Master Thesis Projects

Topics within Agroecology

AgroEnvironmental Management
& Agrobiology MSc Programmes
2018-2019

Lars Juhl Munkholm
Head of MSc Programme,
Department of Agroecology
Aarhus University
April 2018

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.

Contents

Preface 2

1. Weed suppression abilities of cover crops 6
2. Precision farming – use of thermal camera for evaluation of drought stress in potatoes and wheat? 7
3. Vintage vegetable seed production 8
4. Red clover seed production 9
5. Temperature model for germination of weed and/or crop species 10
6. Respiration during seed priming 11
7. Sensing phosphorus binding in soils 12
8. MSc project: Reducing pesticide leaching potential by optimizing soil tillage 13
9. MSc project: Changes of soil hydraulic properties under bio-subsoiling crops 14
10. Ecosystem services provided by small undisturbed patches in agricultural landscapes 15
11. Somatic recombination in the yellow rust pathogen *Puccinia striiformis* 16
12. Effects of soil pH on microbial metabolism and N2O emission 17
13. Water and air distribution in organic growing media – with and without plants 18
14. Peat substitutes – wood fibre characterization 19
15. Digestate as additive to horticultural growing media – risk analysis of non-desirable substances 20
16. Wood fibres – from wood chip to plant production 21
17. Climate change impact on biological control in the Sahel region 22
18. Impact of incubation temperature on muscle metabolism in broilers 23
19. Maturation of Fish – product development 24
20. Testing a future vegetable: the colzácoli 25
21. Crowded or lonely in the field? Plant density effects on salad from white-flowering rapeseed 26
22. Chromosome doubling of European blueberries 27
23. *In vitro* propagation of European blueberries 28
24. Application of FT-NIR Spectroscopy to identify hybrid status of seeds and seedlings of hybrid larch. 29

25. Nitrogen uptake and utilization in grass seed production 30
26. The use of Sentinel satellites in practical grass seed production..... 31
27. Greenhouse gas emissions from rewetted, cultivated peat soils..... 32
28. Ecological intensification for production of vegetables: double-cropping and nitrogen recycling..... 33
29. Quality of old Nordic cultivars of root and cabbage vegetables 34
31. The importance of weeds growing in the rows of cereals..... 35
32. The use of NIR and MIR spectroscopy for evaluation of carbohydrates in biomass for bioenergy /biorefining..... 36
33. Evaluation of genetic variation in allicin content and antibacterial activity of garlic and ramsons..... 37
34. *Pythium* root diseases: Triangle interactions between the plant root, the associated microbiome and *Pythium* studied using next generation sequencing..... 38
35. When do plants get heat stroke?..... 39
36. Stress in wheat production under global change 40
37. Cool plants – how do they react to cool conditions? 41
38. How does plant cope with high humidity..... 42
39. Does changes in light composition affect the plants? 43
40. Legumes for the future..... 44
41. Weed suppression abilities of variety mixtures in organic spring barley and oat... 45

Study regulations concerning Master Thesis Projects.....46
Agreement on Master's Thesis Project between: 48
Guidelines for the MSc thesis contract 50
Guidelines for the MSc Thesis Research Proposal.....54
Guidelines for writing the Thesis Report 56
Deadlines concerning Master Thesis Projects.....59

1. Weed suppression abilities of cover crops

Department and supervisor
Department of Agroecology, section of Crop Health, Bo Melander, bo.melander@agro.au.dk, mobile 22 28 33 93.

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

Project start
Preferably with start in August or September

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

Short project description
The master project will study a range of cover crop species as sole species or in different species mixtures. Cover crops grown post-harvest are important for the uptake of nutrients and the build-up of soil fertility. However, some cover crops may improve weed proliferation if poorly managed. The benefits of mixing cover crop species can be better suppression of weeds, better uptake of nutrients and a stronger improvement soil fertility.
The knowledge produced can help improving current guidelines for cover crop management, especially the effect on weed growth. The main focus of the project is weed management but additional aspects, such as nutrient uptake and carbon sequestration, can be considered as well, but would then require supplementary supervision from other expertises, which can be organised.
The study will be based on the initiation of field experiments. However, the student will also be able to extract data from ongoing field experiments and to benefit from data of already conducted work. Analyses of the cover crop growth pattern will aid the understanding of their suppressive abilities against weeds. It is important to know the specific properties of the individual cover crops to understand the possible synergies of mixtures, e.g. leaf area, leaf shape, root growth pattern. Some of these 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 late summer.

