




ANNUAL REPORT

2018


**TREES AND CROPS
FOR THE FUTURE**

/TC4F



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Trees and crops for the future, TC4F Annual report 2018

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Chairman of the board / Göran Ståhl

The research programme Trees and Crops for the Future (TC4F) is funded by the Swedish Government as a Strategic Research Area. It is conducted by SLU together with Umeå University and Skogforsk. TC4F develops knowledge to support society's shift from fossil-based to biobased economies through cutting-edge research in disciplines such as plant molecular biology, genetics, plant breeding, silviculture, and agriculture, combined with cross-disciplinary research and dissemination of results to practitioners, students, and the research society.

As announced already in the annual report for 2017 one of the researchers within TC4F, Professor Torgny Näsholm, received the 2018 Marcus Wallenberg Prize, a prestigious international award within forest sciences. This demonstrates the scientific significance of the TC4F programme as well as its societal impact, as one of the criteria for the Marcus Wallenberg Prize is that the scientific finding should have found substantial practical use. Another outcome in 2018 also demonstrates the societal impact of TC4F. Researchers in the programme have been instrumental in developing and launching a new center for securing a strong position for Sweden in agricultural



plant breeding. This center, SLU Grogrund, is funded by the Swedish Government and run by SLU in collaboration with plant breeding and food companies. An important focus of the center is to secure food production in Sweden by developing plant material for competitive and sustainable agriculture and horticulture in the entire country.

In order to benefit more from SLU Grogrund and other new initiatives within the broader research area of TC4F, the Vice-Chancellor of SLU decided (in autumn 2018) to modify the structure of the programme. Whereas TC4F will remain as a united programme, more emphasis will be put on developing synergies with closely related research within forest, agricultural, and horticultural sciences. Two sub-programmes have been formed, each with its own programme leader: one focusing on forest sciences (Prof. Annika Nordin) and the other focusing on agricultural and horticultural sciences (Prof. Eva Johansson). We now look forward to exploring new synergies within the revised programme structure!

Chairman of the board - Göran Ståhl

Program director / Annika Nordin

Plant science in focus

Trees and Crops for the Future – TC4F – develops knowledge on sustainable plant production and plant-based product development within agricultural and forestry systems with the main objective to support the development of a new circular bioeconomy in Sweden. The questions in focus of our research are, if possible, even more current and prioritized today, than when the program started in 2009 as a strategic research area designated by the government. In 2018 the organization of our program changed slightly, dividing into a tree and a crop unit with separate leaderships. The yearly reports will, however, continue to be common for the program.

The overarching goal of TC4F – producing new knowledge on plant-based systems for biomass production and products has in 2018 been widely recognized in relation to significant events and debates in science and society.

Trees for the future

At the TC4F large scale field research site in north-Sweden, the significantly dry and hot summer led to the main finding that the compound effect of drought and heat triggered thermal damage to leaves, causing a substantial reduction of the annual forest productivity at the site. Interestingly, our subsequent modelling analyses identified plant traits that could prevent such damages in our model organism Norway spruce. This means that it would be possible to modify the transcriptional responses of forest trees and their associated microbiome so that damage by changes in climate could be circumvented. However, this theoretical knowledge will have to be tested in practice, which is in scope for upcoming research bridging from basic research to application and between scientific disciplines.

Also, the summer's abundant forest fires led to increased media interest for our research at the site of the 2014

Västmanland forest fire, where TC4F researchers study long-term forest restoration and regeneration following fire.



Our demonstration example for new plant varieties using genome editing (CRISPR/Cas9) was intensively involved in the societal debate about whether genome edited plants should be considered genetically modified organisms (GMO). Despite the numerous testimonials of cutting-edge researchers from all over the world, that genome edited plants cannot be distinguished from a natural breeding product, the European Court of Justice ruled to change their status from being considered products of breeding to GMO.

This has great impact on both research on genome edited plants, but mostly influences the applicability of results of this research: not because of hampered application but because of restrictive legislation for growth, labelling and use of GMO and products containing GMO.

Crops for the future

For the development of crops for the future, Plant Protein Factory and fractionation of proteins from the non-used green tissues of plants for food, cosmetics and industrial applications have attracted major attention of media and public. Moreover, media was very interested in the nutritional type of GM-potato and the development of nutritional barley in cooperation with Lantmännen. New sources for oil production were further developed, on the one hand by domesticating and industrializing new species such as crambe and field cress, and on the other hand improving oil production in already domesticated species as rice, wheat and oat, where infrastructure for growth and processing is already established. The new Raspberry PI Platform for imaging of the kinetics of seed germination

and early seedling growth enables accurate comparison among genotypes and sampling for downstream lipid analysis and chemical screen and validation pipeline for discovery of small molecules with autophagy modulating activity in plants.

A major breakthrough was achieved in the creation of plant-protein based sustainable super absorbent polymers (SSAP), that can be composted or processed to biogas after use.

Successful long-term initiatives

For 2018, 87 peer reviewed articles were produced. Having run for ten full years, some long-term projects have been successfully completed, for example the sequencing of the aspen genome as well as a major breakthrough in the management methods for aspen and poplar establishment in practice. These species provide an interesting opportunity for short-rotation and high yield forest management in Sweden and hence a crucial finding from TC4F is that poplar (*P. trichocarpa* hybrids) is much more sensitive to the aluminium ions in acidic forest soil than hybrid aspen (*P. tremula* × *tremuloides*). Liming would, however, allow for efficient establishment of poplar on these acidic forest soils. We foresee that the deepened knowledge about the aspen genome and gene regulation will now allow for a develop-

ment of even better environmentally adapted poplar trees for the future.

Within Theme 4, two projects, Plant Protein and Factory Problöja, which were rooted in TC4F could be taken to the next level in developing novel plant-based products. Vinnova supports the establishment of a Protein Factory at SLU Alnarp and will in 2019 fund a diaper production pilot factory.

Grogrund, the competence centre for plant breeding was founded and received funding from the Swedish government.

New developments and restructuring 2019

From 2019 onwards, TC4F will be conducted as one research project with two parts, one T4F, focussing on trees and the other C4F focussing on crops. Theme 1, 2 and 3 will be included in T4F and Theme 4 will become C4F.

Within this new structure, Annika Nordin becomes the Program Leader for T4F and Karin Ljung will join her as the Vice Program Leader. Eva Johansson will become Program Leader for C4F with Li Hua Zhu as her Vice Program Leader.

Text: Annika Nordin, Anke Carius

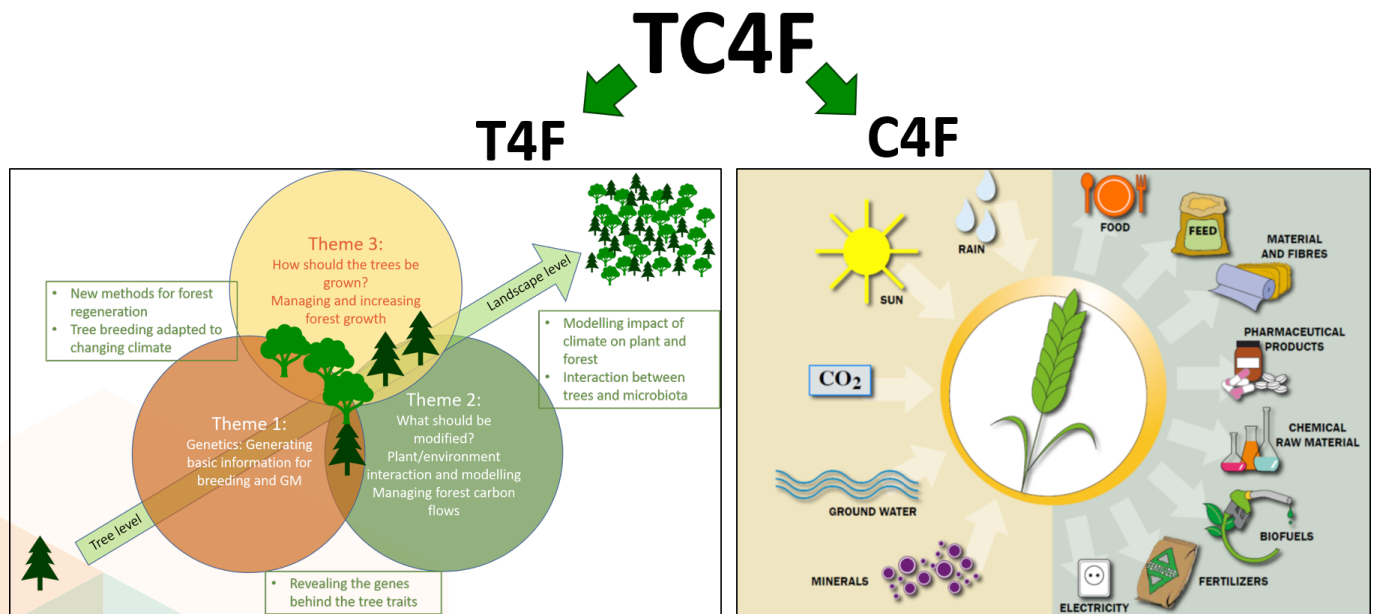




Photo: Mats Hannerz/Silvinformation AB

A photograph of a snowy forest scene. In the foreground, a large pile of cut logs is visible, with a metal cage-like structure on the left. A single tree trunk stands prominently in the center-right. The background is filled with snow-covered trees and branches. The overall tone is cool and wintry.

