS part) may create the basis for an international, peer-reviewed manuscript.

Useful reading

- Berisso, F.E., Schjønning, P., Keller, T., Lamandé, M., Simojoki, A., Iversen, B.V., Alakukku, L., Forkman, J. 2013. Gas transport and subsoil pore characteristics: Anisotropy and long-term effects of compaction. *Geoderma* 195-196, 184-191.
- Munkholm, L.J., Schjønning, P. & Rüegg, K. 2005. Mitigation of subsoil recompaction by light traffic and on-land ploughing: I. Soil response. *Soil & Tillage Research* 80, 149-158.
- Munkholm, L.J., Schjønning, P., Jørgensen, M.H. and Thorup-Kristensen, K. 2005. Mitigation of subsoil recompaction by light traffic and on-land ploughing: II. Root and yield respons. *Soil and Tillage Research* 80, 159-170.
- Schjønning, P. 1986. Jordløsningens indflydelse på jordstrukturen. Seminarrapport, NJF: Jordpackning, Skørdepåverkan - Motåtgärder - Ekonomi. *Rapporter från Jordbearbetningsavdelningen (Uppsala)*, 71, 157-164.
- Olesen, J.E., Munkholm, L.J., 2007. Subsoil loosening in a crop rotation for organic farming eliminated plough pan with mixed effects on crop yield. *Soil Till. Res.* 94, 376-385.

5. Forage legume seed production and pollination

Main supervisor

Birte Boelt

E-mail: Birte.Boelt@agro.au.dk

Phone: 8715 8276

Physical location of the project

Department of Agroecology, AU-Flakkebjerg, 4200 Slagelse

Project start

June 2017

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

Main subject area

Crop production and pollination

Short project description

White clover, red clover and alfalfa are important forage crop and are being used more and more due to their high nutritional value. Denmark is the largest producer of white clover seed within the EU having a very specialised production, whereas we use to have a large red clover seed production but the production area is decreasing due to low seed yields.

The project aims at studying how we can improve seed yields by better managing pollinating insects – bumble and honeybees.

We seek information on the pollination insects, their activities, nectar and pollen production in the florets, seed set etc.

At AU-Flakkebjerg you will have access to experimental plots with white clover, different varieties of red clover and of alfalfa.

Additional information

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

6. Small molecules with high importance in Agroecology

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> together co-supervisor according to chosen theme and assisted by head laboratory technician Bente B. Laursen

Physical location of the project:

Department of Agroecology, Flakkebjerg, 4200 Slagelse.

Project start:

Can be decided individually.

Extent and type of project:

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data. The publication of a scientific paper on basis of the theses will strongly be encouraged.

Main subject area:

Small molecules with high importance in Agroecology cover a) natural product chemicals b) xenobiotics and c) primary metabolites

Natural product chemicals, produced by the agricultural crops often can have suppressive effects on weeds, insects and/or diseases or health-protecting effects in humans. The presence of these compounds in agricultural crops can therefore be exploited in self-defense for crops and in health-protecting food products.

Xenobiotics (chemical compounds that are foreign to living organisms) in agriculture include applied pesticides as well as contaminants that end up in agricultural soils through processes such as application of sludge and manure. Environmental chemistry deals with the fate, effects and reactions of xenobiotics.

Primary metabolites are part of the metabolism and are necessary for life and growth. Changes in the complete pattern of the metabolites – the metabolome – illustrate the effect, when an organism is exposed to biologically active natural chemicals or by xenobiotics.

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](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 (name of co-supervisor in brackets):

- Chemistry of plant root signaling compounds with importance for the plant-associated microbiome and disease resistance? (Mogens Nicolaisen, Kouros Hooshmand)
- Root-protected grass. (Birte Boelt)
- Pyrethroids in private homes. (Karl-Martin Vagn Jensen)
- BENZEX. Biosynthesis, transport and exudation of 1,4-benzoxazin-3-ones as determinants of plant biotic action (Hans A. Pedersen)
- RyeproC. Whole grain rye as a functional food for suppression of prostate cancer –elucidating the role of benzoxazinoids and other bioactive constituents. (Stine Krogh Steffensen)
- Metagenomic and metabolomic aspects of organic nitrogen uptake by plants – how is organic nitrogen acquisition influenced by microorganisms in rhizosphere? (Weronika Graj)
- Characterization of conjugates and bound residues of azoxystrobin metabolism in lettuce (Maheswor Gautam)
- Wheat suppressive effects of rye, wheat and triticale. (Antje Reiss)
- Arming honeybees with nature's pharmacy. (Nanna Vidkjær)

Relevant literature: see recent publications IFO: <http://pure.au.dk/portal/en/inge.fomsgaard@agro.au.dk>

7. Can invasive plants come to the rescue of chemically polluted aquatic environment?

Main supervisor

Inge Fomsgaard. Email: inge.fomsgaard@agro.au.dk

Co-supervisor

Maheswor Gautam. Email: maheswor.gautam@agro.au.dk

Physical location of the project

Department of Agroecology, Forsøgsvej 1, Flakkebjerg, 4200 Slagelse

Project start

June/July 2017

Extent and type of project

45/60 ECTS

Main subject area

Phytoremediation, Analytical chemistry (LC-MSMS), Biochemistry

Short project description

Extensive use of agricultural land necessitates use of agrochemicals to control pests, pathogens and weeds to keep up with agricultural production. Leaching, run-off, and spray drift of applied pesticides contribute to surface and ground water contamination that adversely affects aquatic environment. Aquatic environment and wetlands are under stress due to agricultural activities in Denmark [1]. Some invasive species are known to have populated aquatic environment such as lakes in Denmark; among them is Canadian waterweed (*Elodea canadensis*). *E. canadensis* is reported to have enzymatic capacity to remove fungicides from water [2]. However, practical studies utilizing *E. canadensis* for removal of pesticides is lacking.

A prospective MSc thesis student will get opportunity to be a part of planning, designing, and executing the project. You will establish model aquatic environment in lab and assess the fungicide removal potential of *E. canadensis*. Liquid Chromatography-Mass Spectrometry will be used to undertake quantitative studies. Enzyme assays will also be undertaken to support the findings. The results are expected to be developed into a scientific manuscript.

Additional information

1. Odgaard, M.V., et al., *A multi-criteria, ecosystem-service value method used to assess catchment suitability for potential wetland reconstruction in Denmark*. *Ecological Indicators*, 2017. **77**: p. 151-165.
2. Dosnon-Olette, R., et al., *Enzymatic basis for fungicide removal by Elodea canadensis*. *Environmental Science and Pollution Research*, 2011. **18**(6): p. 1015-1021.

8. How to produce high yielding maize with low environmental impact in Danish future climate

Main supervisor:

Ib Sillebak Kristensen, IbS.Kristensen@agro.au.dk, +458715 8036

Elly Møller Hansen, Elly.M.Hansen@agro.au.dk, +45 8715 7732

Physical location of the project:

Department of Agroecology, AU Foulum, 8830 Tjele

Project start:

The optimal start is in the beginning of the growing period, with planning of the work and sowing field plot trials in the semester prior to start.

Extent and type of project:

30-60 ECTS: Theoretical theses based on literature studies, analyses of existing data sets and/or generating own data.

Main subject area:

For instance: Measurements of responses to N-fertilizer and undersown crops in a) ongoing field trials, b) in maize fields in different areas of Denmark; c) Phonological studies of development of maize and undersown catch crops during the growing period and after harvest; d) investigate environmental load with model studies.

Short project description:

Reduced fertilization or undersown catch crops may reduce nitrate leaching, but catch crops can also reduce maize yield if soil nutrient status is low.

You can start your own investigation as a supplement to the ongoing field trials: You can, for example

- Investigate the possibilities of growing undersown crops between maize with different row distances in order to reduce leaching;
 - Measure the development of root, leaves, stems and catch crops during the growing season;
 - Investigate the drought resistance;
 - Investigate the possibilities of organic maize production without weed spraying.
-
- You can study literature concerning maize production.
You can measure feed quality of different maize yield components in the laboratory.
 - You can initiate a survey in 50 maize fields on private farms in order to describe the yield development under different conditions.
 - You can model maize growth under different climatic conditions (Cold/present/future climate(+5 degree of C))

9. 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.

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.

10. Quality of old Nordic cultivars of root and cabbage vegetables

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.

Project start

Any time

Main subject area

Sustainable plant food production: cultivars of Nordic vegetables, vegetable quality, sensory properties: bitterness/sweetness, bioactive compounds

Short project description:

The growing conditions and genetic background are of major importance for the inner quality of vegetable products. Traditional cabbage and root vegetables are healthy and in focus due to the success of the new Nordic cuisine. They produce secondary metabolites that are important for the health and sensory properties of the products. Producers, retailers and consumers are highly interested to gain new knowledge and exploit these properties in the promotion of healthy products with specific quality attributes. The aim of the master project is to investigate the relationship between growing conditions, yields and quality of traditional and modern cultivars of a number of cabbages and root vegetables such as savoy and red cabbage, cauliflower, pointed cabbage, Brussels sprouts, turnip, parsnip and parsley root in field trials.

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 BitterSund granted by GUPD (NaturErhvervStyrelsen) and involves collaboration with Aarstiderne A/S and organic vegetable growers.

11. Testing a future vegetable: the colzacoli

Department and supervisor

Associate professor Hanne Lakkenborg Kristensen, 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.

Project start

Any time but could be timed with experiments running in the project.

Main subject area

Vegetable breeding, horticulture, quality assessment, food chemistry, plant physiology, secondary metabolites, *Brassica*.

Short project description

Through traditional breeding, crossing of rapini (*Brassica rapa*) and a rapeseed (*Brassica napus*) with white flowers has resulted in the new vegetable *colzacoli*. We expect the vegetable to have a distinct taste and a unique profile of secondary metabolites which is linked to increased human health. The project aims to find the best candidates for further crossing based on evaluations of i.a. growth parameters, seed yield, and attack of diseases besides taste and appearance of the vegetable. In the project you will have the possibility to analyze for secondary metabolites (carotenoids and polyphenols) and/or focus on the horticultural discipline. Furthermore, the project gives you the possibility to get insight into a small breeding company and its' work.

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 but we cannot guarantee it will be with the *colzacoli* due to limited amounts of seeds.

Additional information

Project supervisor: Marie Grønbaek (Industrial postdoc), gronbaek@food.au.dk, +45 8715 8327. The master project will be linked to an industrial postdoc project where we are testing a newly bred vegetable, which is not yet on the market. It's the breeding company Knold & Top who made the new vegetable (www.colza.dk).



12. Investigating healthy compounds in salad grown from white-flowering rapeseed

Department and supervisor

Associate professor Hanne Lakkenborg Kristensen, hanne.kristensen@food.au.dk, +45 8715 8354.

Physical location of the project and students work

Department of Food Science, AU Årsløv, Kirstinebjergvej 10, 5792 Årsløv.

Project start

Any time but could be timed with experiments running in the project.

Main subject area

Horticulture, growing conditions, food chemistry, plant physiology, secondary metabolites, glucosinolates, carotenoids, polyphenols, *Brassica*.

Short project description

All *Brassica* crops such as cabbages contain the potential health-beneficial secondary metabolite glucosinolate, which is furthermore related to the taste of the plant. They also contain other secondary metabolites of relevance to human health such as carotenoids and polyphenols. The content of secondary metabolites can be modified through growing conditions of the crop e.g. fertilization levels, plant developmental stage at harvest, light level and temperature, thereby resulting in potentially healthier vegetables. With this starting point you have the possibility of making your own hypothesis or you can use one already given in the project. You will learn the basic principles of setting up an experiment, analyze the plant content of a secondary metabolite besides data analysis. Furthermore, the project gives you the possibility to get insight into a small breeding company and its' work.