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 the supervisors to discuss the opportunities for designing the project you envision.

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

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

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

Project start
June 2018

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

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

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

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

3. Vintage vegetable seed production

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

Physical location of the project and students work
AU-Flakkebjerg

Project start
Anytime

Main subject area
Seed quality, seed germination, seed treatments, genebank accessions

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 qualtity 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.

In 2018-2020 we are growing various vegetable species for seed production in tunnels. You can be part of this or carry out your experiments with some of this material.

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

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

4. Red clover seed production

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

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

Project start
From June 2018

Main subject area
Crop production and pollination

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

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

In 2018 we will be doing field trials in diploid and tetraploid varieties of red clover and further we will use the LIDAR-technique to try and characterize bumblebee species.

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

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

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

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

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

5. 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.

6. Respiration during seed priming

Main supervisor
Fiona Hay
E-mail: Fiona.Hay@agro.au.dk

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

Project start
Any time

Extent and type of project
Thesis 45 ECTS credits (experimental thesis in which the student is responsible for collection and analysis of original raw data) OR *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).

Main subject area
Testing and improvement of seed quality

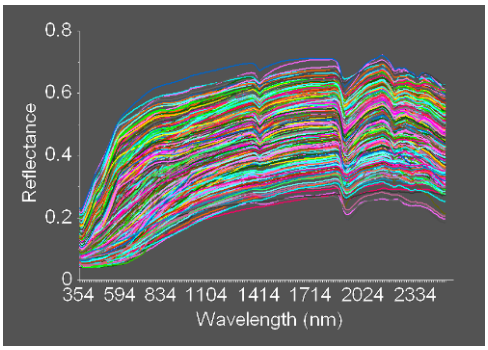
Short project description
The Q2 is a relatively new instrument that can measure the respiration of individual seeds as they progress to radicle emergence. Following uptake of water, the molecular apparatus within the seeds has to be repaired. This process is exploited in seed priming, whereby seeds are allowed to take up water but not complete germination; the seeds are dried back to low moisture content, ready for final sowing. Primed seeds germinate more quickly and uniformly. In this project, you will aim to determine whether the Q2 instrument can be used to identify the optimum priming treatment at the level of individual seeds, based on their rate of respiration.

Suggested reading
Bradford KJ, Bello P, Fu JC, Barros M. 2013. Single-seed respiration: a new method to assess seed quality. *Seed Science and Technology* **41**, 420-438.

Tomlinson S, Dalziell EL, Withers PC, Lewandrowski W, Dixon KW, Merritt DJ. 2018. Measuring metabolic rates of small terrestrial organisms by fluorescence-based closed-system respirometry. *Journal of Experimental Biology* doi: 10.1242/jeb.172874

7. Sensing phosphorus binding in soils

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



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

Project start
Summer 2018

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

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

Useful reading Stenberg et al. 2010. Advances in Agronomy, 107:163-215

Short project description
Background. On the intensively farmed land in Europe and elsewhere large amounts of phosphorus (P) have accumulated in soils due to decades of surplus P additions. In the past, this P accumulation was seen as a resource to agriculture. Today it has become a source for the P-induced eutrophication of surface waters. In Denmark leaching of dissolved and particulate P to drains is a major pathway of P transfer from soil to water, which is controlled by P binding reactions in soils. In order to devise effective and targeted mitigation we need to map high-risk areas for P leaching. Therefore, a research initiative at AU aims at modelling the risk of P leaching on much of the agricultural land in Denmark. A challenge with this approach is obtaining the necessary spatially distributed data for describing the P binding in soils. Currently this is done in laborious and expensive laboratory studies, severely limiting the data available for model parameterization. Recent developments in soil sensing technology suggest that Near Infrared Spectroscopy (NIRS) allows for the rapid, inexpensive measurement of key soil properties related to P binding. The overall goal of the MSc project is, therefore, to explore the feasibility of a NIRS approach to characterize a soil's P binding behavior.
Aim. The aims of this MSc project are i) to conduct P sorption experiments and determine chemical properties related to P binding for a range of soils; ii) to obtain and analyze NIR spectra from these soils; iii) to develop relationships for predicting key P binding parameters from NIR spectra.
Approach. The student will assist in conducting infinite sink P sorption experiments and obtaining NIR spectra at the proximal sensing lab at the Department of Agroecology. Soil property data linked to P binding will be made available. Experts in NIRS and proximal sensing at the department will guide and support the student in the data analysis and building prediction models. This work is linked to and supported by a sizeable research imitative at the department, the FOSFORKORTLÆGNING project (2017-2019) funded by the Danish Environmental Agency. The student will thus be introduced to cutting-edge research that explores new avenues for predicting soil environmental processes.