THEME REPORTS AND RESEARCH PORTRAITS

Theme 1 - Forest genetics and next generation of forest trees

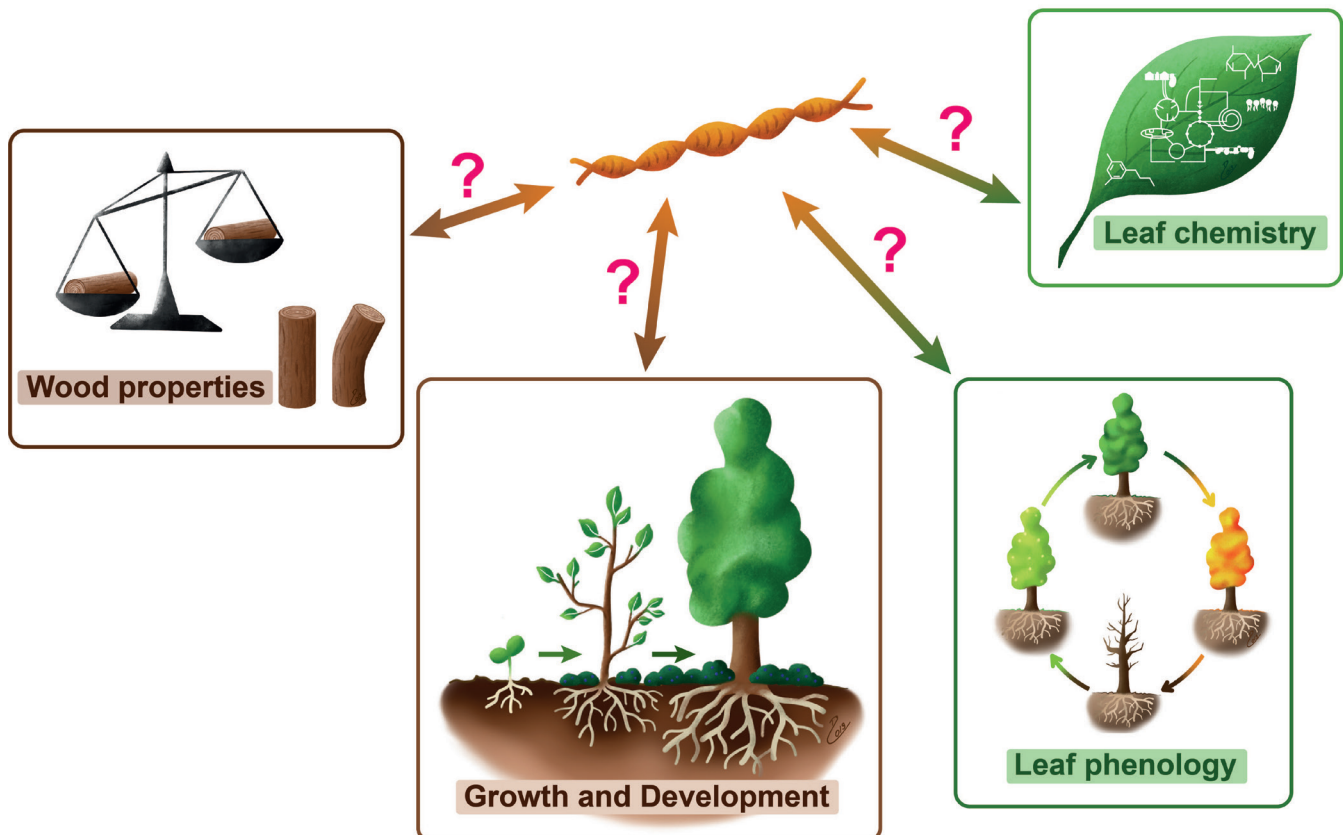
Theme 1 combines the world-leading genomic research at UPSC with applied tree breeding and other research disciplines. Recent progress include, for example, a reference genome sequence for aspen, the first genome-wide association study of aspen, and studies of genetic variation in pine-weevil resistance.

Overall progress of the research in 2018
The work in Theme 1 on novel forest trees bridges basic research at Umeå University and SLU with operational breeding at Skogforsk. Many basic scientific findings of the project results from the analysis of trees that are in breeding programs and/or are interesting for forestry. Activities within Theme 1 confirm that our scientific environment

is producing leading research on forest genetics and genomics with relevance for forest tree breeding.

A very significant proportion of the funding of Theme 1 is used for research infrastructure (e.g. tree transformation, bioinformatics, field experiments and cell wall analysis), supplementing other project funding. This infrastructure is

Theme 1: Forest genetics and next generation of forest trees



used by most research groups connected to UPSC but not all the research output of these groups is listed here, only activities directly relevant for TC4F.

The basic science parts of the program are mainly performed using aspen as model system. Two very fundamental long-term efforts have been published, the sequencing of the aspen genome (Lin *et al.* 2018) and the identification, using GWAS, of an aspen FT gene as mainly responsible for natural variation in bud set in the Swedish aspen population (Wang *et al.* 2018). This is perhaps the best example so far in the literature on the identification of a gene from a tree controlling an economically and ecologically important trait, all the way from an undomesticated tree population down to the molecular details. These landmark studies form the basis of the aspen work.

Main findings in 2018

Several of the published articles deal with tree phenology (Michelson *et al.* 2018, Grimberg *et al.* 2018, Ding *et al.* 2018, Wang *et al.* 2018) but also the interaction between trees and fungi (Agostellini *et al.* 2018, Albrechtsen *et al.* 2018, Haas *et al.* 2018, Randriamanana *et al.* 2018). Also, genome evolution has been addressed (Cole and Ingvarsson, 2018) and studies on wood formation has been completed (Ratke *et al.* 2018, Jokipii-Lukkari *et al.* 2018). Leaf development studies have been performed, using RNAseq, morphology and GWAS studies, giving a better understanding of leaf development in *Populus*. The version 2 of the *Populus tremula* genome has been completed (using PacBio reads and integrating optical and genetic maps) and is at present annotated. Other tools for advanced genomic analysis have been developed, like the seidr co-expression network interference tool (Schiffthaler *et al.*, in preparation) and improvements to the PlantGenIE resource (Mannapperuma *et al.*, submitted). Work to integrate PlantGenIE with the PLAZA resource from VIB, Belgium is underway underpinning other projects at UPSC like a joint UPSC-VIB-STT project to identify novel candidate genes for modifying plant growth and yield.

Genomic studies on *Eucalyptus* (Tan *et al.* 2018), *Pinus tabulaeformis* (Xia *et al.* 2018) and the chinese tree *Malania oleifera* has also been completed (Xu *et al.* 2018).

The more applied aspects of TC4F are mainly connected to Skogforsks breeding program. The potential in spruce for genomic selection (GS) relative to conventional pedigree-based selection have been studied (Chen *et al.*, 2018). The

GS accuracies were lower than those based on pedigree-based selections but as the breeding cycle length may be considerably reduced by using GS the efficiency per year was higher.

The effects of longitudinal transfer on phenology has also been studied and the results show that more northerly origins exhibit earlier onset of shoot growth and that continental origins show more northern phenological behavior Andersson Gull *et al.* 2018) which has implications on climatic adaptation.