Extent and type of project

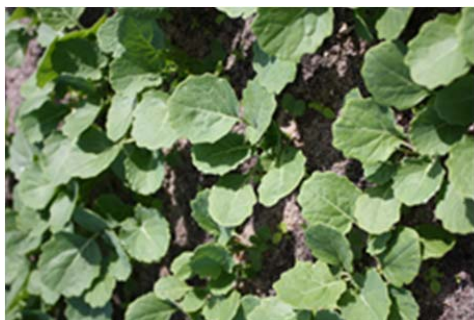
30 ECTS: Theoretical thesis based on literature studies and/or analysis of issued and edited data sets.

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

Project supervisor: Marie Grønbaek (industrial postdoc), gronbaek@food.au.dk, +45 8715 8327. The master project will be linked to an industrial postdoc project working on new products of green leafy vegetables (salad or seedlings) developed from white-flowering rapeseed (*Brassica napus*) together with the breeding company Knold & Top (www.colza.dk).



13. Combined free-range piglet and energy crop production – impact on nutrient leaching and ammonia emission

Department and supervisor

Dept. Agroecology, senior scientist Uffe Jørgensen, uffe.jorgensen@agro.au.dk, phone +45 87157729 , co-supervisor: senior scientist Anne Grete Kongsted, anneg.kongsted@agro.au.dk, phone +45 87157993

Physical location of the project

AU-Foulum. Data collection on private farms.

Main subject area

Organic agriculture/agroecology/nutrient leaching, ammonia emission

Project start

Any time.

Extent and type of project

30, 45 or 60 ECTS

Additional information

The thesis could be based on a literature review combined with experimental work at one or two private farms. The master will be linked to the project ‘pEcosystem – Pig production in eco-efficient organic systems’ led by Dept. Agroecology (AU) in cooperation with Center of Development for outdoor livestock production, Knowledge Centre for Agriculture, Danish Pig Research Centre and Organic Denmark.

Useful reading

Read more at: <http://agro.au.dk/forskning/projekter/pecosystem/> (in Danish), Horsted et al. 2012: Combined production of free-range pigs and energy crops – animal behavior and crop damages. *Livestock Science* 150: 200-208

Short project description

Organic free-range piglet production of today has some disadvantages in terms of nutrient hotspots and poor possibilities for the sows to perform behavioral temperature regulation. Combining perennial energy crop and piglet production might compose a new concept for free-range production with low nitrate leaching and high standards for animal welfare. Results from a previous study indicate that it is possible to combine a production of growing-finishing pigs with a production of energy crops in favor of animal welfare and environment. However, a quantification of the environmental consequences (nutrient leaching, ammonium emission) is lacking.

14. Crop management effects on soil carbon and nitrogen in organic farming

Main supervisor:

Jørgen E. Olesen, jorgene.olesen@agro.au.dk, +45 8715 7778

Physical location of the project and students work:

Department of Agroecology, AU Foulum, 8830 Tjele

Project start:

Any time

Main subject area:

Plant nutrition / organic agriculture

Short project description:

Soil carbon and nitrogen content is affected by long-term management effects. These changes affect soil fertility through various mechanisms that may also be affected by short-term management.

To quantify the N fixation in selected leguminous catch crops and/or to quantify the contribution of the catch crop to the supply of plant available N in the following crops.

Data on soil carbon as well as inputs in crop residues, manures etc. are available from long-term experiments (>14 years) in organic farming. The dataset also contains information on crop yield. In addition additional sampling of soil organic carbon and nitrogen can be undertaken to also categorise effects on different soil organic matter pools that may differently affect soil fertility. This may be related using statistical procedures to crop N supply and crop yield.

15. Non-target effects of herbicides: Influence of plant species and phenological stage

Main supervisor:

Per Kudsk, per.kudsk@agro.au.dk, +45 8715 8096

Physical location of project and students work:

Department of Agroecology, AU Flakkebjerg, 4200 Slagelse

Project start:

Any time but bioassays should preferably be carried out from April to September.

Short project description:

As part of the registration procedure of pesticides applicants are obliged to submit data on potential effects on non-target organisms. For herbicides effects on non-target plants in, e.g. field margins are the major concern. Existing protocols allow herbicide manufacturers to use crop species instead of wild plants and to apply herbicides to plants at juvenile growth stages. Recent studies have shown that the susceptibility of wild plants may differ from that of crop species and that plants at reproductive growth stages may be susceptible than plants at juvenile growth stages if seed production is chosen as an end point.

The objective of the thesis work is: 1) to compare the susceptibility of crop species and wild plants to a range of herbicides using the widely adapted standard method, 2) to compare the response of selected wild plants at different phenological stages to one or two herbicides and 3) to develop recommendation for a new test method for assessing effects of herbicides on non-target plants.

Additional information:

Facilities for conducting the experiments are available in Flakkebjerg.

Anyone interested in the topic is encourage to read the paper by Boutin et al. (2014) published in ENVIRONMENTAL POLLUTION Volume: 185 Pages: 295-306

16. Multicriteria impact assessment of agricultural biomass production for a sustainable bio-based economy and natural resource utilization

Main supervisor:

Tommy Dalgaard, tommy.dalgaard@agro.au.dk, +45 8715 7746

Physical location of the project and students work:

Department of Agroecology, AU-Foulum, 8830 Tjele

Project start:

Any time

Main subject area:

Sustainability and impact assessment, possibility for a focus on organic farming systems assessment

Short project description:

Development of a bio-based economy is a top priority for the future research and technology promotion in Europe, and a focus area for Aarhus University, where we have a series of research projects on sustainable development of agriculture as a provider of increased biomass harvest (food, feed, fibre and energy production), in combination with the provision of other services in the form of environmental and nature protection, mitigation of greenhouse gas emissions, rural development etc.

The exact project need to be defined in collaboration with the supervisor, but an important topic for the project will be the review and development of multi-criteria assessment methods for the evaluation of scenarios for the development of a more sustainable agriculture in Denmark. For example scenarios for conversion to organic farming systems, or increased biomass harvest to biorefineries in Denmark, including assessment of whole production chains (land-based Life Cycle Assessment techniques, cradle to cradle production etc.), and Geographical Information System based methods for the mapping and optimization of logistics and land-based resource use. The aim is to evaluate the potentials for transition to a knowledge based bioeconomy, and the special regional potentials for innovation and development within this area.

Additional information:

This study can be linked to the ongoing research projects on sustainable development of agriculture as a provider of increased biomass harvest (food, feed, fibre and energy production), in combination with the provision of other services in the form of environmental and nature protection, mitigation of greenhouse gas emissions, rural development etc. (see fx. www.BioValue.dk).

17. The importance of weeds growing in the rows of cereals

Main supervisor:

Bo Melander, bo.melander@agro.au.dk,

Physical location of project and students work:

Department of Agroecology, AU Flakkebjerg, DK 4200 Slagelse

Experimentation will be done under field conditions.

Project start:

Preferably from early spring.

Short project description:

Mechanical weed control continues to play a significant role in weed control programmes for organic cereals and might become important for conventional ones also in the near future. Inter-row cultivation for weed control in cereals grown at a slightly expanded inter-row spacing has become increasingly important in organic cereals. The method may also have relevance for conventional cereals since herbicide use is becoming more restricted in the future due to herbicide resistance and legislation.

Inter-row cultivation only controls weeds growing in the inter-row space while intra-row weeds, i.e. those growing in the crop line, are mostly unaffected. The question is how much interference this intra-row weed growth exerts on the crop. A thesis should study the impact of intra-row weeds on crop growth through field experimentation at Flakkebjerg. Small plots will be established to study these aspects in close collaboration with the staff at Flakkebjerg.

Additional information:

I suggest contacting the supervisor for further information and inspiration: bo.melander@agro.au.dk or mobile phone: +45 22 28 33 93

18. Allelopathy in Winter Cereals: Weed Suppressive Effect of Wheat, Triticale and Rye

Department and supervisor

Per Kudsk, per.kudsk@agro.au.dk, +4587158096
Antje Reiss, antje.reiss@agro.au.dk, +458715 8192
Department of Agroecology, Crop Health

Physical location of the project and students work

Flakkebjerg

Project start

Spring 2017

Main subject area

Weed science

Short project description

Plants can interact and communicate with each other, for example by exuding allelochemicals in the rhizosphere. This may include positive, as well as negative effects on neighbouring plants. The exploitation of phytotoxic effects of crops on weeds is gaining attention as part of an integrated weed management strategy.

The objective of the project is to evaluate the allelopathic effects of selected varieties of wheat, triticale and rye on problematic weed species in these 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*

19. Herbicide resistance: Comparing the response in whole plant bioassays and quick tests

Main supervisor:

Per Kudsk, per.kudsk@agro.au.dk, +45 8715 8096

Physical location of project and students work:

Department of Agroecology, AU Flakkebjerg, 4200 Slagelse

Project start:

Any time but bioassays should preferably be carried out from April to September

Short project description:

World-wide herbicide resistance is an increasing problem and the need for easy and cheap methods to detect resistance is pertinent. The most common test method is to harvest seeds of putative resistant plants, growing plants from the seeds and spraying the plants. This method is both labour-intensive and time consuming and will not produce results in the same season. A quick and accurate means of confirming herbicide resistance is necessary to take timely management decisions and for future resistance monitoring.

The objective of the thesis work is to compare a range of quick tests to the whole plant test for different herbicide modes of action, types of resistance and weed species to assess the potential for using quick tests in practice.

Additional information:

Facilities for conduction the experiments are available in Flakkebjerg.

Note: Other topics related to herbicide resistance can also be pursued. Please contact the main supervisor.

20. The use of NIR and MIR spectroscopy for evaluation of carbohydrates in biomass for bioenergy /biorefining

Main supervisor:

René Gislum, rg@agro.au.dk, 20542092

Physical location of project and students work:

Flexible

Project start:

Any time

Short project description:

An important quality parameter in biomass for bioenergy/biorefining is carbohydrates. The current project will elucidate the use of NIR and MIR in characterisation of different carbohydrates in on-going field experiments where the aim is to produce biomass for bioenergy/biorefining. Depending on the students interest the project can focus on e.g. specific carbohydrates for biofuel or the possibility of producing high quality carbohydrates from grass. There are several on-going projects in biomass production for bioenergy/biorefining at the institute and aim of this project is to cooperate with these projects in the search for new knowledge within carbohydrates.

21. Food and energy; challenging the boundaries for agricultural production in Denmark

Main supervisor

Tommy Dalgaard, tommy.dalgaard@agro.au.dk, 87157746

Nicholas Hutchings, nick.hutchings@agro.au.dk, 87157747

Physical location of the project

Dept of Agroecology, Research Centre Foulum

Project start

2016-2017

Extent and type of project

30 ECTS: Theoretical theses based on literature studies and/or analyses of issued data sets

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

Main subject area

National renewable energy and food production, nitrogen losses to the environment.

Additional information

The master project will be connected to the Strategic Research Council alliance (www.dnmark.org) which deals with a range of issues relating to flows of nitrogen at different scales in Denmark. The master project is in particular related to Research Component 1, which focuses on regional and national nitrogen flows, and research component 6 scenarios.

Useful reading

The inspiration for the DNMARK alliance was the European Nitrogen Assessment. The book accompanying this exercise can be read online at <http://www.nine-esf.org/ENA-Book>.

Short project description

The objective of this project would be to compare the current structure of agricultural production in Denmark with the situation that would be necessary to achieve one or more hypothetical, deliberately provocative, policy objectives. Any existing policies or regulations that get in the way of our objectives will be ignored. The student will have some influence in the policy objectives chosen but one at least will aim at achieving self-sufficiency in renewable energy production and thereafter maximising food production, in both cases without the import of plant products (e.g. biomass, animal feed). The project will assess the consequences of the resulting structure of agricultural production in terms of a range of indicators but especially those related to losses of N to the environment.

22. *Pythium* root diseases: Triangle interactions between the plant root, the associated microbiome and *Pythium* studied using next generation sequencing

Department and supervisor

Mogens Nicolaisen, Senior researcher, mn@agro.au.dk, 87158137

Physical location of the project and students work

Flakkebjerg, Slagelse. Transport will be covered.