8. MSc project: 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 2018

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 Characteristiscs. 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 predict pesticide leaching potential for different weather scenarios using the Daisy model.

9. MSc project: Changes of 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 2018

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., Båth, 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.

10. 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 ecolgoy/ 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 is increasing beneficial functions (like pest contorl 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. perquisites, conditions, useful reading, etc.....)

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

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

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

Project start
Anytime

Main subject area: Population genetic and epidemiology

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

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

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

Additional information

Park, R., Wellings, C.R., 2012. Somatic Hybridization in the Uredinales. *Annual Review of Phytopathology*. 50 (1): 219-239.
Rodriguez-Algaba, Julian, Walter, Stephanie, Sørensen, Chris K., Hovmøller, Mogens S. Justesen, Annemarie F. Justesen, 2014. Sexual structures and recombination of the wheat rust fungus *Puccinia striiformis* on *Berberis vulgaris*. *Fungal Genetics and Biology* 70: 77-85.
Hovmøller, Mogens S., et al., 2015.Replacement of the European wheat yellow rust population by new races from the centre of diversity in the near-Himalayan region. *Plant pathology* 65 (3): 402-411.

12. Effects of soil pH on microbial metabolism and N2O emission

Department and supervisor
Lars Elsgaard, associate professor, lars.elsgaard@agrsci.dk, 8715 7476

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

Project start
Project can start from April 2018 or later

Main subject area
Soil microbial ecology

Short project description
Soil pH affects all microbial processes, yet specific responses of microbial carbon mineralization to pH are not well described. Based on soil samples from a long-term field experiment, studies of microbial responses at a pH gradient will be made in the laboratory, using a versatile technique of testing profiles of carbon source utilization (Campbell et al., 2003). Overall, the aim will be to characterize the effects of pH manipulations on functional physiological diversity in soil. The student work will be linked to an EU project exploring interactions between soil pH and microbial responses in a wider context also including focus on climate change mitigation (Wang et al., 2017). Optionally the student work can be combined with controlled experiments to explore the interaction between soil pH and emissions of the greenhouse gas, nitrous oxide (N_2O).

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

Additional information
Campbell CD, Chapman SJ, Cameron CM, Davidson MS, Potts JM (2003). A rapid microtiter plate method to measure carbon dioxide evolved from carbon substrate amendments so as to determine the physiological profiles of soil microbial communities by using whole soil. A*pplied and Environmental Microbiology* 69, 3593-3599

Wang Y, Guo J, Vogt RD, Mulder J, Wang J, Zhang X. Soil pH as the chief modifier for regional nitrous oxide emissions: New evidence and implications for global estimates and mitigation. *Global Change Biology* 1–10. https://doi.org/10.1111/gcb.13966

Contact supervisor for a briefing and further info.

13. Water and air distribution in organic growing media – with and without plants

Main supervisor
Senior scientist Karen Koefoed Petersen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: karenk.petersen@food.au.dk
Phone: 87158336 or 93508520
Homepage: http://pure.au.dk/portal/da/persons/id(d66e86e4-c15c-4719-8e46-212a78c39858).html

Physical location of the project
Department of Food Science, Kirstinebjergvej 10, 5792 Aarslev (Fyn)

Project start
Anytime

Extent and type of project
30, 45 or 60 ECTS (30 ECTS if only literature study)

Main subject area
Horticulture, water retention, characterization of organic growing media, oxygen distribution, cation exchange capacity, root development

Additional information
Co-supervisor 1: Rasmus Lakmann, Pindstrup Mosebrug
Co-supervisor 2: Senior scientist Martin Jensen, Department of Food Science