Finally, the consequences of clonal forestry has been addressed in two studies (Bradshaw *et al.* 2018, Ingvarsson and Dahlberg, 2018).

Contributions to social benefit

In addition to creating societal benefit through the development of tools and resources for the tree breeders, visibility of the TC4F activities has also come through the participation in the societal debate, for example the European regulation of new plant varieties generated using genome editing (CRISPR/Cas9), where TC4F has funded the development of a “demonstration example”, that after the decision of the European Court of Justice on 25/7 2018 had got even more international attention (Jansson 2018 a and b).



Regulation of plant metabolism in response to abiotic environmental factors

The new Associate Professor in Theme 1 will use the experience gained from Arabidopsis to improve the understanding of environment stress responses in trees. Biological aging – senescence – is a complex mechanism where genetics and environment interact, and Olivier Keech goes deeper into the process.

By the end of 2018, Olivier Keech started his work as an Associate Professor within TC4F. Olivier's work about coping mechanisms for environmental stress factors in plants is a snug fit for Theme 1: Forest genetics and next generation of forest trees. Although Olivier's work has dealt mostly with *Arabidopsis*, he hopes that within the TC4F framework his knowledge on cellular metabolism will also benefit the research on trees.

Olivier's research focuses on two important metabolic processes; senescence and photorespiration. Both of them affect growth and biomass production in most plant species. For instance, when hotter and drier conditions are applied

to a plant, the flux through its photorespiratory pathway will be increased, which eventually leads to a lower carbon assimilation for a higher use of energy.

A plant has two options in response to such abiotic stress; either adapt to the new conditions with its existing structure or to replace the structures, a process called senescence. During senescence, or biological aging, plants have a genius, yet complex, self-recycling mechanism, by which they are able to remobilize key nutrients to other parts of the plant. In addition, grain filling, the senescence of the whole plant in favour of the seeds, may depend on the efficiency of this remobilization process, which thus



Leaf shedding is an example of how plants use senescence to meet environmental stress.



Olivier is showing an example of senescence in a poplar tree.

About Olivier Keech

Olivier Keech has completed two PhD-exams. In 2008, he became Doctor in Forest Ecophysiology at the University of Nancy and Doctor in Plant Biochemistry at Umeå University. He has also worked as a research associate in Perth, Australia between 2008-2011, and as Postdoc at Umeå University between 2011-2013 in collaboration with Professor Per Gardeström. Since 2014, he has been assistant professor at the department of Plant Physiology at Umeå University. He has also been awarded as laureate of the Gunnar Öquist Award and the SPSS Early Career Award.



strengthens the importance of this research. By gaining a better understanding of these molecular and physiological mechanisms, Olivier aims to optimize tree and crop production while minimizing the ecological impact on our ecosystems.

His vision is that after 2020, TC4F will become an essential research programme supporting and developing sustainable plant breeding, significantly reducing the ecological impact of forestry and farming.

/Text and photos Anke Carius.

Theme 2 - Growth and interaction with the environment - current and future

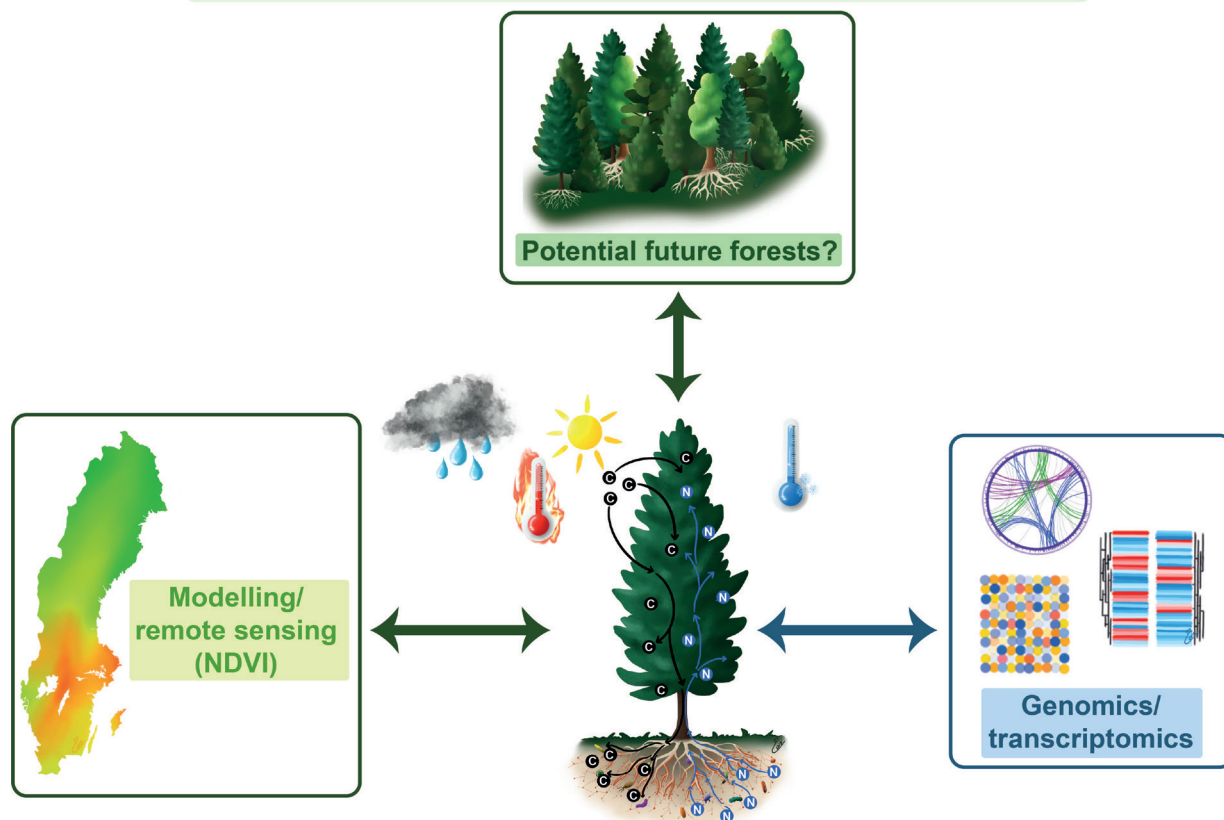
Research in Theme 2 deepens our understanding of the important carbon and nitrogen cycles, and the effects of climate change. Examples of research topics include plant responses to rising temperatures and increasing dry spells, process-based models for predicting vegetation responses to a changing climate and soil studies using metagenomics and microdialysis.

Overall progress of the research in 2018

The long-term goal of T4F is to provide strong basic research to aid the forest sector to prepare Sweden's forests to withstand future warmer and more extreme climates, while at the same time ensuring productivity and sustainability. Towards this goal, we have been working at a range of scales.

Specifically, we have used remote sensing data to determine risks to forest health and productivity arising from heat and drought stress, identified key molecular responses in Norway spruce (*Picea abies*) to heat, drought and cold stress, and assessed the physiological, biochemical and transcriptional responses of Norway spruce to long-term growth under elevated CO₂.

Theme 2: Growth and interaction with the environment - current and future -



We have also developed the expertise to analyze the response of the forest tree and forest soil microbiomes to changes in climate factors such as soil water and nitrogen input. As a logical subsequent step, we are now in the process of developing tools for analyzing the coordinated changes to both the tree and microbiome community transcriptional behavior so that we can assess the linked functional consequences of these different trophic-level responses to climate change and forest management. The negative effects of extreme heat and drought that clearly emerged in Northern Europe during the extreme summer 2018 have brought into stark focus just how urgent and challenging the future will be for the forest sector and wider society. The past and current research planned by this theme provides a coherent and planned response to this ongoing challenge.

Main findings in 2018

During 2018 our large-scale analyses, combining remote sensing data and standard meteorological data, showed that the compound effects of a lack of precipitation and warmer temperatures were the main trigger for thermal damage and substantial reduction of forest productivity within the mesic climate of Northern Europe. Our subsequent modelling analyses identified plant traits that allow high photosynthetic rates and prevent leaf level thermal damage during periods of high temperature and low evaporative cooling due to drought.

In partnership with these large-scale studies, we have been using Norway spruce as our model forest tree to identify the key genes and molecular mechanisms boreal conifers use to combat periods of drought. We found that in Norway spruce previously characterized key controllers of gene expression, *i.e.* transcription factors, identified from studies in flowering plants to control plant drought responses played only a limited role in Norway spruce. In contrast, a majority of differentially expressed genes were specific to the drought response of Norway spruce.