Project start

Any time

Main subject area

Plant pathology

Short project description

Main idea of the proposal

Until now, plant pathogens have been studied, and regarded as an interaction between the host, the pathogen and the environment. This approach totally disregards the effect of the huge diversity of microorganisms that are present in the soil. It is our main hypothesis that the plant actively shapes its microbiome in order to prevent disease. We have developed next generation sequencing strategies that allow us to study, in particular, oomycete communities but also fungal, nematode and bacterial communities in the soil. These will form one of the basic approaches for studying the microbial communities.

Objectives

Specifically, we will study the plant *Arabidopsis* and its interactions with the plant pathogenic genus *Pythium* and the rhizosphere microbiome. We hypothesize that the development of *Pythium* root rot is dependent on an interaction of the plant root, its exudates, the *Pythium* species complex and the myriad of other organisms in the rhizosphere together with environmental factors.

Workplans:

The work has been divided into different workpackages. There are three 'players' that we will study individually and in interaction: 1) the root and its exudates 2) the microbiome and 3) *Pythium*.

WP0 Establishment of an *Arabidopsis* – *Pythium* – soil/rhizosphere microbiome system

We will analyse the *Arabidopsis* transcriptome in roots in response to *Pythium*. Despite the fact that plant roots are exposed to diverse microbial interactions, little is known on the root-pathogen interaction.

WP1 Defining the core microbiome in the *Arabidopsis* rhizosphere

Initially, we will define the *Arabidopsis* microbiome. We will grow *Arabidopsis* in different soil types and in soils with different capabilities of causing *Pythium* diseases. We will examine the rhizosphere microbiomes at seedling and at adult plant stage. We will use pyrosequencing and Illumina sequencing for analyzing species composition.

WP2 Screening of *Arabidopsis* mutants with an altered exudate/microbiome profile.

Do individual *Arabidopsis* exudate mutants affect the composition of the rhizosphere microbiome? We will use a range of *Arabidopsis* knock-out mutants that have altered rhizodeposition patterns in a screen of rhizosphere communities at the seedling and at the adult plant stage.

WP3a *Arabidopsis* root exudation profiles

The metabolite profile of *Arabidopsis* mutants (and the wild-type) that will be selected will be determined for different populations of *Pythium* in the soil.

WP3b *In vitro* effects and mechanisms of exudates

In this WP we will study the mechanism by which *Arabidopsis* metabolites shape the microbiome. We will do that using *in vitro* assays using individual metabolites and individual microorganisms, in particular *Pythium* to answer the following questions: do individual exudates affect individual *Pythium* species and do the individual species respond according to pathogenicity or e.g. biocontrol abilities?

WP4 Microbiome interactions

How does the rhizosphere microbiome affect development of *Pythium* root diseases? We hypothesize that the microbiome or individual members of the microbiome affects *Pythium* and disease severity of *Pythium*.

Extent and type of project

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

Additional information

The above mentioned project is too big even for a 60 ECTS project, it is the idea that the student can select one or two WPs from the description.

23. Predicting the risk of phosphorus loss from agricultural land

Main supervisors

Associate Professor Goswin Heckrath, Senior Scientist Charlotte Kjærgaard
Department of Agroecology
goswin.heckrath@agro.au.dk

Physical location of the project

Department of Agroecology, Research Centre Foulum

Project start

Anytime.

Extent and type of project

60 ECTS: Experimental theses in which the student is responsible for planning, trial design and collection and analysis of his/her own original data. Optionally, the project could be arranged corresponding to 45 ECTS.

Main subject area

Soil and Environmental Sciences, GIS.

Useful reading

Nelsen, N.O. and Shober, A.L. 2012 [Evaluation of Phosphorus Indices after Twenty Years of Science and Development](#) *J. Environmental Quality* 41:1703-1710.

Short project description

Background. Phosphorus (P) loss from agricultural land is a major cause of surface water eutrophication. Concerns for water quality have let regulators devise river basin management plans that require land manager to take action for limiting P transfer to waters. The risk of P loss is spatially very variable and typically highest where an effective transport process links a source of potentially mobile soil P with surface waters. The identification of such critical source areas (CSAs) is a prerequisite for the installment of targeted and effective mitigation options. This can in practice be achieved with the help of modelling tools that use generally available data in a spatially explicit context. The Danish P index is an example of such a user friendly tool that ranks fields according to their risk of P loss. A prototype version of this tool has been set up for the whole country; however, a rigorous evaluation is still lacking.

Aim. The aims of this MSc project are i) to conduct a case study and update the existing P index for an agricultural catchment in Denmark with the latest available data; ii) to compare P index predictions with observations of P loss in drainage and by surface runoff obtained in the catchment; iii) to illustrate and discuss the strength and weaknesses of P indexing in guiding mitigation plans.

Approach. The study area is part of the Norsminde catchment. An up-to-date spatial database will be established in collaboration with the Soils2Sea project <http://www.soils2sea.eu/> and supported by the local farmer association assuring access to relevant data. The existing P index will be modified to accommodate this data and critical source areas for P mapped. Field-scale data on soil erosion and P loss in drainage collected with state-of-the-art monitoring systems are used to evaluate the P index.

24. Plant organic N uptake in legume based cropping systems

Department and supervisor

Jim Rasmussen, researcher, jim.rasmussen@agro.au.dk, 87157418
Department of Agroecology

Physical location of the project and students work

Research centre Foulum

Project start

Any time

Main subject area

Soil N cycling, plant N availability, and plant N uptake.

Short project description

Nitrogen (N) is the nutrient that most often limits plant production, therefore continuous inputs of N is essential to sustain soil fertility. Legumes, e.g. white clover, add N to soils via biological N₂-fixation, which can substitute energy demanding mineral N fertilizers. Hence, increasing the use of legumes is a tool to improve the sustainability of the plant production via long term improvement of soil N fertility. However, greater reliance upon biological N₂-fixation induces an enhanced risk of environmentally harmful losses.

Nitrogen is in soil stored primarily in organic form and agricultural soils generally contain large organic N pools. Small molecular weight (M_w) organic N is a direct source of N for both microorganisms and plants, but for the soil organic N pool to become biological available it requires that bound organic N is mobilized into the soil solution and that large M_w organic N is depolymerized to small M_w organic N. Unfortunately there is a great lack in our understanding of how organic N is bound in soil and what processes controls the mobilization of organic N. If we are to improve the management of soil N then we need to fill this knowledge gap.

The project work can aim at investigating for example (i) the chemical nature of organic N derived from forage legumes, (ii) processes controlling the presence of organic N in the soil solution and thus the availability of N for plants, or (iii) the direct uptake of organic N by plants under different environmental or soil fertility conditions.

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

Please contact Jim Rasmussen for further information and additional reading.

25. Carbon cycling and greenhouse gas emissions in peat soils

Department and supervisor

Lars Elsgaard, associate professor, lars.elsgaard@agro.au.dk, 8715 7476

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele.

Project start

Project can start from spring 2017 or later

Main subject area

Carbon cycling and climate change

Short project description

Natural peatlands are efficient ecosystems in storing carbon and serve as a net sink of atmospheric CO₂. However, drainage and use of peatlands for agriculture and forestry may turn these natural ecosystems into net sources of CO₂ as the peat degradation is accelerated due to processes such as increased soil aeration and fertilization. In a new project we will study the effects of various cropping systems (such as potato, grass and barley) on C cycling and greenhouse gas emissions in peat soils. Different management strategies are adopted at the field site to reduce the emissions of GHG. The candidate will work in a research team using contemporary advanced chamber methods to study and document the emissions of GHG at the field site.

Extent and type of project

45 or 60 ECTS according to wishes of candidate

Additional information

Kandel T, Elsgaard L, Lærke PE, 2013. Measurement and modelling of CO₂ flux from a drained fen peatland cultivated with reed canary grass and spring barley. *Global Change Biology Bioenergy* 5: 548-561.

Contact supervisor for an informal further info.

26. Effect of biochar on soil microbiology and crop growth

Department and supervisor

Lars Elsgaard, associate professor, lars.elsgaard@agro.au.dk, 8715 7476

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele.

Project start

Project can start from spring 2017 or later

Main subject area

Experimental soil microbiology

Short project description

Biochar is the carbon-rich residue from energy-producing pyrolysis of biomass, such as straw and wood chips under anoxic conditions. Biochar can be used as soil additive, and recently it has been proposed to improve crop yields, reduce nutrient leaching and mitigate climate change. Much research is presently devoted to substantiating these claims. Presently we are testing the effects of biochar in the Danish soil agroecosystems. The candidate will be involved in the experimental part of the project that will cover aspects such as: biochar effects on soil microbial processes, biochar effects on plant nutrient use efficiency and interactions of biochar and soil contaminants. Depending on the interest of the candidate one or more of these themes will be developed in the MSc work. The work will be done in association with a research team including several ongoing PhD studies.

Extent and type of project

45 or 60 ECTS according to wishes of candidate

Additional information

Lehmann J, Rillig MC, Thies J, Masiello CA, Hockaday WC, Crowley D (2011) Biochar effects on soil biota – a review. *Soil Biol Biochem* 43:1812-1836

Contact supervisor for an informal further info.

27. Temperature effects on soil microbial ecology

Department and supervisor

Lars Elsgaard, associate professor, lars.elsgaard@agro.au.dk, 8715 7476

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele.

Project start

Project can start from spring 2017 or later

Main subject area

Soil microbiology and data analysis

Short project description

Temperature has a fundamental influence on biological and chemical reactions and therefore needs to be controlled or recorded in most biological studies. Special tools for incubation of samples in a gradient of stable temperatures have a long record of use for example in studies of seed germination and microbiology; at AU Foulum we have a custom-build facility for such studies (Elsgaard and Jørgensen, 2002). To analyse temperature effects in soil microbiology different models have been described and used according to non-linear regression techniques. Using the free statistical software R has facilitated such analyses of temperature effects. The current MSc project will develop a novel understanding of temperature effects based on non-linear regression models implemented in R. The candidate should have some background (or at least an interest to explore) biological data sets using R. Further an understanding or interest in statistical methods and soil microbial processes is an advantage.

Extent and type of project

30 or 45 ECTS according to wishes of candidate

Additional information

Elsgaard L, Jørgensen LW, 2002. A sandwich-designed temperature-gradient incubator for studies of microbial temperature responses. *Journal of Microbiological Methods* 49:19-29.

Contact supervisor for an informal further info.

28. Modeling scale-dependency of soil mechanical strength

Department and supervisor

Department of Agroecology

Main supervisor: Mathieu Lamandé, Mathieu.Lamande@agro.au.dk, +45 8715 7694

Co-supervisors: Per Schjønning

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele

Project start

Optional

Main subject area

Soil structure, soil mechanics, tensile strength, modeling, Distinct Element Model.

Short project description

Soil compaction is a serious problem in modern agriculture. State-of-the-art soil compaction models derive from foundation engineering and consider soils as continuous and homogeneous media. However, agricultural soils are structured at different scales. Modeling mechanical strength as a probability-distribution function will account for anisotropy and scale-dependency of soil physical properties.

In this project, we propose to quantify tensile strength as a probability-distribution function (e.g. Weibull, 1951) and to implement that function in a Distinct Element Model (DEM). Model simulations will be compared to measurements and visualization of stress-strain behavior of beads of soil aggregates under loading.

The main project objective is to implement an alternative model for predicting soil compaction ready for use in decision support tools created by the project consortium in other running projects.

Extent and type of project

30 ECTS: Theoretical thesis based on analysis of issued and edited data sets (3D images from X-ray CT scans, tensile strength measurements).

Additional information

Keller T., Lamandé M., 2010. Challenges in the development of analytical soil compaction models.

Soil Tillage Res. 111, 54-64.

Keller T., Lamandé M., Peth S., Berli M., Delenne J.-Y., Baumgarten W., Rabbel W., Radjai F., Rajchenbach J., Selvadurai A.P.S., Or D., 2013. An interdisciplinary approach towards improved understanding of soil deformation during compaction. Soil Tillage Research 128 61-80.