Short project description
For many years, peat has been widely used in the horticultural industry as a growing medium because it has a relatively high air volume, a high volume of plant accessible water and the volume weight is low. There is an increasing concern regarding harvest of natural peat resources used in the horticultural industry and an increasing awareness and focus on circular bio economy and use of side streams. The overall aim of this project is to determine the distribution of water and air in peat supplemented with different additives (wood fibers, fiber fraction from biogas production compared to well-known additives like perlite and coir). Physical factors affecting the suitability of a substrate as growing medium is the volumetric distribution between solid matter and pores and the size of pores resulting in differences in pore distribution, retention curves, air filled porosity and oxygen distribution. Physical characterization will take place in growing medium not influenced by plants but will be supplemented with a study on above ground plant growth, root development, oxygen profile, compaction of growing medium, nutrient analyses and other measurements.

14. Peat substitutes – wood fibre characterization

Main supervisor
Senior scientist Martin Jensen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: martin.jensen@food.au.dk
Phone: 87158331 or 40594286
Homepage: http://pure.au.dk/portal/en/martin.jensen@agrsci.dk

Physical location of the project
Department of Food Science, Kirstinebjergvej 10, 5792 Aarslev (Fyn)

Project start
Flexible

Extent and type of project
30, 45 or 60 ECTS (30 ECTS only literature study)

Main subject area
Horticulture, growing medium, chemical analysis, lignin, cellulose, hemicellulose, carbohydrates, fibre characterization, fibre resistance to degradation

Additional information
Co-supervisor 1: Rasmus Lakmann, Pindstrup Mosebrug
Co-supervisor 2: Karen Koefoed Petersen, Department of Food Science

Short project description
For many years, peat has been widely used in the horticultural industry as a growing medium because it has a relatively high air volume, a high volume of plant accessible water and the volume weight is low. There is an increasing concern regarding harvest of natural peat resources used in the horticultural industry and an increasing awareness and focus on circular bio economy and use of side streams. One such side stream is fibres from processing of different tree species. The overall aim of this project is to characterize different types of wood fibres with regard to physical and chemical stability at different environmental conditions. This could include determination of the size distribution of fibres, the relative resistance of fibres to biological and/or enzymatic degradation and their correlation to chemical properties determined by a literature study (lignin, cellulose and hemicellulose and carbohydrate profile). Comparison of wood fibres with other available growing media (peat, coir and composts).

15. Digestate as additive to horticultural growing media – risk analysis of non-desirable substances

Main supervisor

Senior scientist Karen Koefoed Petersen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: karenk.petersen@food.au.dk
Phone: 87158336 or 93508520
Homepage: http://pure.au.dk/portal/da/persons/id(d66e86e4-c15c-4719-8e46-212a78c39858).html

Physical location of the project

Department of Food Science, Kirstinebjergvej 10, 5792 Aarslev (Fyn)

Project start

Flexible

Extent and type of project

30 ECTS

Main subject area

Horticulture, water retention, anaerobic digestion, digestate, microbiology,

Additional information

Co-supervisor 1: Rasmus Lakmann, Pindstrup Mosebrug
Co-supervisor 2: Henrik Bjarne Møller, Department of Engineering

Short project description

For many years, peat has been widely used in the horticultural industry as a growing medium because it has a relatively high air volume, a high volume of plant accessible water and the volume weight is low. There is an increasing concern regarding harvest of natural peat resources used in the horticultural industry and an increasing awareness and focus on circular bio economy and use of side streams. One such side stream could be digestate from biogas plants. The overall aim of this project is to review the literature regarding plant toxic compounds and human and environmental questionable compounds and microorganisms in the solid fraction from biogas plants. What is the fate of antibiotics, pesticides, heavy metals, microorganisms causing human diseases etc. Are they broken down or inactivated during anaerobic digestion or during processing before or after anaerobic digestion?

16. Wood fibres – from wood chip to plant production

Main supervisor
Senior scientist Karen Koefoed Petersen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: karenk.petersen@food.au.dk
Phone: 87158336 or 93508520
Homepage: http://pure.au.dk/portal/da/persons/id(d66e86e4-c15c-4719-8e46-212a78c39858).html

Physical location of the project
Department of Food Science, Kirstinebjergvej 10, 5792 Aarslev (Fyn)

Project start
Flexible

Extent and type of project
30, 45 or 60 ECTS (30 ECTS if only literature study)

Main subject area
Horticulture, water retention, characterization of organic growing media, oxygen distribution, cation exchange capacity, root development