In related studies, and in response to concerns by the forest industry that spring frosts were causing increasing damage to planted conifer seedlings, our studies indicate that Norway spruce principally utilizes early response transcription factors that are similar to those already characterized in flowering plants. However, we identified a large group of transcription factors that are unique to Norway spruce that mounted a strong, delayed transcriptional response to cold, including previously unidentified transcription factors that exhibit root-specific responses.

These results demonstrate not only the importance of profiling both above- and below-ground tissues but also highlight the importance of conducting detailed molecular studies in conifer model species so that we can identify target genes for selective breeding programs for spruce and pine.

The studies described above all address key plant-climate or plant-atmosphere interactions. However, understanding plant responses to climate and ecosystem level changes also requires disentangling the diverse and complex plant-soil interactions.

During 2018 we initiated a WABI long-term support project on meta-transcriptomics analysis of Norway spruce root-associated fungal species, coupled to in-depth analysis of seasonal and nutrient-induced changes in spruce root transcriptional behavior. To analyze these highly complex datasets we have applied machine learning approaches that identified key hub genes describing the interactions between these different driving forces.

We also know that nutrient availability and the composition and role of the soil microbiome will likely change under future climate conditions and that this will impact forest growth. We have combined the analysis of the soil microbiome with microdialysis in order to establish the responsiveness of the soil microbial community to various substrates known to be released from plant roots. This will influence plant nutrient availability, and the project will characterize at the micro-scale the diversity of microbes colonizing the membranes, and thus growing roots, when they are releasing different compounds into the soil.



Evaluating the economy of tree microbe symbiosis using an artificial root system

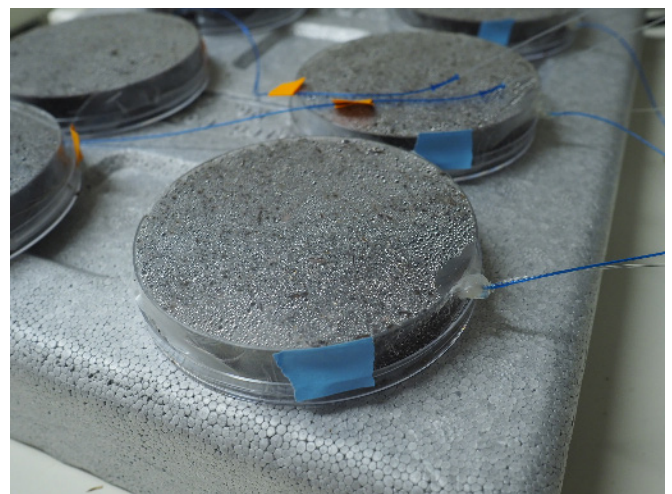
Mark Swaine, a post-doc in Sandra Jämtgård's group within Theme 2, has moved the root system into the lab to study root-microbe interactions. In a natural root/microbe symbiosis, the microbes deliver nutrients, mostly nitrogen, to the plant which in return nourishes the microbes with organic carbon.

The difficulty with studying interactions between two biological systems is the great number of unknown factors; both the microbes and the roots are difficult to monitor simultaneously. Instead, Mark is developing the microdialysis method to study the importance of amino acid availability to plants in soil. Microdialysis mimics a plant root and was previously developed by Torgny Näsholm's group.

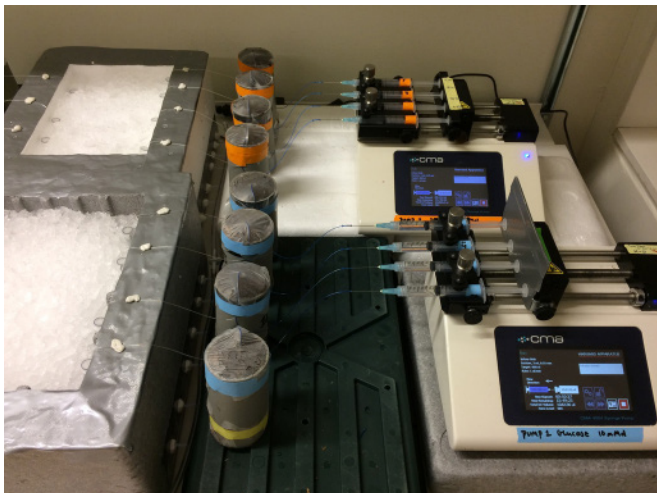
The microdialysis membrane is colonised by soil microbes by providing a carbon source for growth. In this system, the root side of the symbiosis is fully controlled by the researcher. He or she can therefore dictate the type of carbon that is applied to the system, and this gives a possibility to study the effect of different root exudate compounds on the structure of soil microbial communities. Moving the system to the laboratory presents a new opportunity for analysis of the variation in the soil microbial community. Next generation sequencing is applied in this part of the project and data is being evaluated in cooperation with Nathaniel Street and his group.

Future steps may allow the possibility to understand exactly how much carbon a plant is paying the microbes for nutrient return and how this relates to the structure of the colonising 'root' microbes. When this is combined with environmental factors, as for example the climate, these data will be of great value for future modelling approaches, contributing to the estimation of the impact of climate change on plant nutrient availability.

/Text Anke Carius.



The field studies in Rosinedal, Vindeln. The upper organic layer has been moved to the petri dishes. Photo: Mark Swaine.



Sampled cores from the Rosinedal study, making a "semi-in situ" experiment in the laboratory. *Photo: Mark Swaine.*

About Mark Swaine

Mark Swaine has a Bachelor of Science in Environmental Science at the University of Nottingham and a Master of Science in Environmental Management at the University of Reading. His PhD was defended at the University of Nottingham. He is currently a Postdoc at the Swedish University of Agricultural Sciences in Umeå in the group led by Sandra Jämtgård.



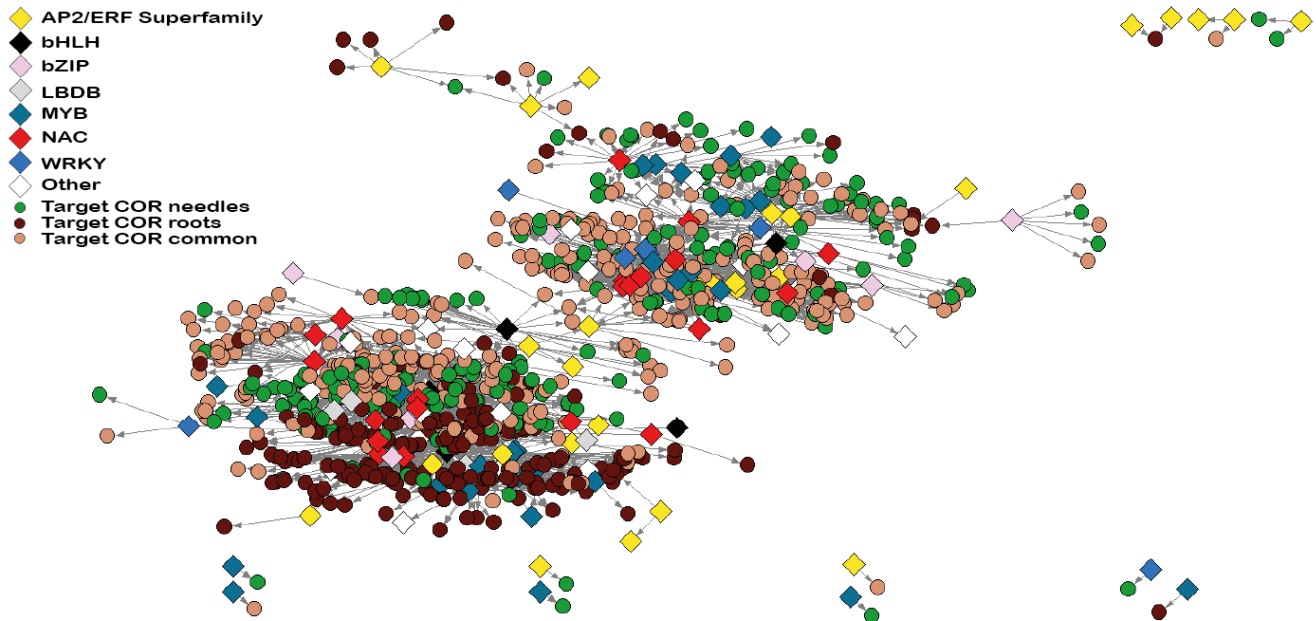
Studying gene regulatory mechanisms of Norway spruce in the face of stress

Computer models can help researchers reveal and understand relations between different causes and effects. In Theme 2, modelling is used to show relations between climate and gene expression. Alexander Vergara works on establishing a model of the regulatory network of stress responses in Norway spruce.