Munkholm, L.J., Schjønning, P., Kay, B.D. 2002. Tensile strength of soil cores in relation to aggregate strength, soil fragmentation and pore characteristics. *Soil Tillage Res.* 64, 125-135.

29. How soil water repellency affects water infiltration and storage in agricultural soils?

Main supervisor

Professor Lis Wollesen de Jonge, lis.w.de.jonge@agro.au.dk, 24940550

Co-supervisor

Postdoc Marcos Paradelo Pérez, marcos.paradelo@agro.au.dk

Physical location of the project and students work

Department of Agroecology, AU Foulum, Blichers Allé 20, 8830 Tjele

Project start

The optimal start is the spring or autumn where the soil surface is appropriate for soil sampling.

Main subject area

Soil water transport and storage, soil hydrophobicity, groundwater protection

Short project description

Water repellency (WR) of soils affects hydrological processes such as water infiltration, preferential flow, and surface erosion. In agricultural soils water storage would be reduced, pesticides and fertilizers faster transported to the groundwater and soil top layer partially lost. Soils may become water repellent at dry conditions due to the re-orientation of organic molecules coating soil particles, which results in a non-zero contact angle between water and soil. For extreme cases, contact angle larger than 90° , water droplets cannot infiltrate the soil. Infiltration rates and patterns can also be significantly affected by 'sub-critical' repellency, which occurs when the water–solid contact angle is non-zero, but less than 90° .

This project will study the infiltration patterns on water repellent soils collected from Danish agricultural fields. Irrigation experiments with water or ethanol, since ethanol is not affected by hydrophobic substances, will be performed varying initial soil water content and irrigation rates. This project will help to understand and improve water management in agricultural soils prone to WR.

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

Additional information

Müller, K., S. Carrick, E. Meenken, G. Clemens, D. Hunter, P. Rhodes, et al. 2016. Is subcritical water repellency an issue for efficient irrigation in arable soils? *Soil and Tillage Research* 161: 53-62.

De Jonge, L.W., O.H. Jacobsen and P. Moldrup. 1999. Soil water repellency: Effects of water content, temperature, and particle size. *Soil Sci Soc Am J* 63: 437-442.

Drop impact on water repellent soil <https://www.youtube.com/watch?v=20TkPq8Obss>

30. Testing predictive ability of vis-NIR spectroscopy for estimation of cation exchange capacity

Department and supervisor

Department of Agroecology, AU Foulum, 8830 Tjele

Mogens H. Greve, senior scientist (mogensh.greve@agro.au.dk)

Co-supervisors:

Lis Wollesen de Jonge, professor (lis.w.de.jonge@agro.au.dk)

Maria Knadel, postdoc (Maria.Knadel@agro.au.dk)

Emmanuel Arthur, postdoc (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, Clay mineralogy, Soil surface properties, Modeling

Short project description

Soil clay content ($< 2\mu\text{m}$) is strongly related to specific surface area (SSA) and cation exchange capacity (CEC). These two properties are important for processes such as contaminant adsorption, microbial attachment and nutrient dynamics in soils. Visible near infrared (vis-NIR) is a fast and non destructive analytical method that can be applied to soil soils. Application of spectroscopy for the analysis of the key soil properties is based on the fact that spectra hold information on soil fundamental composition – its organic and inorganic materials. Different clay minerals have unique response in the visible near-infrared (vis-NIR) spectral range. The influence of mineralogy on vis-NIR spectra is therefore a valuable feature for accurate predictions of clay content. Even though clay is a common parameter determined with vis-NIRS, the CEC are better defined and more directly related to particle size distribution and mineralogy than clay content. Therefore, better predictions of CEC with vis-NIR spectra are expected. The student will conduct vis-NIR measurements on a wide range of soil types and develop spectral models for clay and CEC to test this hypothesis.

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., Deng, F., Thomsen, A., Greve, M.H., 2012. Development of a Danish national Vis–NIR soil spectral library for soil organic carbon determination. *Digital Soil Assessments and Beyond: Proceedings of the 5th Global Workshop on Digital Soil Mapping 2012, Sydney, Australia (Vol. 403)*. CRC Press (July).
Arthur, E., et al., 2013. Soil specific surface area and non-singularity of soil-water retention at low saturations. *Soil Science Society of America Journal* 77(1), 43-53.

31. 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 or Postdoc Marcos Paradelo Pérez, marcos.paradelo@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. Sorption of contaminants in Greenlandic soils, 4. Water repellency of Greenlandic soils, 5. Effects of adding glacier flour to Greenlandic soils, 6. Perform 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 vegetation. 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 all these 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 in relation to particularly water and organic matter availability.

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, sorption capacity 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*

32. Electromagnetic soil mapping (DUALEM21s)

Department and supervisor

Mogens Humlekrog Greve, Head of Section, **Dept. of Agroecology**, Aarhus University, Blichers Allé 20, Postboks 50, DK-8830 Tjele. Tel.: +45 8715 7748, Mobile: +45 2072 6734, Email: MogensH.Greve@agro.au.dk

Physical location of the project and students work

Foulum / Århus

Project start

Any time

Main subject area

EM soil mapping is used by Precision Agriculture as a reliable option for zoning fields according to soil type. It is a fast and cost effective way of measuring soil moisture content, salt levels, and soil texture, ie clay content.

This technology can be used across all types of terrain. It is suitable for use on any ground and we have found good results across Denmark.

The DUALEM measures the apparent electrical conductivity of soil through the use of sensors. The electromagnetic sensors are applied across the soil surface by towing the sensor by quad bike, which is fitted with RTK GPS, around the field. It sits on a sledge and placed in a tube. Data is transmitted to a pc fitted to the front of the quad. The sensor is approximately 2m long.

It works through the use of a transmitting coil that induces a magnetic field that varies in strength according to soil depth. A receiving coil reads primary and secondary induced currents in the soil. It is the relationship between these primary and secondary currents that measures soil conductivity.

Short project description

Several research questions are available:

Using EMI techniques to establish homogenous mapping zones, guide soil sampling, graduate lime application and many more application

Using Emi techniques to reveal hidden traces of medieval/ Viking buildings/settlements

Using EMI sensor to compile detailed 3D soil map on field scale.

Extent and type of project

All three projects are available

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

(E.g. prerequisites, conditions, useful reading, etc.....)

33. Drone assisted Soil mapping

Department and supervisor

Mogens Humlekrog Greve, Head of Section, **Dept. of Agroecology**, Aarhus University, Blichers Allé 20, Postboks 50, DK-8830 Tjele. Tel.: +45 8715 7748, Mobile: +45 2072 6734, Email: MogensH.Greve@agro.au.dk

Physical location of the project and students work

Foulum / Århus

Project start

Any time

Main subject area

Drones can provide farmers with three types of detailed views. First, seeing the soil or a crop from the air can reveal patterns that expose everything from irrigation problems to soil variation and even pest and fungal infestations that aren't apparent at eye level.

Second, airborne cameras can take optical, thermal and multispectral images, which can be combined to create a view of the soil or the crop that highlights differences between healthy and distressed a way that can't be seen with the naked eye. Finally, a drone can survey the soil or a crop every week, every day, or even every hour. Combined to create a time-series animation, that imagery can show changes in soil moisture or the crop, revealing trouble spots or opportunities for better crop management.

Short project description

Several research questions are available:

Comparing and combining different sensors to revile which one or which combination is best for soil mapping.

Can thermal sensors be used to find groundwater springs in wetlands.

Combining drone images with DUALEM soil sensors for effective soil mapping

Extent and type of project

All three projects are available

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

(E.g. perquisites, conditions, useful reading, etc.....)

34. Geography of food

Main supervisor(s)

Chris Kjeldsen, Chris.Kjeldsen@agro.au.dk, 87157749

Martin Hvarregaard Thorsøe, post doc, Martinh.Thorsoe@agro.au.dk, 87157751

Physical location of the project

Department of Agroecology, AU Foulum

Project start

2017-2018

Extent and type of project

30 ECTS: Theoretical theses based on literature studies and/or analyses of issued data sets

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

Main subject area

Producer-consumer networks; food; culture; rural development; rural; urban; rural-urban continuum; agricultural development

Short project description

The objective of this project would be to explore dimensions of the geography of food. Subjects could include interactions between rural and urban areas (e.g. urban fringe dynamics or peri-urban dynamics), but also other aspects of the geography of food, including New Nordic Food, terroir, development trajectories in the food sector, the development of the organic sector in Denmark, Danish rural development, processes of modernization in the agricultural and food sector.

Additional information

The master project will be connected to current research projects such as the Danish Innovation Foundation project ProvenanceDK (see www.provenance.dk). The project will furthermore be informed by research carried out in PhD and postdoc projects embedded within the ProvenanceDK project at the Department of Agroecology.

Useful reading

Goodman, D., and M. K. Goodman. 2009. Alternative food networks. In *International Encyclopedia of Human Geography*, eds. R. Kitchin and N. Thrift, 208-220. Oxford: Elsevier

Kjeldsen, C., and B. A. Christensen. 2014. Steps towards an integrated eco-economy: The case of Randers, Denmark. *Spanish Journal of Rural Development* 5 (Special 1):19-34.

Kjeldsen, C., L. C. Deleuran, and E. Noe. 2013. The quality turn in the Danish food scape: new food chains emerging – new territorial impacts? *Acta Agriculturae Scandinavica, Section B - Soil & Plant Science* 63 (sup1):19-28.

Tregear, A. 2011. Progressing knowledge in alternative and local food networks: Critical reflections and a research agenda. *Journal of Rural Studies* 27 (4):419-430

Gatrell, J. D., N. Reid, and P. Ross. 2011. Local food systems, deserts, and maps: The spatial dynamics and policy implications of food geography. *Applied Geography* 31 (4):1195-1196.

Niles, D., and R. J. Roff. 2008. Shifting agrifood systems: the contemporary geography of food and agriculture: an introduction. *GeoJournal* 73 (1):1-10.

35. Mapping crop diversity in Danish agriculture

Main supervisor(s)

Chris Kjeldsen, Chris.Kjeldsen@agro.au.dk, 87157749

Physical location of the project

Department of Agroecology, AU Foulum

Project start

2017-2018

Extent and type of project

30 ECTS: Theoretical theses based on literature studies and/or analyses of issued data sets

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

Main subject area

Land use; cropping systems; agricultural development; GIS

Short project description

The objective of this project is to map the development of Danish cropping systems in the period 2000-2015. The project should focus on issues such as crop diversity and specialisation, in order to identify notable development trends in the spatial pattern of Danish cropping systems in recent years. The empirical base for the project will be data from the agricultural databases at Department of Agroecology. Analysis of data will be carried out using MS Access/SQL and ArcGIS.

Additional information

The master project will be connected to current research projects such as the Danish Innovation Foundation project ProvenanceDK (see www.provenance.dk). The project will furthermore be informed by research carried out in PhD and postdoc projects embedded within the ProvenanceDK project at the Department of Agroecology.

Useful reading

Levin, G., and B. Normander. 2008. Arealanvendelse i Danmark siden slutningen af 1800-tallet. Faglig rapport fra DMU nr. 682, 2008. Roskilde: Danmarks Miljøundersøgelser (DMU). Available from http://www2.dmu.dk/pub/fr682_final.pdf.

36. Crop suitability in Danish agriculture

Main supervisor(s)

Chris Kjeldsen, Chris.Kjeldsen@agro.au.dk, 87157749

Mogens Humlekrog Greve, MogensH.Greve@agro.au.dk, 87157748

Physical location of the project

Department of Agroecology, AU Foulum

Project start

2017-2018

Extent and type of project

30 ECTS: Theoretical theses based on literature studies and/or analyses of issued data sets

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

Main subject area

Agricultural geography; land use; crop suitability modelling; GIS; databases

Short project description

The objective of the project is (1) to carry out a review of research on crop suitability in temperate climates, (2) select an array of crops suitable for Danish conditions, and (3) synthesize the findings. The results of the project will be embedded within current work on modelling Danish terroirs, which are carried out as part of the Danish Innovation Foundation project ProvenanceDK (see below)

Additional information

The master project will be connected to current research projects such as the Danish Innovation Foundation project ProvenanceDK (see www.provenance.dk). The project will furthermore be informed by research carried out in PhD and postdoc projects embedded within the ProvenanceDK project at the Department of Agroecology.