Additional information
Co-supervisor 1: Rasmus Lakmann, Pindstrup Mosebrug
Co-supervisor 2: Senior scientist Martin Jensen, Department of Food Science
Co-supervisor 3: ?? if biological characterization included

Short project description
For many years, peat has been widely used in the horticultural industry as a growing medium because it has a relatively high air volume, a high volume of plant accessible water and the volume weight is low. There is an increasing concern regarding harvest of natural peat resources used in the horticultural industry and an increasing awareness and focus on circular bio economy and use of side streams. The overall aim of this project is to give a physical, chemical and biological characterization of growing media based on wood fibres; from initial production to plant production.
Chemical characterization – Nitrogen use when wood fibres are mixed with peat. What happens during storage and transport and during plant production and release of volatile organic compounds (VOC) during decomposition of different types of wood fibres?
Physical characterization – Decomposition and structural and functional stability over time
Biological characterization – Plant protective and inhibitory microorganisms, plant pathogens and their influence on the chemical environment.

17. Climate change impact on biological control in the Sahel region

Department and supervisor

Niels Holst
Senior Scientist
Agroecology, Flakkebjerg Campus
niels.holst@agro.au.dk
22 28 33 40

Physical location of the project and student's work

Theoretical work in Flakkebjerg or elsewhere. Experimental work in Benin, Burkina Faso or Niger.

Project start

Any time.

Main subject area

Biological control, integrated pest management, entomology, ecological modelling, climate change, tropical agriculture.

Short project description

Evidence has been growing over the last decade, that climate change could upset the balance of tritrophic agroecosystems (*i.e.*, systems composed of crop-pest-natural enemies) thus destabilizing the natural regulation of pests and igniting pest outbreaks. To study these mechanisms, a combination of lab work, field work and simulation modelling is needed. The student will take part in one or more of these activities during this project, relying upon existing collaboration between the department and research institutes in West Africa.

Extent and type of project

The project can be tailored to any dimensions:

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

Good English or French and an interest in ecological modelling is required. For further information contact Niels Holst.

18. Impact of incubation temperature on muscle metabolism in broilers

Main supervisor

Associate professor Margrethe Therkildsen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: Margrethe.Therkildsen@food.au.dk
Phone: +45 87158007
Homepage: www.food.au.dk

Physical location of the project

At department of Food Science, Foulum

Project start

1st of August or 1st of September 2018

Extent and type of project

Master thesis 45 or 60 ECTS

Main subject area

In this project, you can use your knowledge from biochemistry, muscle growth, structure of muscle based food, enzymes in food and impact on meat quality.

Short project description

Meat from broilers is highly appreciated by the consumers, and specifically the demand for the breast fillet is increasing. Thw demand has been met by genetic selection of lines characterized by fast post-hatch growth and greater yield of the breast fillet but not leg muscles. This focus in the selection has caused an imbalance in the body of the chickens, leading to very large pectoralis muscles but decreased leg strength, which cause impaired animal welfare because of decreased ability to walk. In this project, we study fetal programming by manipulation with temperature during incubation of chicks. The early incubation temperature has been shown to affect the number of muscle fibres in the leg muscle of chick embryos and this may support a more balanced development post-hatch between the breast and leg muscles, supporting the chickens ability to walk. An increased incubation temperature from 37.5 to 38.5°C from day 4 to 7 increase the embryonic movements and this may explain the increased number of muscle fibres and ratio of nuclei per fibre at day 18 of the incubation period (Hammond et al. 2007). Also, the muscle metabolism might be affected, which could have an impact on the meat quality. Thus, this project aim at describing the glycogen content and activity of metabolic enzymes [e.g. citrate synthase, lactate dehydrogenase and beta-hydroxy CoA dehydrogenase] in broilers, which have been exposed to fetal programming.

19. Maturation of Fish – product development

Main supervisor
Associate professor Margrethe Therkildsen
Department of Food Science
Aarhus Faculty of Science and Technology
Aarhus University
E-mail: Margrethe.Therkildsen@food.au.dk
Phone: +45 87158007
Homepage: www.food.au.dk

Physical location of the project

At department of Food Science, Foulum

Project start
1. of August or 1. of September 2018

Extent and type of project
Master thesis 45 or 60 ECTS

Main subject area
In this project, you can use your knowledge from biochemistry, structure of muscle based food, enzymes in food, sensory evaluation and product development.