Norway spruce is a prominent tree species in boreal forests with an important economic value and a key ecological role. Climate change comes not only with higher atmospheric temperatures, drought and higher CO₂ levels, but also with higher temperature fluctuations around zero which imposes an increased risk for the loss of frost tolerance in trees. How fast can spruce adapt to different temperature and growth conditions? Which metabolic pathways are principally affected, and which are the key genes driving these changes? Which genes are good candidates to be manipulated to improve spruce adaptability?

These are central questions for Alexander Vergara, working within the framework of Theme 2, Growth and interaction with the environment - current and future, studying the transcriptional responses of spruce to abiotic stress.

As a bioinformatician, Alex brings data back to life in his computer. He and colleagues evaluate data from transcriptome analysis of spruce trees that have been exposed to cold, drought, heat, or high CO₂ stress. His research helps to estimate the impact of climate change on single trees and the forest as a whole.



Regulatory network analysis. Network representation of regulatory interactions between Transcription Factors (TF) and cold responsive (COR) genes. TF are represented by diamonds and their family membership by colours. COR genes are represented by circles and colored according to the tissue where they are differentially regulated



Norway spruce in a growth facility. *Photo Zsófia Stangl.*



A gas exchange measurement tower and instrument hut at the research site in Rosinedal, Vindeln, Northern Sweden. *Photo Andreas Palmén*

About Alexander Vergara

2009 Ph.D. in Sciences Molecular Biology, Cellular Biology and Neurosciences Doctorate. Universidad de Chile; after his Ph.D. Alex worked for a Biotechnology Company in Chile until coming to Sweden to join TC4F Project in 2017.

By modelling the regulatory networks of stress responses, Alex has identified important regulators of spruce cold stress response which in the future can be used to improve and adapt trees to the changing conditions.

The data Alex uses for his models come from the work of his colleagues in the field. Alex collaborates with Julia Haas and Nathaniel Street analysing cold and drought stress, but also with Zsófia Stangl and Kathryn Robinson in a heat stress response study. His work is a great example how interdisciplinary networking between researchers can contribute to design Trees 4 the Future.

/ Text Anke Carius, photo Alexander Vergara



Theme 3 - Sustainable and adaptive forest management

Theme 3 aims to develop new tools and knowledge for a sustainable use of our forest resources. New site-index calculation based on climate indices, management methods for poplar and hybrid aspen, models for genetically improved Scots pine and establishment of mixed forests are some of the topics in the program.

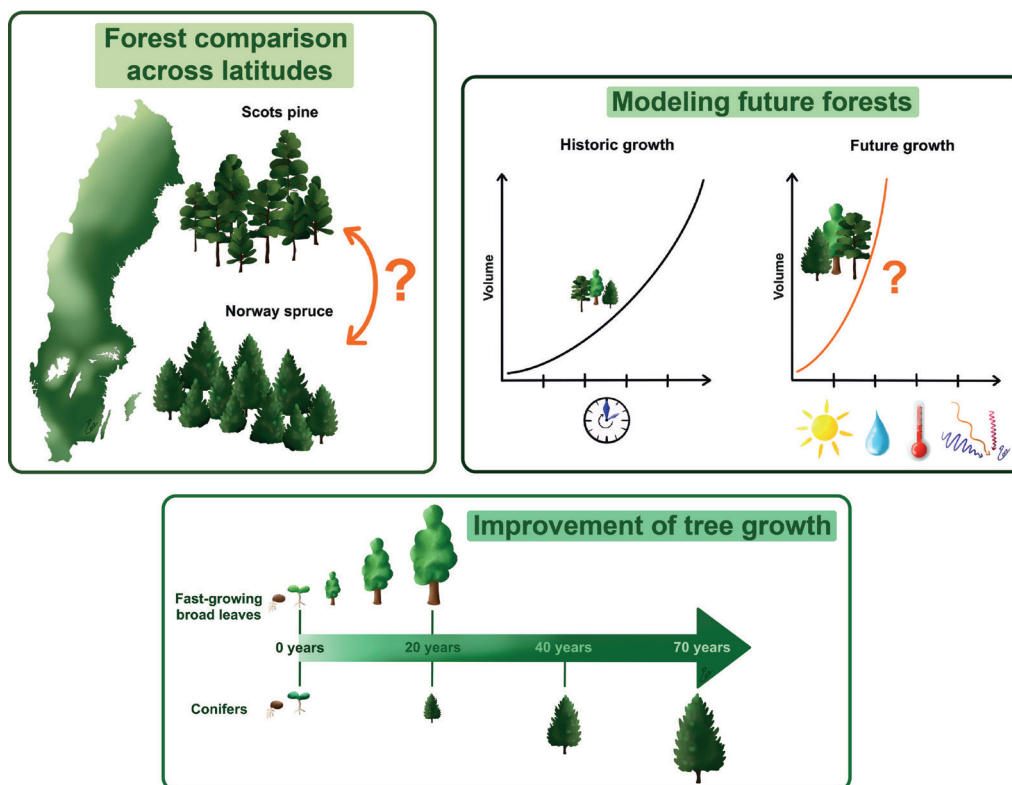
Overall progress of research in 2018

During 2018, activities in Theme 3 was concentrated on continuing projects that were started during 2017 but new research was also initiated. Three PhD-students were ongoing and a fourth student started within the program in the beginning of 2018.

The first student, Oscar Nilsson, is studying silviculture in Scots pine and Norway spruce in southern Sweden. During 2018, he has concentrated on analyzing a large regeneration

experiment that has been followed for six years. The second PhD-student, Theresa Ibáñez, is studying regeneration in the fire-area outside Sala and has been busy collecting data from the field experiments. She has also finished a greenhouse study that will be analyzed and reported during 2019. The third PhD-student, Martin Goude, will build a hybrid growth model for Scots pine and Norway spruce in Sweden. However, to start with, he has constructed an empirical model that will serve as a base-line for the new hybrid model. Martin is currently in New Zealand at the

Theme 3: Sustainable and adaptive forest management





PhD students Martin Goude and Oscar Nilsson were two of the actors in a film about pine, spruce and mixed forests published in the knowledgesystem www.skogskunskap.se. Screenshot.

University of Canterbury in Christchurch where he is working together with Euan Mason who is a world-leading modeler. The fourth PhD-student, Gustav Ståhl, started during 2018 and will be working with carbon sequestration.

However, in addition to the continuation of research projects, intermediate reports from projects that had been started during the previous year and in some cases also during phase one were published (see below).

Main findings in 2018

We have had a major breakthrough in the research findings both with management methods for how poplar establishment should be performed in practice and in the understanding of why there are differences in establishment between poplars and hybrid aspen. A field experiment on lime- and ash-treatments in regeneration has been finished and will be reported in a scientific report. We have applied for funding for establishing long-term experiments to study growth and other ecosystem services in plantations of fast-growing exotic broadleaves as compared to conifers and domestic birch plantation.

An important project within theme three is silviculture in mixed forests. During 2018, we have finished a large survey-study where mixed birch-Norway spruce is compared to pure Norway spruce. With data from the survey, a manuscript on ground vegetation development have been submitted for publication and a Master thesis on year-ring development has been finished. Studies of stem-volume growth is ongoing and will be reported during 2019. Results from a large field experiment on mixtures of Scots pine and Norway spruce showed that the monoculture of Scots pine had highest growth but that high individual-tree growth of Scots pine in the mixture compensated for poor growth of Norway spruce (Holmström *et al.* 2018).

Contributions to social benefit

Research in Theme 3 is partly of an applied nature and is done in close collaboration with the forest sector and other stakeholder categories. Research conducted in Theme 3 is frequently reported in popular forest magazines.

We have continued to arrange excursions and other types of education for the practical forestry. The major excursions during 2018 were one arranged by theme 1-3 in collaboration and one in collaboration with the research school FRAS but we also participated in numerous of other excursions and meetings.