Useful reading

Carré, F., and A. B. McBratney. 2005. Digital terrain mapping. *Geoderma* 128 (3-4):340-353.

Olsen, J. L., A. Olesen, H. Breuning-Madsen, and T. Balstrøm. 2011. A method to identify potential cold-climate vine growing sites – a case study from Røsnæs in Denmark. *Geografisk Tidsskrift-Danish Journal of Geography* 111 (1):73-84.

Townsend, C. G. 2011. Viticulture and the Role of Geomorphology: General Principles and Case Studies. *Geography Compass* 5 (10):750-766.

Vaudour, E., V. A. Carey, and J. M. Gilliot. 2010. Digital zoning of South African viticultural terroirs using bootstrapped decision trees on morphometric data and multitemporal SPOT images. *Remote Sensing of Environment* 114 (12):2940-2950.

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

Main supervisor

Chris Kjeldsen, Chris.Kjeldsen@agro.au.dk, 87157749

Tommy Dalgaard, Tommy.Dalgaard@agro.au.dk, 87157746

Physical location of the project

Department of Agroecology, AU Foulum

Project start

2016-2017

Extent and type of project

30 ECTS: Theoretical theses based on literature studies and/or analyses of issued data sets

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

Main subject area

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

Additional information

The master project will be connected to the Strategic Research Council alliance (www.dnmark.org) which deals with a range of issues relating to flows of nitrogen at different scales in Denmark. The master project is in particular related to Research Component 5, which focuses on aspects of stakeholder involvement and participation. The project will furthermore be informed by research carried out in various PhD projects at the Department of Agroecology, and research carried out within the European research alliance MACSUR.

Useful reading

The inspiration for the DNMARK alliance was the European Nitrogen Assessment. The book accompanying this exercise can be read online at <http://www.nine-esf.org/ENA-Book>.

Short project description

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

38. Relationship between volatile organic compounds and postharvest quality changes of leafy green vegetables

Main supervisor

Merete Edelenbos, Associate professor
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: merete.edelenbos@food.au.dk
Phone: 8715 8334
Homepage: <http://pure.au.dk/portal/en/merete.edelenbos@agrsci.dk>

Physical location of the project

Department of Food Science, AU-Aarslev, 5792 Årslev

Project start

Autumn 2017

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

Main subject area

Food quality, volatile organic compounds, microorganisms, postharvest

Additional information

Co-supervisor research assistant Alexandru Luca, phone: 8715 4879, e-mail: luca@food.au.dk

Short project description

Monitoring of volatile organic compounds (VOCs) released from plant material is a new analytical approach directed on better understanding the physiological and chemical processes that occur in fresh fruit and vegetables after harvest. The information obtained by analyzing VOCs during postharvest storage of leafy green vegetables will be used to develop a new tool for prediction of quality changes such as off-odor formation, senescence, spoilage and produce degradation. The proposed project is aimed to study the relationship between VOCs emitted by different leafy green vegetables (spinach, tatsoi, Swiss Chard...) and changes in their quality during postharvest storage.

Methodology:

- Determine VOC profiles of selected leafy green vegetables by GC-MS
- Monitor release of VOCs from fresh produce during storage
- Perform sensory expert evaluation and analysis of microorganisms

39. Effects of phytase on phosphorus digestibility in cereals

Main subject area

Agroecology
Animal nutrition and physiology

Department and Supervisor

Professor Hanne Damgaard Poulsen, Animal Science, hdp@anis.au.dk, +45 87 15 78 95

Project start

2016/2017

Physical location of project and students work

Animal Science, AU Foulum

Short project description

Phosphorus is first of all an essential nutrient to all living organisms, but at the same time, excess phosphorus may impose negative environmental impacts. Further, phosphorus is a limited global resource. Taken together, these aspects call for a more efficient and sustainable use of phosphorus in livestock production. One of the drawbacks is that the digestibility of phosphorus in cereals which is a main ingredient in e.g. pig feed. However, new tools like enzyme additions and feeding techniques have shown promising results.

The thesis project will include studies on how to improve the usability of phosphorus in cereals and will comprise literature review as well as experimental studies at lab scale or animal studies (depending on the running activities). Pigs will be the main target animal but the work will also be relevant to other species. The thesis work will be connected to running activities.

Additional information

40. Comparison of data from two meteorological stations

Finn Plauborg

Accurate meteorological are important for evaluating effects of weather on agricultural production and interactions to the aquatic environment. A new meteorological station has been launched close to Research Centre Foulum and there is a need for comparison of the measured weather elements between this new site (Havris) and the Foulum met station including some statistical analysis of the data. Further, some important formula for calculating evapotranspiration should be set up and tested and some modelling of water and nitrogen balance at the Havris site should be addressed

41. Vintage vegetable seed production

Department and supervisor

Birte Boelt, Birte.Boelt@agro.au.dk

Physical location of the project and students work

Flakkebjerg and Aarhus

Project start

2016/2017 - anytime

Main subject area

Seed quality, vegetable seed, NordGen seed material, organic seed production

Short project description

In Denmark interest in preserving and utilizing vintage plant material (e.g. old varieties and landraces) is growing and projects focusing on for example agronomic robustness, health and history has been initiated in recent years. Along with these projects there has been a resurgence of interest in making the vintage plant material available for both organic and conventional production in both hobbymarkets and at larger scale for commercial sale. This plant material might not fullfill the requirements in the variety testing system in the EU.

The proposed project aims to make a model for commercial growth of interesting varieties with special characteristics discovery to final production. The project consists of three steps: 1) the process of approval and introduction onto the common Catalogue; 2) demonstration of quality seed multiplication at experienced seed growers sites; 3) securing seed quality for organic producers of cultivars with distinct characteristics.

The proposed project is of particular interest to organic production as the reintroduction of vintage plant material bypasses the refinement of modern varieties (hybrids) that have moved towards a high-input/high-output strategy.

The student can be involved in either one or all steps of the project depending on interests.

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

<http://dca.au.dk/aktuelt/nyheder/vis/artikel/gamle-sorter-af-kaal-og-roedbeder-skal-dyrkes-igen-1/>

42. 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

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.

43. 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

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 CO₂ 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.

44. 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, Årsløv

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 is 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.

45. 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, Årsløv

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 scientific 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.

46. 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

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.

47. 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

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.

48. Designing future lighting systems for propagation and breeding of potato plants.

Department and supervisors

Katrine Heinsvig Kjær, Katrine.kjaer@food.au.dk, + 45 8715 8337, + 45 3029 6592
Department of Food Science, Faculty of Science and Technology, Aarhus University
Hanne Grethe Kirk, hgk@lkfvandel.dk, + 45 4025 2511
LKF Vandel, Grindsted 55, 7184 Vandel

Physical location of the project and students work

Department of Food Science, AU, 5792 Aarslev/ LKF Vandel, 7184 Vandel

Project start

Autumn 2017

Main subject area

Plant physiology, Collaboration with Industry

Short project description

Breeding new potato varieties at LKF Vandel involves controlled crossing of old varieties with specific characters such as high yield, disease resistance or tuber quality. Offspring plants from seeds or from small *in vitro* grown plantlets are propagated under greenhouse conditions in autumn, and evaluated for their ability to grow and set tubers. Further evaluation of disease resistance and tuber quality takes place in the field during the following season. Here, tubers from the best plants are selected, and used for seed production in the coming spring season. The breeding process at LKF Vandel partly takes place in a greenhouse with supplemental lighting from greenhouse lamps. However, the quality of the light from these lamps is not always optimal for the plants. With the new technology of light emitting diodes (LED's) it has become possible to design specific light environments in order to modulate specific characters such as improved tuber formation, compact growth, flowering and seed set, and this may improve the breeding process of potatoes.

Depending on the project set up, you get the chance to focus on:

Light quality effects on *in vitro* grown plants (slow versus fast growth)

Light quality effects on small offspring plants from *in vitro* or from seeds (compact growth and improvement of tuber formation)

Light quality effects on flowering plants in spring (improvement of flowers and number of berries)

You will learn basic principles of setting up plant experiments in controlled environments using the newest technology of LED lighting. You will learn how to analyse plant physiology, and you will experience the working process in a breeding company.

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*

49. Temporal mineralization of manure nitrogen and effects on plant N uptake and N leaching in years after manure application

Department and supervisor

Dept. of Agroecology

Peter Sørensen, Senior scientist, ps@agro.au.dk, +45 25125632

Physical location of the project and students work

Foulum/Aarhus

Project start

Any time

Main subject area

Nutrient cycling and environmental effects of agricultural management.

Short project description

A significant part of nitrogen (N) in animal manure is bound in organic form and not immediately available for plant uptake. The mineralization of N in manure takes place over many years and it is impossible to measure the long-term N release pattern directly. The temporal mineralization pattern determines both when N is available for crops and when it can potentially be leached. This is important knowledge, e.g. for the description of the effects of organic manures on N leaching.

In the suggested study a literature review should be made about manure N mineralization. This might also be used as basis for describing an improved model of the temporal mineralization of manure N in soil depending on e.g. manure type, climatic conditions and soil type.

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 basic knowledge of C and N cycling, and microbiology.

Litterature:

- Sørensen P. & Jensen L.S. 2013. Nutrient leaching and runoff from land application of animal manure and measures for reduction. In: Sommer, S.G., Christensen, M.L., Schmidt, T. and Jensen L.S. (Eds.). *Animal Manure Recycling: Treatment and Management*, First Edition. John Wiley and Sons, Ltd. P. 195-210.
- Webb, J., Sørensen, P., Velthof, G., Amon, B., Pinto, M., Rodhe, L., Salomon, E., Hutchings, N., Burczyk, P., Reid, J. 2013. An Assessment of the Variation of Manure Nitrogen Efficiency throughout Europe and an Appraisal of Means to Increase Manure-N Efficiency. In: Donald, S. (Ed.), *Advances in Agronomy* 119, 371-442.

50. Dynamics of soil physical quality in modern agriculture

Department and supervisor

Department of Agroecology

Main supervisor: Mathieu Lamandé, Mathieu.Lamande@agro.au.dk, +45 8715 7694

Co-supervisors: Per Schjønning

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele

Project start

Optional

Main subject area

Soil structure, soil mechanics, tensile strength, modeling, Distinct Element Model.

Short project description

Soil structure is the spatial organisation of the mineral and organic components of soil. It conditions physical properties and functions. Soil structure is dynamic due to changes in temperature, water content, biological activity, and to soil use (i.e. traffic, tillage, animal trampling). Soil structure influences a range of processes: root growth and the ability to utilize nutrients and water, activity of soil fauna, gas exchange between the soil and the atmosphere, water infiltration and solutes transport, thermal properties, land stability and bearing capacity. A good understanding of soil structure dynamics is crucial to maintain proper soil physical quality in all kinds of environment. Soil structure dynamics results from complex interactions of a range of intrinsic and extrinsic factors. Its understanding needs well defined controlled experiments in the lab based on adequate observations in the field and mathematical models.

In this project, we propose to assess changes in soil structure as influenced by different agricultural managements through morphological descriptors and physical measurements (transport of water, porosity). A conceptual model will be established from observations and measurements.

Extent and type of project

30 ECTS: Theoretical thesis based on analysis of issued and edited data sets (2D images, hydraulic conductivity measurements, bulk density and porosity measurements)

or

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

Lamandé M., Hallaire V., Curmi P., Pérès G., Cluzeau D., 2003. Changes of pore morphology, infiltration and earthworm community in a loamy soil under different agricultural managements. *Catena* 54 (3), 637-649.