Additional information
The project is a collaboration project with Nordsøen Forskerpark, and companies involved in fresh fish from the sea, fish auctions and restaurants – thus you will be part of a bigger project team – all engaged in the development of the 1. gerneration of matured fish in Denmark.

Short project description
Freshness of fish are usually the number one quality criteria of fish. However, a lot of flavour components develop during maturing of muscle and maturation has a major effect on the texture of muscle tissue. Thus in this project we will mature fresh fish to gain an intensification of flavour and an optimized texture, by using the knowledge from meat science from other species. The project will involve consumer survey of expectations towards a matured fresh fish product, design of studies, test of different raw fish qualities depending on way of bleeding and chilling, measurement of glycogen and inosine monophosphate over time, measurement of texture traits and measure of the microbiological development.
You will have the chance to form the content of your master thesis by selecting the areas in which you have most interest.

20. Testing a future vegetable: the colzácoli

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 the experiment running in the project (August/September 2018).

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 *colzácoli*. 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 final selection as an approved cultivar based on evaluations of i.a. a wide range of 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 Grønbæk (Industrial postdoc), gronbaek@food.au.dk, +45 8715 8327. The master project will be linked to an industrial postdoc project (link) 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).

21. Crowded or lonely in the field? Plant density effects on salad from white-flowering rapeseed

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 the experiment running in the project (early summer 2018).

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

Short project description
Leaves from white-flowering rapeseed can be utilized as baby leaf salad but knowledge on horticultural management is missing, as the vegetable is new on the market. An experiment on plant density effects on leaf size, morphology, yield, color, nitrogen content etc. is planned for this season. The master student is encouraged to identify further relevant factors and develop new hypotheses in relation to this experiment (45-60 ECTS project). Analysis of the secondary plant metabolites relating to health or taste could be a possibility. Alternatively, work with the data collected in the present experiment or previous trials within the same subject/project is an option (30 ECTS project). 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 Grønbæk (industrial postdoc), gronbaek@food.au.dk, +45 8715 8327. The master project will be linked to an industrial postdoc project (link) 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).

22. Chromosome doubling of European blueberries

Department and supervisor
Department of Food Science, Martin Jensen, senior scientist, Martin.Jensen@food.au.dk, 87158331, mobile 40594286. Co-supervisor, assoc. prof. Karen Kofoed Petersen.

Physical location of the project and students work
Department of Food Science, AU-Aarslev, 5792 Aarslev.

Project start
Start any time, length from 6 months to a year possible.

Main subject area
Chromosome doubling of selected diploid (Danish origin) European Blueberry (EB, Vaccinium myrtillus) into tetraploid plants as a step before hybridization with tetraploid Highbush Blueberry (HB, Vacc. corymbosum) to ensure fertile offspring with HB. Chromosome doubling of different plant material such as greenhouse plants, *in vitro* plants and during adventitious shoot formation as well as different antimitotic agents will be tested in selected EB clones. Documentation of ploidy level and non-chimeric status by flow cytometry. Basic *in vitro* (tissue culture) propagation methods in European blueberries are available at AU FOOD.

Short project description
AU Food has been working on the domestication of European blueberries (EB) for almost 10 years and has established an archive with more than 100 selected Danish clones. Selection of the few most interesting clones from this is ongoing and will be released very soon as a starting point for a new berry crop in this species. Using this selected material for breeding into Highbush Blueberry (HB) is of high interest. Breeding hybrid genomes from wild EB with HB is of high international interest to achieve better fruit quality and improved cold hardiness in highbush blueberries. Since EB is diploid and HB is tetraploid direct crossing is difficult and will normally end up in triploid genotypes typically non-fertile. Chromosome doubling of EB into tetraploid plants is a possible step before hybridization to ensure fertile offspring with HB. Development of chromosome doubling techniques and regeneration of plants from newly selected clones of Danish EB research is of interest as a first step towards using Danish EB selections in breeding with HB in future. Basic in vitro (tissue culture) propagation methods in European blueberries have been developed and will be available at AU FOOD.
The outcome of a MSc study is a scientific manuscript ready for submission.

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

Additional information
The study will exploit results and knowledge from two prior projects and one ongoing project on EB, currently looking on fruit quality (taste and health compounds) of clones by GCMS and LC-MS.