There has been quite a lot of media attention regarding the recovery of the Sala fire site, and the principal investigator (M-C Nilsson-Hegethorn) has contributed to public information through interviews with media. The research group has during 2018, established new contacts with University of Gothenburgh, Lund University and Swansea University, and they have visited new fire-areas after the dry summer of 2018. The outcome might be practical experiments in some of the fire areas.

During the autumn of 2017, the research project FRAS was started. FRAS is made up of six PhD-students and researchers from Theme 3 act as supervisors for many of the students. Two work-shops and one excursion were arranged by FRAS and TC4F during 2018.



Fire, soil and forest regeneration

Global warming with increased fire frequency will impact the forest ecosystem in many ways. What happens to the soil and the early establishment of seedlings? This is the question to be answered in the doctoral work by Theresa Ibáñez, PhD student in Theme 3.

Theresa Ibáñez' doctoral work aims to improve the understanding of how global warming, fire and salvage logging impact tree seedling regeneration and soil properties. In Sweden, wildfires have become not a potential, but a real, threat to the forests. A fire in central Sweden in 2014 burnt down forest on 14,000 hectares, and the fourth largest fires in 2018 covered together 20,000 hectares.

Wildfire is a natural disturbance in a boreal ecosystem. But extreme weather with increased temperatures and drought may lead to more frequent and intense fires. What are the consequences for the forest ecosystems? Theresa Ibáñez focuses on the initial phase after the fire – the regeneration.

– We need to know more about what happens to the soil processes after fires of different intensities. How will heterotrophic organisms be affected, what about nitrification, and what are the consequences for the trees that will be established there, she asks?

A large number of experimental plots has been established in the area that was struck by the fire in 2014, the so-called *Sala fire* (Hälleskogsbrännan). The plots are distributed over forests of different burn severity, and they are also divided in plots which are logged and plots where the damaged trees are left. She will look at the soil processes as well as monitoring the establishment phase of planted seedlings.



In all plots, half of the area is salvaged logged while the trees remain on the other half. Open-top chambers simulate an even higher temperature.



Greenhouse tests with soil from the burnt sites.

Besides, she conducts experiments in greenhouse and laboratory to study how the biota from soils of different burn severity affect tree seedlings growth of pine, spruce and birch.

– For the greenhouse experiment we sterilized soil, collected in field, and added living biota from the same soil gradient of more or less burnt soil. Statistical analyses are ongoing, but we can already see differences between treatments of biota from the control, high and low burn severity, she says.

An even higher temperature may also affect the soil processes and seedling growth. In open-top chambers in field, a warmer climate can be simulated. The chambers will increase air temperature by 1-2 degrees. For two growing seasons she has studied the phenology and measured growth of the seedlings growing in the open-top chambers. Following season will be the last to observe the development of the seedlings and they will after that be harvested for further biomass estimations.

The Sala fire area is a large experimental arena for many researchers. Theresa Ibáñez work in a ten-person group from SLU who conducts various studies on the soil processes, ground vegetation and tree growth.

– The combined research in the area will gain a better understanding of how the ecosystem recovers after a fire and what the consequences are for the production forest as well as for the natural ecosystem, Theresa Ibáñez concludes.

/ Text Mats Hannerz. Photo Theresa Ibáñez.

About Theresa Ibáñez

Theresa Ibáñez was born and raised on Tjörn on the west coast of Sweden. She gained an early interest in nature, which took her to Master studies in environmental science. A mission in Rwanda had the object to compare soil characteristics between primary and secondary forest, and she found, *inter alia*, that the secondary forest had higher soil respiration. The experiences led to PhD-studies at the Swedish university of Agricultural Sciences in Umeå, where she started in 2017 with Professor Marie-Charlotte Nilsson Hegethorn as main supervisor. The PhD education is planned to be completed in 2021.



Theme 4

- Other renewable plant resources, non-food crops

New barley lines with added value, climate-friendly rice, novel tissues for oil production, plant-derived insect pheromones and human hemoglobin, novel up-scaling methods for biofoams production, crack-resistant biocomposites and protein extraction routes. Those are some examples of deliverables based on research in Theme 4. Most of the products are still under development.

Overall progress in 2018

The majority of the subprojects within Theme 4 have run as planned and produced good quality of science. Some have led to obtainment of new funding to reach the society, of which SLU Grogrund projects, Plant Protein Factory and two FORMAS projects are major examples.

We have produced a number of peer-reviewed publications of high quality, new PhD or Master theses and have new PhD students joining the theme, which are partly in new research areas to secure future good/high quality research. Apart from the above-mentioned major examples, we have also successfully obtained a number of research grants associated with the TC4F program in 2018.

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Fig. 1: The use of modified proteins from bioresources raises a sustainable and economical alternative to water-absorbent materials. These materials with high swelling capability have been prepared as particles and foams, both resembling the swelling properties of their petroleum-based counterparts." Volume 7, Issue 5, Pages 4532-5587 <https://pubs.acs.org/toc/ascecg/7/5>.

Main findings in 2018

In the biobased material part, we have published results about impact of a new source of transglutaminase on dough and baking quality (Ceresino *et al.* 2018a and b; Fig.1). However, the main results are from the Problöja project, which are at present awaiting publication due to patent issues. They are also planned to go into a new Vinnova application for "utvecklingsdriven innovation" to build a pilot factory. The fractionation of proteins from the green tissues of plants for food, cosmetics and industrial applications has attracted good media and public attentions, while the use of horticultural wastes left in the field after harvest is of direct interest for industries (Fig. 2).

We have also published the work on resistant starch (RS) in high amylose potato, in which we concluded that the elongated outer chains of the amylopectin in the high-amylose potato gives recrystallized amylopectin that is partly resistant (Zhao *et al.* 2018). Developing a simplified method for determination of the branching density in amylopectin has been in good progress.

The finding of a molecular Yin-Yang system that regulates the carbon flux between starch and fiber in barley has generated two patents: US provisional patent application (No. 63/731,282) and an international patent (WO 2018/182493 A1), as well as one SLU Grogrund project.

The different isoforms of crambe *DGATs*, the final enzyme in oil accumulation, have been further studied with focus on the fatty acid 22:1 as substrate for further increasing its level in seed oil. The combinatorial effects of the acyl donor and acyl acceptor for the *DGATs* have been investigated and the result shows that the crambe *DGAT* isoforms readily accept 22:1-CoA as acyl donor, but inefficient in utilizing di-22:1-DAG as acyl acceptor.

Field trials on *Camelina* (Fig. 3) were conducted in Nebraska and Sweden and seeds were collected for analyzing the target pheromone precursor content. A new compound for pheromone production and wax esters have been produced in *Camelina* seed oil that could potentially be used as pheromone precursors.

We have established 1) Raspberry Pi-controlled imaging platform for monitoring kinetics of seed germination and early seedling growth that enables accurate comparison among genotypes and sampling for downstream lipid analysis., 2) established chemical screen and validation pipeline for discovery of small molecules with autophagy modulating activity in plants. Three new activators and one inhibitor of autophagy have been identified. We have also performed transcriptional profiling of ATG genes in *Arabidopsis* during starvation-induced autophagy response with the ultimate goal to discover transcription factors controlling rate-limiting steps of autophagy.

We have further characterized the human fetal hemoglobin protein produced in tobacco leaves and performed the mouse test. The results showed the purified protein is active and the mice did not show any negative response after being injected with the protein.

We have finalized and submitted three manuscripts in carbon allocation: 1) phenotypic, metabolic and transcriptomic implications of oil production in wheat endosperm overexpressing oat *WRI1*., 2) analysis and comparison of transcription factor gene expression of oat embryo and endosperm., 3) functions of the transcription factor *WRI1* in channelling carbon to oil in relation to structures and functions of different protein subdomains as well as autoregulation between the *WRI1* protein and its cis-controlling elements. A large set of RNAseq data regarding transcription factors (TFs) involved in embryo development and oil accumulation were obtained and some TFs will be validated regarding their interactions in oil accumulation.



Fig. 2: Kale field during harvest. To the right unharvested, middle harvested and to the left ploughed part of the kale field. Approximately half of the kale plant is used for human food, rest is becoming waste. This waste could be used to extract bioactive compounds, such as phenolic compounds, and dietary fiber. Photo by Emilia Berndtsson



Fig. 3: Camelina (*Camelina sativa*) plants in the field trial in Borgeby that are used for extraction of oil and wax esters for production of insect pheromones, which are then used for control of insects in more secure and environmentally friendly manner than what are used today. Photo by Per Hofvander.