Keller T., Lamandé M., Peth S., Berli M., Delenne J.-Y., Baumgarten W., Rabbel W., Radjai F., Rajchenbach J., Selvadurai A.P.S., Or D., 2013. An interdisciplinary approach towards improved understanding of soil deformation during compaction. *Soil Tillage Research* 128 61-80.

Munkholm, L.J., Schjønning, P., Kay, B.D. 2002. Tensile strength of soil cores in relation to aggregate strength, soil fragmentation and pore characteristics. *Soil Tillage Res.* 64, 125-135.

51. Modeling scale-dependency of soil mechanical strength

Department and supervisor

Department of Agroecology

Main supervisor: Mathieu Lamandé, Mathieu.Lamande@agro.au.dk, +45 8715 7694

Co-supervisors: Per Schjønning

Physical location of the project and students work

Department of Agroecology, AU Foulum, 8830 Tjele

Project start

Optional

Main subject area

Soil structure, soil mechanics, tensile strength, modeling, Distinct Element Model.

Short project description

Soil compaction is a serious problem in modern agriculture. State-of-the-art soil compaction models derive from foundation engineering and consider soils as continuous and homogeneous media. However, agricultural soils are structured at different scales. Modeling mechanical strength as a probability-distribution function will account for anisotropy and scale-dependency of soil physical properties.

In this project, we propose to quantify tensile strength as a probability-distribution function (e.g. Weibull, 1951) and to implement that function in a Distinct Element Model (DEM). Model simulations will be compared to measurements and visualization of stress-strain behavior of beads of soil aggregates under loading.

The main project objective is to implement an alternative model for predicting soil compaction ready for use in decision support tools created by the project consortium in other running projects.

Extent and type of project

30 ECTS: Theoretical thesis based on analysis of issued and edited data sets (3D images from X-ray CT scans, tensile strength measurements).

Additional information

Keller T., Lamandé M., 2010. Challenges in the development of analytical soil compaction models.

Soil Tillage Res. 111, 54-64.

Keller T., Lamandé M., Peth S., Berli M., Delenne J.-Y., Baumgarten W., Rabbel W., Radjaï F., Rajchenbach J., Selvadurai A.P.S., Or D., 2013. An interdisciplinary approach towards improved understanding of soil deformation during compaction. Soil Tillage Research 128 61-80.

Munkholm, L.J., Schjønning, P., Kay, B.D. 2002. Tensile strength of soil cores in relation to aggregate strength, soil fragmentation and pore characteristics. *Soil Tillage Res.* 64, 125-135.

52. Controlled drainage as a mitigation option for nutrient reductions

Main supervisors

Christen Duus Børgesen
Dep of Agroecology

Physical location of the project

Near the town of Odder ca. 20 km south of Aarhus and in North Jutland near Åbybro (Birkelse)

Project start

August 2017

Extent and type of project

MSc projects each at 30, 45 or 60 ECTS: Modelling and analysis of measurements.

Main subject area

The aim of the project is to test if controlled drainage is a possible new mitigation measure on tile drained fields for reducing nutrient emissions to groundwater and surface waters. Data on crop growth, yields, soil water dynamics, water balances has been monitored and can be part of the analysis.

Additional information

MSc projects is linked to a recent GUDP research project where 4
7 tile drained sub-fields on three larger field, grown with both winter wheat and spring crops have been instrumented and monitored for water, nitrogen and phosphorus during the winter of 2012/2013, 2013/14 and 2014/15.

Useful reading

- Drury, C.F., Tan, C.S., Reynolds, W.D., Welacky, T.W., Oloya, T.O., Gaynor, J.D. (2009) Managing Tile Drainage, Subirrigation, and Nitrogen Fertilization to Enhance Crop Yields and Reduce Nitrate Loss. *J. Environ. Qual.* 38, 1193–1204.
- Gilliam, J. W., Skaggs, R. W., Weed, S. B. (1979) Drainage control to diminish nitrate loss from agricultural fields. *J. Environ. Qual.* 8, 137-142.
- Wesström, I., Messing, I. (2007). Effects of controlled drainage on N and P losses and N dynamics in a loamy sand with spring crops. *Agric. Water Man.* 87, 229-240.
- Wesström, I., Messing, I., Linnér, H., Lindström, J. (2001). Controlled drainage – effects on drain outflow and water quality. *Agric. Water Man.* 47, 85-100.
- Williams M.R., King K.W. Fausey N.R. (2015). Drainage water management effects on tile discharge and water quality. *Agricultural Water Management* 148, 43-51.
- Woli, K.P., David, M.B., Cooke, R.A., McIsaac, G.F., Mitchell, C.A. (2010). Nitrogen balance in and export from agricultural fields associated with controlled drainage systems and denitrifying bioreactors. *Ecological Engineering* 36, 1558–1566.

53. Temperature model for germination of weed and/or crop species

Department and supervisor

Peter Kryger Jensen, Senior Scientist, Dep. Agroecology, PKJ@agro.au.dk. Tlf: 8715 8195

Johannes Ravn Jørgensen, Associate Professor, Dep. Agroecology, jrj@agro.au.dk. Tlf.: 8715 8314

Physical location of the project and students work

Experimental work at AU Flakkebjerg

Project start

Any time, experimental work can also be conducted at any time.

Main subject area

Weed/crop/seed biology

Short project description

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.

54. Weed suppression abilities of variety mixtures in organic spring barley and oat

Department and supervisor

Department of Agroecology, section of Crop Health, Bo Melander, bo.melander@agro.au.dk , 87158198 and Mette Sønderkov, mette.sonderskov@agro.au.dk, 87158231

Physical location of the project and students work

Department of Agroecology, AU Flakkebjerg, forsøgsvej 1, 4200 Slagelse

Project start

Preferably with start in spring, but autumn start is also possible

Main subject area

Crop protection, organic production, barley and oat variety selection and mixing, weed suppression

Short project description

The master project will be linked to an ongoing project (<http://coreorganicplus.org/research-projects/prodiva/>), where a range of barley and oat varieties are tested in different variety mixtures. The benefits of mixing varieties can be better suppression of weeds and better resistance against diseases and pests. Better knowledge of the effects of variety mixtures is one aspect of improving organic production. The knowledge achieved can be used in non-organic crop production as well as part of an IPM program. The main focus of the project is weed management but additional assessments on diseases and pests can be considered and would then require supplementary supervision from other expertise which can be organised.

Field experiments were conducted in 2016 and will be repeated in 2017 at Flakkebjerg and two locations in Poland and Latvia. Several two-variety mixtures are tested. The individual mixtures are based on a rationale of complementary properties of the varieties. The student will be able use the Danish field experiment for measurements and registrations to investigate the weed suppressive ability of the mixtures. Analyses of the crop growth pattern will aid the understanding.

It is important to know the specific properties of the individual varieties to understand the possible synergies of variety mixtures, e.g. leaf area, leaf shape, root growth pattern. Some of the properties can be measured in field experiments, while others are more suitable for semifield or green house experimentation. Depending on the timing of the project these types of experiments are possible; field experiments require start in spring.

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 you envision. Link to project webpage

55. Reducing pesticide leaching potential by optimizing soil tillage

Main supervisor

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone 8715 7727

Physical location of the project

Department of AgroEcology, Research Centre Foulum

Project start

Spring/summer 2017

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

Soil surface properties, water infiltration, soil tillage, soil wet stability.

Additional information

The project will be linked to the Future Cropping project (www.futurecropping.dk) – work package on Intelligent tillage and crop establishment. There will be close collaboration with Carsten Petersen at University of Copenhagen who is leading the work on modelling pesticide leaching potential and with Agro Intelligence, who are developing technology for site-specific tillage.

Useful reading

- Abdollahi, L., Munkholm, L.J. 2014. The Effect of Different Tillage Systems and Cover Crops on Soil Quality, Part I: Chemical, Mechanical, and Biological Properties. *Soil Science Society of America Journal*, 78,262-270.
- Abdollahi, L., Munkholm, L.J., Garbout, A. 2014. The Effect of Different Tillage Systems and Cover Crops on Soil Quality, Part II: Pore Characteristics. *Soil Science Society of America Journal*, 78, 271-279.
- Munkholm, L.J., Schjønning, P., 2004. Structural vulnerability of a sandy loam exposed to intensive tillage and traffic in wet conditions. *Soil & Tillage Research* 79, 79-85.
- Petersen, C.T., Hansen, S., Jensen, H. E. (1997): Tillage-induced horizontal periodicity of preferential flow in the root zone. *Soil Sci. Soc. Am. J.* 61:586-594.
- Petersen, C.T., Jensen, H. E., Hansen, S., Koch, C.B. (2001): Susceptibility of a sandy loam soil to preferential flow as affected by tillage. *Soil Tillage Res.*58: 81-89.
- Petersen, C.T., Hansen, S., Jensen, H. E., Holm, J., Koch, C.B. (2004): Movement of suspended matter and a bromide tracer to field drains in tilled and untilled soil. *Soil Use Manag.* 20: 271-280.
- Petersen, C.T., Nielsen, M.H., Rasmussen, S.B., Hansen, S., Abrahamsen, P., Styczen, M., Koch, C.B. 2016. Jordbearbejdningens indflydelse på pesticidudvaskning til markdræn. Bekæmpelsesmiddelforskning nr. 167. Miljøstyrelsen, København, 158p.

Short project description

Soil tillage strongly affects the surface properties of importance for mobilization and transport of pesticides. The aim of the project is to quantify spatial variation in soil surface properties induced by soil tillage. The surface properties will be quantified for different tillage intensities and followed over time. Measurements will be carried out in the field and samples will be taken for more detailed analysis in the laboratory. The results will be used to predicting pesticide leaching potential for different weather scenarios using the Daisy model.

56. Optimized prediction of field readiness

Main supervisor

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone 8715 7727

Physical location of the project

Department of AgroEcology, Research Centre Foulum

Project start

Autumn 2017

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

Soil workability, optimization of soil quality and resource use in arable farming.

Additional information

The project will be linked to the Future Cropping project (www.futurecropping.dk) – work package on Intelligent tillage and crop establishment. There will be close collaboration with PhD. student Peter Bilson Obour who is working on soil workability and with Agro Intelligence, who are developing technology (tillage and decisions support tools) for site-specific tillage.

Useful reading

- Edwards, G., Dybro, N., Munkholm, L.J., Sørensen, C.G. 2016. Assessing the actions of the farm managers to execute field operations at opportune times, *Biosystems Engineering* 44, 38-51.
- Edwards, G., White, D.R., Munkholm, L.J., Sørensen, C.G., Lamandé, M. 2016. Modelling the readiness of soil for different methods of tillage. *Soil and Tillage Research*, 155, 339-350.
- Munkholm, L.J., Schjønning, P., 2004. Structural vulnerability of a sandy loam exposed to intensive tillage and traffic in wet conditions. *Soil & Tillage Research* 79, 79-85.
- Obour, P.B., Lamandé, M., Edwards, G., Sørensen, C.G., Munkholm, L.J. Predicting soil workability and fragmentation in tillage: a review. *Soil Use and Management* (In Press).

Short project description

Soil workability and friability are of vital importance when creating suitable seedbeds for crop establishment and growth. Knowledge of soil workability is important for scheduling tillage operations and for reducing the risk of tillage-induced structural degradation of soils. A field experiment is planned for autumn 2017 where tillage will be carried out at different water contents and thus at different soil workability states. Soil structure will be assessed immediately before and after tillage and followed during the autumn and winter. Results will be utilized to improve a field readiness decision support tool.