23. *In vitro* propagation of European blueberries

Department and supervisor
Department of Food Science, Martin Jensen, senior scientist, Martin.Jensen@food.au.dk, 87158331, mobile 40594286. Co-supervisor, assoc. prof. Karen Kofoed Petersen.

Physical location of the project and students work
Department of Food Science, AU-Aarslev, 5792 Aarslev.

Project start
Start any time, length from few months to a year possible.

Main subject area
Development of efficient *in vitro* (tissue culture) propagation methods (axillary as well as adventitious shoot formation) in European blueberries as a critical initial step in establishing commercial propagation of selected clones from this species as a part of domestication of European blueberries to a new commercial berry crop. Basic in vitro methods for this species is available at AU FOOD but needs further optimization for newly selected clones.

Short project description
AU Food has been working on the domestication of European blueberries (EB) for almost 10 years and has established an archive with more than 100 selected Danish clones. Over the last few years recordings of plant growth and fruit yield have provided data that will make it possible, to select the most interesting clones as the world's first selected cultivars of EB. Propagation by summer cuttings is possible and cost-efficient but depends on access to a large pool of plant material to reach a quantity of commercial interest to future growers. Going fast from one selected plant to the first many thousands of plants (>100.000 plants) by *in vitro* techniques is a critical step, that will speed up the implementation of the crop and establish the basis for future propagation by cuttings. Without *in vitro* propagation, relying on only propagation by cuttings from one selected clonal plant, will delay the introduction of this new species for many years. Basic knowledge on successful *in vitro* propagation for EB is available but not optimized to be an efficient tool in commercial propagation. Within the project a fast and high throughput method using the selected clones will be developed.
The outcome of a MSc study is a scientific manuscript ready for submission.

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

Additional information
The study will exploit results and knowledge from two prior projects and one ongoing project on EB, currently looking on fruit quality (taste and health compounds) of clones by GCMS and LC-MS.

24. Application of FT-NIR Spectroscopy to identify hybrid status of seeds and seedlings of hybrid larch.

Department and supervisor
Department of Food Science, Martin Jensen, senior scientist, Martin.Jensen@food.au.dk, 87158331, mobile 40594286.

Physical location of the project and students work
Department of Food Science, AU-Aarslev, 5792 Aarslev.

Project start
Start any time, length from 6 months to a year possible.

Main subject area
FT NIR spectroscopy scanning of single seeds from hybrid larch seed and seedling lots, setup experimental study using selected seed and seedling material, obtaining and analyzing spectra, building and verifying models, performing PCA and PLS analysis of multivariable data sets, validating prediction models. Forest tree seeds, genetical identity, seed sorting.

Short project description
Crossing European larch with Japanese larch provides offspring with clear heterosis effects, i.e. stronger growth, compared to the maternal and paternal origin and are used as standard in Danish forestry. However, the percentage of hybrid seeds is influenced by weather and pollination events and may result in varying degree of hybridization (50-100%), some seeds being the maternal species following selfing. Hybrid seeds cannot be separated visually by eye or machine at this moment, whereas seedlings may show minor but distinct morphological differences at 1-2 years age. FT NIR spectroscopy (Near infrared Radiation) is a technique that expose seeds to modulated light and capture infrared reflection (or absorption) from around 400-2500 nm wave length, that provide a unique light absorption fingerprint depending on the molecules and structure in the seed tissue. AU FOOD holds a patent on using NIR to identify seed quality in nordmann fir seeds and thus have strong experience in studying seeds with NIR. In this project we would like to study if it is possible to identify and separate/predict hybrid larch seeds from non-hybrid seeds using FT NIR on seeds of reciprocal crossings of the two larch species, several commercial hybrid seed lots with known hybrid percentages and seeds of pure species of larch. In addition tissue (bark, needles and apical buds) from young seedlings of pure larch species and hybrid seedlings will be investigated to identify if separation alternatively may be done in the seedling stage. An FT NIR scanner and methods of NIR scanning of seeds are available at AU FOOD.
The outcome of this MSc study is a scientific manuscript ready for submission.

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

Additional information
The study will have close contact with seed companies and nurseries that grow hybrid larch.