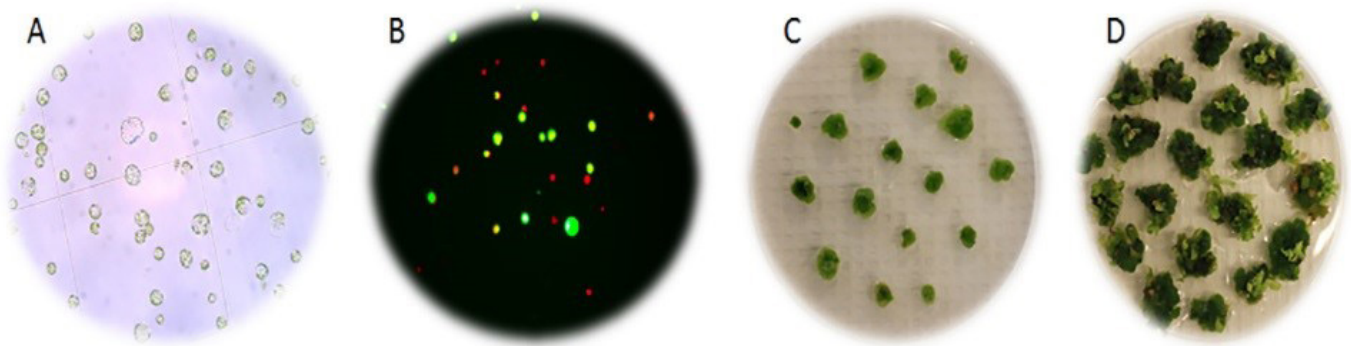


Fig. 4: Protoplast regeneration process of *Lepidium campestre*. A: Freshly isolated protoplasts. B: Protoplast viability test by FDA, green protoplasts are living ones. C: Callus formation from protoplasts. D: Shoot formation from the callus. Photos by Emelie Ivarson, Sjur Sandgrind and Li-Hua Zhu.

We have recently found that the higher oil content in wild rice (Fig. 5) is regulated by a single gene and overexpression of this gene in a rice cultivar led to significantly higher oil content and biotic stress tolerance against rice brown planthopper and rice blast fungus.

We have successfully developed an efficient protocol for growing protoplasts of *Lepidium* (Fig. 4), which is an essential method for genome editing using CRISPR/Cas9 through transient gene expression with no any external DNA integration into the plant genome.

Contributions to social benefit

The theme has been able to provide new knowledge and information to the general public on novel potential uses of proteins derived from plant residues. The interest in the research activities within this theme has been increased in 2018 with more contacts with industry and society for several research activities. We have also started to build pilot plants to reach the society and obtained a couple of large projects with close collaboration with industries with a clear goal to reach the society, while the more nutritional type of GM-potato has attracted high attention of media.

The finding of the Yin-Yang system has enabled a closer collaboration with Lantmännen for developing nutritional barley for commercial production, which would bring benefits to consumers and producers. With a growing global population and climate changes together with depletion of fossil oils, more and more vegetable oil will be needed in a near future for food, biofuels and industrial purposes.

Domestication of the new oil species *Lepidium* will provide possibility to grow oil crops in cold climate conditions where there is almost no oil crop production today. We are also

exploring novel tissues and new species for oil production particularly in crop species where an infrastructure for extraction already is in place and where oil biosynthesis could provide an additional valuable side stream in processing.

Plant production of fatty acid derivatives used for insect pheromone production is renewable and more environmentally friendly in comparison to synthetic alternatives that are currently available on the market.

There is increasing worldwide demand for donated blood and blood products, especially in rapidly developing countries. However, the number of blood donors is not matching these demands, Moreover, blood has short storage ability and needs to be cold stored and has a susceptibility to viral contamination. A blood substitute can provide clinical benefits in terms of availability, safety and convenience. Development of plant-based blood substitute would contribute to saving lives and human health.





Fig. 5: Transgenic rice plants overexpressing a lipid biosynthetic gene showing increased oil content. Photo by Chuanxin Sun

Improved starch for health and environment

Mariette Andersson uses the new technology genome editing to design tailor-made plants with better properties. Her focus is on potato starch. Starch that can be used for bioplastics and healthy starch with a low glycemic index are just two examples of all options with genome editing.

– Genome editing is a very powerful tool, and it can be used in many ways to improve sustainability and health, she says.

Mariette and her colleagues develop new potato varieties where they tailor the starch quality for various purposes. Potato starch is made up of the molecule *amylose* (20-30 percent) and *amylopectin* (70-80 percent). By editing various stages in the starch biosynthesis, they have been able to develop varieties with either only amylopectin or with mostly amylose, instead of a mix between the two.

The starch with amylopectin is, when used in products, storage stable and can pass through several processes in food production without losing its function. This starch can be used to give texture to soups, sauces and creams without the need of chemical modification. The content list on food packages sometimes shows “modified starch”. This chemical modification is energy- and resource-demanding. Amylopectin potatoes would thus be a more environmental-friendly alternative.

– A cooperation with Lyckeby Starch AB has resulted in an amylopectin potato that is ready for upscaling, and later on commercialization, says Mariette.

Starch with only amylose has other benefits. It has a low glycemic index and acts more as a dietary fiber than a carbohydrate. The reason is that the amylose molecules have long straight glucose chains. The amylopectin has,

in contrast, short branched chains. The properties of the amylose make it suitable also for environmental-friendly packaging materials.

Much of the attention that has landed on Mariette Andersson in recent years has been about genome editing, method development and the advanced amylopectin and amylose starch products. Products which might have difficulties to enter the market due to EU regulation.

– If we shall achieve the sustainability goals, we must change our lifestyle. But we must at the same time come up with technological innovations that can contribute to sustainability. Our research is an example of how new technology can contribute to sustainable development, but the European legislation that regulates genetic modification and genome editing is unfortunately a hurdle, explains Mariette Andersson.

Mariette Andersson has studied potatoes and starch quality during most of her career. She wrote her doctoral thesis when she was employed in the plant biotech industry.

– My industrial background has made me interested in applied research. I am glad that my results are applicable and of interest for the industry.

/ Text Lisa Beste. Portrait photo Viktor Wrange.



Genome editing can make this potato healthy.
Photo: Mariette Andersson.

Genome editing

Genome editing, or genome engineering, is a type of genetic engineering in which DNA is inserted, deleted, modified or replaced in the genome of a living organism. Unlike early genetic engineering techniques that randomly inserts genetic material into a host genome, genome editing targets the insertions to site specific locations. (Wikipedia)



About Mariette Andersson

Mariette Andersson is a Researcher and Deputy Head of Department at Swedish University of Agricultural Sciences, Department of Plant Breeding, SLU, Alnarp. Her main research interest is to design plants to produce tailor made compounds with health- and/or environmental benefits, by using genome editing or genetic modification. Prior the current position, she was working 12 years in the plant biotech industry, focusing on the development of different potato traits and characterisation of GM elite events for deregulation in EU. Mariette received her PhD in Biochemistry from Lund University 2004.



TC4F in 2018

5 December

Julia Haas defends her thesis:
"Abiotic stress and plant-microbe interactions in Norway spruce"



12 October

Faraz Muneer defends his thesis
"Novel uses of bio-polymers in composites: from chemistry to processing of materials and food"



25 September

Henrik Böhlenius publishes news and popular science article about why Poplar grow much better with liming on acidic forest soils.



21 August

TC4F excursion to research sites around Umeå. The youngest participant Linus.



July

Large forest fires result from extremely dry summer month, threaten research sites rise attention to research topics as forest regeneration.



July

Aug

Sep

Oct

Nov

Dec



Jan

Feb

March

April

May

June

2 February



How green is a healthy plant?
Environmental monitoring from the sky gains media attention for European Cost Action Harmonious project

8-10 March



Scifesten:
Theme 4 is involved in the presentation of future foods for kids and families in Uppsala

12 April



Stefan Jansson, Interview in Erin Brodwin: A controversial technology could save us from starvation — if we let it.

Businessinsider



TC4F publications and activities 2018

The four themes of TC4F have published 86 articles in peer-reviewed scientific journals, contributed to society with popular communication and media presence, and been involved in education as supervisors or course organizers. In 2017, 10 students supervised in TC4F defended their PhD or Master degrees.