57. Changes og soil hydraulic properties under bio-subsoiling crops

Department and supervisor

Department of AgroEcology

Lars J. Munkholm, lars.munkholm@agro.au.dk, phone 8715 7727

Co-supervisor: Mansonia Pulido-Moncada (Post-doc)

Physical location of the project and students work

Department of AgroEcology, Research Centre Foulum and Research Centre Flakkebjerg

Project start

September 2017

Main subject area

Hydraulic conductivity, Cover crop, Biological tillage

Short project description

Cover crops are mainly used to reduce soil erosion problems as well as nitrate leaching. Additionally, the potential soil structure improvement by cover crop roots has been evaluated for few soils and species. Knowledge on cover crops (considered as ‘bio-tillering’ or ‘bio-subsoilers’) effects on soil structure related properties such as infiltration and soil hydraulic conductivity, is still needed. Therefore, studies on a wide range of species that differ in root system are of high value. The project aims to evaluate the effect of eight different potential bio-subsoiler crops on the soil hydraulic parameters of a severely compacted soil. Soil hydraulic measurements will be conducted in the screening trial at Research Centre Flakkebjerg at two depths. Disturbed and undisturbed samples will be taken near the measurement location to obtain the initial and final water content, and pore characteristics, total porosity and bulk density, respectively.

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*

Additional information

The project will be linked to the COMMIT project (Soil compaction mitigation for productivity and sustainability). Experiments will be conducted using a screening trial at Research Centre Flakkebjerg. The activities will be linked to ongoing project, which focus on soil compaction and effect of cover crops as a means to mitigate soil compaction.

Useful reading

Bodner, G., Leitner, D., Kaul, H. P. 2014. Coarse and fine root plants affect pore size distributions differently. *Plant and soil*, 380(1-2), 133-151.

Guaman, V., Báth, B., Hagman, J., Gunnarsson, A., Persson, P. 2016. Short time effects of biological and inter-row subsoiling on yield of potatoes grown on a loamy sand, and on soil penetration resistance, root growth and nitrogen uptake. *European Journal of Agronomy*, 80, 55-65.

Hu, W., Shao, M., Wang, Q., Fan, J., Horton, R. 2009. Temporal changes of soil hydraulic properties under different land uses. *Geoderma*, 149(3), 355-366.

58. Biological control of pests in white clover seed production

Department and supervisor - Dept. Agroecology. Henrik Bak Topbjerg, topbjerg@agro.au.dk 87158253(supervisor), Birte Boelt, Birte.Boelt@agro.au.dk, 8715 8276 (co-supervisor), Henrik Skovgaard, henrik.skovgaard@agro.au.dk, 87158115 (co-supervisor).

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

Project start - Suggested topics differ in start periods, see within each topic. The work is to be conducted in the 2016 or 2017 growing season.

Main subject area

In a current project, the possibility of using biological control for the Clover Head Weevil (*Hypera meles*) is being tested. It is estimated that *Hypera* weevils cause yield losses of around 15 percent in white clover seed production (Hansen and Boelt, 2008). A native parasitic wasp could aid in decreasing the damage caused by *H. meles*. The parasitic wasp *Bathyplectes curculionis* parasitises the larvae of *H. meles* and cocoons of this wasp are found in vast numbers in the residues from the white clover seed cleaning process. The project will answer if it is possible to utilize effectively the parasitic wasp in next year's white clover seed fields as a control organism. However to do this successfully, knowledge is needed on a variety of topics. Findings will be directly beneficial for both growers and the industry.

Within the suggested topics, work can be conducted on different scales ranging from commercially grown white clover fields over cage experiments to investigations in the laboratory or a literature study. A project can hold one or be compiled to hold a number of the following project ideas.

Short descriptions of project ideas

- *How is the cocoons influenced by the seed harvest?*
- *How is the oviposition of *B. curculionis* synchronised with the biology of *H. meles*?*
- *Is the vitality of the cocoons connected to cocoon size?*
- *Which species of hyperparasites can be found in the cocoons and are the species problematic for the use of *B. curculionis* as a biological control agent?*
- *Where do the parasitic wasp and the Clover Head Weevil overwinter?*
- *Dose the use of insecticides influence *B. curculionis*?*
- *Is the Clover Head Weevil resistant or tolerant towards insecticides containing active compounds belonging to the pyrethroids?*
- *Can the parasitic wasps cocoons be stored for a longer period and how can the life span of the emerging imago's be prolonged?*

Extent and type of project - 30, 45 and 60 ECTS.

For 30 ECTS – Data is to be collected in the growing season 2016.

Useful reading

- Hama, N.N. and Davis, D.W., 1983. Lethal effects of high temperatures on nondiapausing pupae of *Bathyplectes curculionis* [Hym.: Ichneumonidae]. *Entomophaga*, 28(3): 295-302.
- Hansen, L.M. and Boelt, B., 2008. Thresholds of economic damage by clover seed weevil (*Apion fulvipes* Geoff.) and lesser clover leaf weevil (*Hypera nigrirostris* Fab.) on white clover (*Trifolium repens* L.) seed crops. *Grass and Forage Science*, 63(4): 433-437.
- Parrish, D.S. and Davis, D.W., 1978. Inhibition of diapause in *Bathyplectes curculionis*, a parasite of the alfalfa weevil. *Annals of the Entomological Society of America*, 71(1): 103-107.

59. Learning how to create defect potatoes in a controlled manner

Department and supervisor

Anders Kjær, Researcher Anders.kjaer@food.au.dk 27522674

Physical location of the project and students work

Department of Food Science, Årslev, Fyn

Project start

Can be decided individually

Main subject areas

Potatoes, plant growth, plant physiology, plant nutrition, microscopy, biochemistry, experimentation

Short project description

Invisible internal defects in potatoes is a big problem for the world-wide potato industry, especially for the french fry (pommes frites) production. The company Newtec A/S produces potato sorting machines, but in order to “train” the machines to recognize the defects, they need sets of potatoes with known internal defects. A 3-year project at AU-Årslev will develop methods to provoke especially the defect Hollow Heart. Literature is full of suggestions on how to prevent the defect, both early and late in the growth development of the potatoes, but only little is known about provoking the defect. The project will be a detective work, where combinations of many different influencing factors will be tested, first in greenhouses, and since in the field. The project will have continuous experiments running and we can tailor-make a detective project which suits your interests.

Extent and type of project

30 ECTS - 60 ECTS

Additional information

Rex BL, Mazza G. 1989. Cause, control and detection of hollow hearts in potatoes: A review. American potato journal (66) 165-183.

60. Honey bee disease defence: The influence of bioactive plant compounds from pollen and nectar.

Department and supervisor

Department of Agroecology, Research Centre Flakkebjerg, Aarhus University, 4200 Slagelse
Senior Scientist Per Kryger, e-mail: per.kryger@agro.au.dk, phone: 87158219
Postdoc Nanna Hjort Vidkjær, e-mail: nanna.vidkjaer@agro.au.dk, phone: 87158213.

Physical location of the project and students work

Department of Agroecology, Flakkebjerg, 4200 Slagelse.

Project start

Can be decided individually, but preferably the project should be initiated in spring or summer.

Main subject area and short project description

Worldwide commercial and wild bee populations are declining causing major concern because bees are important pollinators of many food crops. Without bees, the production of many fruits and vegetables would fall below current consumption levels. No single factor responsible for the declining bee populations has been identified and the causes are most probably a combination of several factors ranging from pesticide exposure, pathogens e.g. viruses, to changes in floral resources. This project addresses the influence of bioactive plant chemical compounds present in the bees' pollen and nectar diet on the disease resistance of honey bees. Bioactive compounds from plants have for centuries been widely used in human medicine and the main hypothesis of this ongoing research project (Arming honey bees with nature's pharmacy) is that these compounds also have a positive effect on the disease resistance of honey bees.

The master project work will aim at investigating how pollen and nectar from different plants as well as individual plant compounds influence the detoxification and immune systems of honey bees and how this impact is related to the bees susceptibility towards virus diseases. The project work will involve using quantitative PCR to study gene expression related to detoxification and immune functions as well as quantifying virus titers in the bees. The student will be involved in field/greenhouse experiments with the bees, learn practical laboratory work by generating samples for the analysis, advanced data analysis with appropriate statistical methods, and presentation of the result in the form of a research publication.

Extent and type of project

60 ECTS.

Additional information

We strongly encourage interested students to contact the supervisors for further information and discussion of master projects within this area.

Note: Additional topics related to honey bee diseases as well as the role of dietary plant compounds in the bees disease defence can be offered for interested students, please contact the supervisors.

61. Ecological Modelling

Department and supervisor

Senior Scientist Niels Holst
Department of Agroecology, AU Flakkebjerg
niels.holst@agro.au.dk – 22 28 33 40

Physical location of the project and students work

Flexible. A purely theoretical project can be conducted from anywhere.

Project start

Any time.

Main subject area

Ecosystem management, integrated pest management, population dynamics, simulation modelling, computer science.

Short project description

Ecological systems tend to be difficult to manage, even difficult to reason about, but then we use models – mental models to arrange our thoughts, mathematical models to obtain precision in rationale and communication, computational models for inquiry and planning. In the Ecological Modelling Lab led by Niels Holst, we develop models for all these purposes. We are an international group (Fig. 1) meeting online in seminars and courses.

You are free to define your own modelling project, or you can participate in an on-going modelling project, in which you will develop your own sub-model. Your project will involve coding in R and C++, basic statistics and basic math. Let me stress: really basic math. Your project may be based on your own empirical data, on data from other projects, or on publicly available data.

Extent and type of project

Your project can be accustomed to 30, 45 or 60 ECTS.

Additional information

Home page of the Ecological Modelling Lab: www.ecolmod.org.



Fig 1. Modellers. Easily recognizable by their cool hats.

62. 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

Autumn 2017

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 where 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 pathogen's 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 trial.

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.

63. Genetic diversity in *Puccinia graminis* causing stem rust disease in cereals and grasses

Department and supervisors

Prof. Mogens Støvring Hovmøller, mogens.hovmoller@agro.au.dk, +4522283361

Annemarie Fejer Justesen, senior researcher, annemariefejer.justesen@agro.au.dk, +4587158135

Mehran Patpour, post.doc, Mehran.patpour@agro.au.dk

Physical location of the project and student work

Department of Agroecology, Forsøgsvej 1, 4200 Slagelse

Project start

Any time

Main subject area

Plant pathology, population genetics

Short project description

Stem rust in cereals and grasses is caused by the biotrophic fungus *Puccinia graminis* which spreads by airborne spores over long distances. The disease is considered a warm weather disease and can cause severe epidemics at a large geographical scale. The strain Ug99 attacking wheat was detected in East Africa in 1998 and has since been of great concern due to its ability to overcome resistance which had been effective for many years. In Europe stem rust has not been considered a problem since the 1950s but recent epidemics of stem rust caused by another aggressive strain in Sicily has drawn the attention to the potential threat to European wheat production (<http://www.nature.com/news/deadly-new-wheat-disease-threatens-europe-s-crops-1.21424>). Little is known about the origin and spread of new strains of *P. graminis* emerging in Europe. The aim of the project will be to study the genotypic diversity of *P. graminis* isolates using molecular markers such as Simple Sequence Repeat (SSR) markers. The thesis work will include multiplication of isolates in the greenhouse, DNA extraction, PCR, scoring and analysis of molecular data. Genotypes of European isolates will be compared to isolates sampled outside Europe to study the genetic relationship of European strains and strains occurring in other parts of the world. The genotypic data will be combined with virulence phenotyping data which is already available at the Global Rust Reference Center (GRRC). The MSc project will be linked with the ongoing project "Delivering Genetic Gain in Wheat" (<http://www.globalrust.org/page/delivering-genetic-gain-wheat>) funded by the Melinda and Bill Gates Foundation.

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 where the student is responsible for planning, trial design and collection of his/her own original data.

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

Main supervisor

Professor Mogens S. Hovmøller, mogens.hovmoller@agro.au.dk, +45 8715 8129

Co-supervisors: senior scientist Annemarie Fejer Justesen and academic employee Julian Rodriguez-Algaba

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.