25. Nitrogen uptake and utilization in grass seed production

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

Physical location of the project
Aarhus and Flakkebjerg

Project start
Anytime

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

Main subject area
Nitrogen and grass seed production

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

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

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

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

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

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

Physical location of the project and students work
Anywhere

Project start
Any time

Main subject area
Satellites images and crop pruduction

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

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

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

27. Greenhouse gas emissions from rewetted, cultivated peat soils

Department and supervisor
Lars Elsgaard, associate professor, lars.elsgaard@agrsci.dk, 8715 7476

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

Project start
Project can start from April 2018 or later

Main subject area
Soil microbial ecology

Short project description
Natural peatlands are efficient ecosystems in storing carbon and serve as a net sink of atmospheric CO_2. However, drainage and use of peatlands for agriculture may turn these ecosystems into net sources of CO_2 and nitrous oxide (N_2O) due to processes such as increased soil aeration and N fertilization. To mitigate such greenhouse gas emissions, incentives for rewetting are now in place, and several areas are under consideration for rewetting and extensification. The student work will be related to ongoing projects evaluating the greenhouse gas mitigation potential of rewetting. The work can be combined with more targeted studies of changes in soil microbial ecology as result of peatland rewetting.

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

Additional information
Kandel et al. (2017) Complete annual CO_2, CH_4, and N_2O balance of a temperate riparian wetland 12 years after rewetting. Ecological Engineering
https://doi.org/10.1016/j.ecoleng.2017.12.019

Contact supervisor for an informal further info.

28. 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.

29. 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.

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

Main supervisor:
Bo Melander, bo.melander@agro.au.dk,

Physcial 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 plays 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 this 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

32. 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

Physcial 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.

33. Evaluation of genetic variation in allicin content and antibacterial activity of garlic and ramsons.

Department and supervisor
Department of Food Science (FOOD), AU-Aarslev, Martin Jensen, senior scientist, Martin.Jensen@food.au.dk, 87158331, mobile 40594286. Co-supervisor, senior researcher Ole Højberg, Department of Animal Science (ANIS), AU-Foulum.

Physical location of the project and students work
Shared between FOOD, AU-Aarslev, 5792 Aarslev and ANIS, AU-Foulum, 8830 Tjele.

Project start
Start any time, length from 6 - 9 months.

Main subject area
Chemical characterization of variation in allicin concentration by HPLC in a Danish genetic pool of wild ramsons and cultivated garlic varieties. Evaluation of variation in antibacterial activity against pathogenic E coli, including demonstration of dose-response effects.

Short project description
FOOD has in recent years together with ANIS and DMRI (Danish Meat Research Institute) built up knowledge on food-based plants with antibacterial compounds that may be used in both food preservation and as an alternative to antibiotics and zinc oxide in livestock production. The compound allicin, found in both ramsons (Allium ursinum) and in garlic (Allium sativum), is known for its antimicrobial properties and using dried powders from these species has shown very promising effects against several pathogenic bacteria. Especially E. coli may be controlled effectively by adjusting the content of allicin to provide an effective dose. Only limited knowledge is, however, available on the variation of allicin in different plant material of ramsons and garlic, and expanding this knowledge is crucial for ensuring reproducible antibacterial activity and for optimizing plant production and lower costs. This study will investigate the biochemical concentration of allicin (FOOD) in a range of plant material of the two species focusing on Danish produced plant resources. In addition, the study will evaluate the antimicrobial activity (ANIS) of the same samples and establish a firm dose-response base for the antibacterial activity of allicin.
The outcome of this MSc study is a scientific manuscript ready for submission.

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

Additional information
The study will be aligned to an ongoing FOOD project RAMVAR that collect ramsons from all over Denmark for characterization of phenotypic and genotypic differences in growth and chemical contents. Plant material will be available at FOOD. Antibacterial test methods using pathogenic E coli are available at ANIS, where Ole Højberg is expert in microbiology with relevance for animal production.

34. *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
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.

35. 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.

36. 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 CO_2 can make the plant less sensitive or whether combinations of stresses affect the plants differently using state of art technology to monitor plants reactions. The projects are part of an international project ModCarbostress aiming to improve models of plant reactions to climate change.

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

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

Physical location of the project
Department of Food Science, Årslev

Project start
No specific time

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

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

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

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

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

38. How does plant cope with high humidity

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

Physical location of the project
Department of Food Science, Årslev

Project start
No specific time

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

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

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

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

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

39. 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.

40. 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.

41. 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 Sønderskov, 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

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/