65. Characterization of the Danish population of *Puccinia triticina* causing leaf rust in wheat

Department and supervisors

Prof. Mogens Støvring Hovmøller, mogens.hovmoller@agro.au.dk, +4522283361

Annemarie Fejer Justesen, senior researcher, annemariefejer.justesen@agro.au.dk, +4587158135

Mehran Patpour, post.doc, mehran.patpour@agro.au.dk

Physical location of the project and student work

Department of Agroecology, Forsøgsvej 1, 4200 Slagelse

Project start

Any time

Main subject area

Plant pathology, population genetics

Short project description

Breeding for disease resistance in agricultural crops is important to reduce yield losses in conventional and organic farming. For efficient disease phenotyping of breeding material it is crucial to have access to a diverse array of well characterized pathogen isolates. Leaf rust (brown rust) in wheat is caused by the biotrophic fungus *Puccinia triticina*. Little is known about the race diversity and genotypic diversity in general of the Danish *P. triticina* population.

The aim of the project is to characterize the Danish population of *P. triticina* in wheat in order to establish a representative isolate collection for the Danish plant breeders. A collection of Danish isolates are available at the Global Rust Reference Center (GRRRC) but additional isolates will be sampled and multiplied during the project. Isolates will be virulence phenotyped on a set of differential wheat varieties with known resistance genes. A selection of these isolates will also be genotyped using molecular markers such as Simple Sequence Repeat markers (SSR). The genetic diversity of Danish *P. triticina* isolates will be analyzed and compared to reference isolates of European origin. The MSc project will be linked with the ongoing project MULTIRES (<http://wheatrust.org/research/multires/>).

Extent and type of project

60 ECTS experimental theses where the student is responsible for planning, trial design and collection of his/her own original data.

66. Rustfight: meeting the new challenges from infectious rust fungi on crop plants

Department and supervisor

Department of Agroecology

main supervisors:

Mogens Støvring Hovmøller, professor (mogens.hovmoller@agro.au.dk) +45 87158129

Annemarie Fejer Justesen, senior scientist (annemariefejer.justesen@agro.au.dk) +45 87158135

co-supervisors:

Yan-Jun Chen, postdoc (angie.yanjun.chen@agro.au.dk)

Josef Korbinian Vogt, assistant professor (josef@cbs.dtu.dk)

Physical location of the project and students work

Flexible/laboratory work at AU Flakkebjerg/bioinformatics work at DTU Lyngby

Project start

Anytime in 2017

Main subject area

Rust fungi, wheat, plant-microbe interactions, plant pathology, qPCR, RNAseq analysis

Short project description

Yellow rust (*Puccinia striiformis*) is currently one of the most prevalent and damaging disease on wheat, which may threaten global food security. This is emphasized by new strains adapted to warmer temperatures, and being more aggressive in general, which have spread rapidly in many wheat growing areas in recent years. More detailed knowledge is needed for understanding rust biology and epidemiology, e.g., the characteristics of aggressive isolates. Since 2011, the “Warrior” race, which is considered aggressive, has spread rapidly in Europe (Hovmøller *et al.*, 2016). In this study, progeny isolates arising from a selfing of the ‘Warrior’ isolate DK09/11 on *Berberis vulgaris* (Rodriguez-Algaba *et al.*, 2014) were selected for transcriptomic analysis. Aggressive and non-aggressive isolates will be compared at the transcriptomic level at different growth stages. The project offers an opportunity to learn the laboratory molecular work e.g. qPCR and the bioinformatics work, e.g. RNAseq analysis to identify differentially expressed genes.

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 can be linked to the ongoing research project RUSTFIGHT supported by Innovation Fund Denmark and collaborated with DTU Bioinformatics at Lyngby.

References:

- Hovmøller MS, Walter S, Bayles RA, *et al.*, 2016. Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region. *Plant Pathology* 65, 402-11
- Rodriguez-Algaba J, Walter S, Sørensen CK, Hovmøller MS, Justesen AF, 2014. Sexual structures and recombination of the wheat rust fungus *Puccinia striiformis* on *Berberis vulgaris*. *Fungal Genetics and Biology* 70, 77-85.

67. Effect of physical treatment on the ability of green forages to compact

Main subject area

Animal Science, cattle nutrition and physiology

Department and supervisor

Main supervisor: Senior Scientist Martin Weisbjerg, martin.weisbjerg@anis.au.dk

Senior Scientist Troels Kristensen, troels.kristensen@agro.au.dk

[Scientist Jesper Overgaard Lehmann, JesperO.Lehmann@agro.au.dk](mailto:JesperO.Lehmann@agro.au.dk)

Project start

Preferably spring 2017 (the project is dependent on access to green forages)

Physical location of project and student work

Department of Animal Science and Department of Agroecology, AU Foulum

Short project description

This M.Sc. thesis project will focus on methods for assessing the degree of physical treatment of forage during harvest and the effect on silage density and quality.

Physical treatment of green forages at harvest might affect fiber digestibility, ability to ensile, and the ability of the forage to compact.

However, to develop equipment for physical treatment, it is important that the degree of physical treatment can be measured.

The methods to be assessed will be a measure of compaction using volume after vacuum packing in plastic bags as parameter. Further, measure of conductivity will possibly be used as second measure (has earlier been used but with little success). The compaction/vacuum bag method has to our knowledge not been used earlier for this purpose. The material to be used will be different green forages, which after harvest will be physically treated at different degrees before the tests. Green forages could include different forages harvested at different growths and at different maturities in combination with different prewilting time (DM content).

The literature part of the thesis could, apart from the above methods, be a review of the effect of physical treatment (maceration, chopping) on the silage quality.

Additional Information

This project will be part of the GUDP project BEGROME in cooperation with Kverneland

68. Public perceptions of agriculture, food and environmental protection

Department and supervisor

Martin Hvarregaard Thorsøe, post doc, Martinh.Thorsoe@agro.au.dk, 87157751

Chris Kjeldsen, senior scientist, Chris.Kjeldsen@agro.au.dk, 87157749

Co-supervisor:

Morten Graversgaard, PhD- student, Morten.Graversgaard@agro.au.dk, 25645560

Physical location of the project and students work

Department of Agroecology, AU Foulum

Project start

2017-2018

Main subject area

Sociology; mixed methods; survey data; public perceptions; agriculture; landscape planning

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 data and 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 master project will be connected to the innovation foundation project: ProvenanceDK ([www](http://www.provenancedk.com)). The project will furthermore be informed by research carried out in various PhD and postdoc projects at the Department of Agroecology, and research carried out within the BufferTech project: <http://www.buffertech.dk/>

Useful reading

Thorsøe, M.H.; Graversgaard, M.; Noe, N. The challenge of legitimizing spatially differentiated regulation: Experiences from the implementation of the Danish Buffer zone act. *Land Use Policy* **2017**, *62*, 202–212.

69. Distributed Life Cycle Inventory data compilation is the first step towards internalizing externalities

Supervisors:

Jakob Raffn, PhD Student, AU Foulum, raffn@agro.au.dk

Tommy Dalgaard, Chris Kjeldsen et al.

Physical location of the project and students work:

Department of Agroecology, AU-Foulum, 8830 Tjele

Project start:

Any time

Extent and type of project:

45 or 60 ECTS

Main subject area:

Life Cycle Inventory Analysis, IT systems e.g. Agent-oriented/based modelling, , Targeted regulation

Short project description:

The societal transition from depletive to regenerative is the key challenge of our time. If we know where and when a human intervention occurs and what resource use and emissions are taking place, we will be better at regulating our behavior and minimize negative externalities.

The overall aim of this project is to contribute to testing the hypothesis in the title - tentatively with Samsø as a case study and in relation to the www.SoilCare.eu case sites; specifics will be decided in conversation with supervisors and collaborators. It could be framed something like:

“Review of previous and current attempts at distributing the workload of making sustainability assessments between the actors participating in food networks. Understanding what went well and wrong and what engaged stakeholders perceive as critical is needed to define which specifications, at minimum, will be needed for a Danish Prototype. Design and carry out a mapping of the interconnections of stakeholder and how their systemic involvement can be anticipated to effect a Danish implementation of a distributed inventory compilation system”. Current systems that can give an idea of the current level are www.provenance.org and www.blunumber.org. Frameworks of interest are Security by Design: http://blog.privacytrust.eu/public/Reports/Nye_digitale_sikkerhedsmodeller.pdf and Agent Based Modelling.

Additional information:

You are welcome to contact Jakob Raffn on +4560135257 for more information.

The research will be developed and carried out in collaboration with PhD students offering substantial time, and it is the intention to publish the results in a suitable peer-review journal.

Knowledge of LCA, MCA, and data models is recommended.

70. Development and evaluation of a dynamic scalable water footprint impact assessment model on Samsø covering both quantity and quality parameters.

Supervisors:

Jakob Raffn, PhD Student, AU Foulum, raffin@agro.au.dk, +45 6013 5257

Lea Staal, PhD Student, AU Foulum, staal@agro.au.dk, +45 2548 2808

Tommy Dalgaard, Bo Vangsø Iversen et al.

Physical location of the project and students work:

Department of Agroecology, AU-Foulum, 8830 Tjele and a case location on Samsø

Project start:

Fall 2017

Extent and type of project

45 or 60 ECTS

Main subject area:

Water Footprint, Impact Assessment, In-situ and remote sensing, geophysics GIS, Earth System Modelling

Short project description:

Assessment of impacts relies on two things – reporting of human interventions and understanding of the environment where they occur in high temporal and spatial resolution. Keeping the sum of interventions below the carrying capacity is needed to shift to a regenerative society and not diminishing the quality of existence for other entities.

The student (or group of students) will review and identify suitable methods (or suite of methods) for estimating the energy and mass transfers between field, atmosphere and hydrosphere, and apply them on a case location on Samsø.

Terrestrial and aquatic biodiversity could be measured concurrently, and the suitability as an indicator for eco-system regenerative capacity could be tested. The field/point measurements should be linked with remote sensing data (satellite or drone based) as to identify potential correlations enabling extrapolation at significantly reduced costs.

The data should be interoperable for modelling in GIS and Hydrologic Modelling Software.

The MSc. projects will be scoped and delimited according to the skills, interests and number of the students collaborating.

Additional information:

You are welcome to contact Jakob Raffn on +4560135257 for more information regarding water footprint, earth observation- and modelling and Lea Staal on +4525482808 regarding measuring the fluxes between field, atmosphere and hydrosphere.

71. Comparison of field mass and energy balance under no-, biological-, animal- and/or conventional tillage procedures.

Supervisors:

Tommy Dalgaard, Chris Kjeldsen et al.

Co-supervisor: Jakob Raffn, PhD Student, AU Foulum, raffn@agro.au.dk, +45 6013 5257

Physical location of the project and students work:

Department of Agroecology, AU-Foulum, 8830 Tjele and a case location on Samsø, in connection to the

Project start:

Fall 2017 / Spring 2018

Extent and type of project

45 or 60 ECTS

Main subject area:

Alternative tillage systems, Impact Assessment, In-situ and remote sensing, GIS, Earth System Modeling

Short project description:

There is a lack of data describing the systemic effects non-conventional tillage procedures in LCA.

Present study seeks to quantify the mass and energy balance at the field and farm level applying two or more cropping and tillage systems depending on the focus area of the student(s).

It is critical that the study incorporates more indicators of sustainability than financial costs, labor input and GHG emissions – all of which ought to be included. Additional indicators of interest could be leaching of nutrients, gas flux to atmosphere, biodiversity (terrestrial and/or aquatic), soil quality, water quality etc.; with for e.g. Samsø as a case study and in relation to the www.SoilCare.eu case sites

If animal tillage is chosen it could for instance involve quantification of animal welfare and it could also be interesting to look into the added value by special and regional products, and what value chain integrations will be needed to fully reach these potentials (<http://www.provenance.dk>, The Provenance Project focus on such aspects).

The study could be carried out by a group of students in collaboration with other projects focusing on quantifying the effects of cultivation methods.

Additional information:

You are welcome to contact Jakob Raffn on +4560135257 for more information

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 objective 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/>