Authors marked in **bold** represent researchers that have been financed by, or are associated to, TC4F.

Theme 1

- Forest genetics and next generation of forest trees

Scientific publications

During 2018 Theme 1 has published 33 peer reviewed scientific articles in international journals.

Agostinelli, M., Cleary, M., Martin, J.A., **Albrechtsen, B.R.**, Witzell, J. 2018. Pedunculate oaks (*Quercus robur* L.) differing in vitality as reservoirs for fungal biodiversity. *Frontiers in Microbiology*, 9,1758.

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Jansson, S. 2018. Cited in USA dają zielone światło żywności modyfikowanej za pomocą CRISPR. *Dziennik Naukowy* 25/10 2018. <https://dzienniknaukowy.pl/czlowiek/usa-daja-zielone-swiatlo-zywnosci-modyfikowanej-za-pomoca-crispr>

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Jansson, S. 2018. Interview in Daniela Ruffel: The EU Court of Justice extends the GMO Directive to gene-edited organisms. *FEBS Letters* 13/11 2018. <https://febs.onlinelibrary.wiley.com/doi/full/10.1002/1873-3468.13293>

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Jansson, S. 2018. Cited in Lorene Mesot: Pas de super-légumes au menu des Européens. *Largeur* 20/12 2018. <https://largeur.com/?p=8372>

Jansson, S. 2018. Interview in CRISPR och makten över vår evolution. *Sveriges Radio P3 Dystopia* 24/12 2018. <https://sverigesradio.se/avsnitt/1222549>

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Lee, N. 2018. Interview *Vetenskapsfestivalen*, with Karin Gyllenlev, Möt en av Sveriges 100 häftigaste forskare

Street, N.R. 2018. Asporskare går i mål efter tio år, November 1. <https://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=7078013>

Westin, J. 2018. Unik skogsforskning kan bli kvar i Sävar. Intervju SVT Västerbotten 2018-12-05 https://www.svt.se/nyheter/lokalt/vasterbotten/omtag-for-jarnvagen-forbi-savar?utm_campaign=unspecified&utm_content=unspecified&utm_medium=email&utm_source=apsis-anp-3

Scientific presentations

Jansson, S. 2018. Cooking (and eating) the first gene-edited meal. Invited lecture, GARNET conference, Bristol, UK 26/3 2018

Jansson, S. 2018. Genome editing using CRISPR/Cas9 in plants and the EU GMO legislation. Invited CBC Keynote lecture, Loomis (CBC Symposia & Workshop. Genome editing – Putting together the pieces, Ames, Iowa, USA 9/5 2018.

Jansson, S. 2018. Genome editing and the EU GMO legislation. Where Is Life Science Heading In The Future? Invited talk Engelsbergs bruk 14-15/5 2018. <https://www.axess.se/tv/program.aspx?id=5570>

Jansson, S. 2018. Natural variation in aspen. Beijing Forestry University. Invited talk August 29.

Jansson, S. 2018. Genome editing using CRISPR/Cas9 in plants and the EU GMO legislation. Invited talk OECD conference CRISPRing, Budapest, Hungary 4/9 2018.

Jansson, S. 2018. Genome editing using CRISPR/Cas9 in plants and the EU GMO legislation. Invited talk ÖGMBT conference, Wien, Austria 17/9 2018.

Jansson, S. 2018. Genome editing in plants using CRISPR/Cas9 and the European GMO legislation. Invited talk on seminar Genome editing - to feed, to fuel and to cure. IVA Stockholm, 24/10 2018. <https://www.iva.se/event/genome-editing---to-feed-to-fuel-and-to-cure/>

Jansson, S. 2018. How genomics has tied Skogforsk and UPSC together. Invited talk on Bengt Anderssons retirement symposium, Skogforsk Umeå 13/12 2018

Keech, O. 2018. The regulation of primary metabolism during leaf senescence or “how to exchange a piston while the engine is running”. Invited lecture at University of Lorraine, Nancy, France (May 2018).

Lee, N. 2018. The role of microbes in a changing world – what are the threats and possibilities? University of Pretoria, South Africa, South Africa-Sweden Research & Innovation Week, 14-18 May 2018.

Lee, N. 2018. Cave biology and astrobiology. Swazi Trails Adventure, Swaziland. 20th May 2018.

Lee, N. 2018. Microbial Geoecology and Astrobiology, Microbiology and Environmental Biotechnology Research Group Agricultural Research Council, Pretoria, South Africa. 22nd May 2018.

Lee, N., Gentili, F., Funk, C., Sellstedt, A. 2018. Measuring nitrogen fixation - a historical overview and future prospects. 13th European Nitrogen Fixation Conference, 18-21 August 2018, Stockholm, Sweden.

Nilsson, O. 2018. FT Paralog Subfunctionalization in the Regulation of Plant Growth and Development. University of Grenoble. Invited talk March 26.

Nilsson, O. 2018. FT Paralog Subfunctionalization in the Regulation of Plant Growth and Development. Beijing Forestry University. Invited talk August 29.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen and Norway spruce. PDBMBTS International Symposium Aug 2018, Beijing Forestry University, China.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen. Taiwan Society of Plant Biologist Annual Meeting Aug 2018, Tainan, Taiwan.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen and Norway spruce. Acta Sinica Invited presentation, Aug 2018, Taipei, Taiwan.

Street, N.R. 2018. Phenotypic possibilities from transcriptional plasticity. Gordon Research Conference ‘Multiscale Plant Vascular Biology’, June 2018, Mount Snow, Vermont, USA.

Popular scientific presentations at meetings or excursions

Jansson, S. 2018. Why should you communicate science? Presentation at REAL (course for future research leaders), Umeå 25/1 2018.

Jansson, S. 2018. Nye planteforædlingsteknikker – snart i et køkken tæt ved dig? Presentation at Landbrugsstyrelsens temadag om nye planteforædlingsteknikker (Folketinget, Danmark). 30/1 2018. <http://www.ft.dk/samling/20171/almdel/MOF/bilag/543/index.htm>

Jansson, S. 2018. Are GMOs the future of sustainable agriculture? Popular science presentation at Chalmers, Göteborg 1/3 2018.

Jansson, S. 2018. CRISPR – Hur fungerar det? Popular science presentation at Nobelmuseets lärardagar, Umeå 8/4 2018.

Jansson, S. 2018. Plant from the lab. Popular science presentation

at Sweden Foodtech The Big Meet. Kulturhuset Stockholm 6/6 2018

Jansson, S., Andersson, M. 2018. New plant breeding technologies. Popular science presentation EU Food 2030 conference, Plovdiv, Bulgaria 14-15/6 2018

Jansson, S. 2018. Global livsmedelsförsörjning – vilken roll kan GM-grödor spela? opular science presentation Örebro universitet 18/9 2018

Jansson, S. 2018. Deltagande i paneldebatt "Genrevolution gir ny mat - Er vi klare for genredigering i Norge?". Litteraturhuset, Oslo 27/9 2018

Jansson, S. 2018. Frankenfood - kan miljörelsen bli vetenskapens fiende? Popular science presentation på temadag om Frankenstein, Väven, Umeå 6/10 2018

Jansson, S. 2018. To be or not to be a GMO. Popular science presentation. Scientific American seminar, Sao Paulo, Brazil, 15/10 2018

Jansson, S. 2018. To be or not to be a GMO? Popular science presentation for Finnish students. Umeå 22/11 2018.

Jansson, S. 2018. UPSC – Norra Europas ledande växtforskningsmiljö. Popular science presentation at temadag on Livsmedelsproduktion i Västerbotten, Umeå 6/12 2018.

Jansson, S. 2018. Paneldiskussion: Kan du lita på Miljömärkningen? Hur vet du det? Almedalen 3/7 2018. <https://www.youtube.com/watch?v=0cNsl4g2epc&app=desktop>

Lee, N. 2018. Nordbiets mikrobiologi, vad vet vi och varför behöver vi veta något om det? Nordbikonferens, Ånge, 3-4 mars 2018.

Lee, N. 2018. Astrobiologi och några visioner om en spännande framtid. Årsmöte för Sweden Bio, 19 mars 2018, Stockholm.

Lee, N. 2018. Cosmochemistry, astrobiology and the search for the origin of life. Lecture series on biochemistry and biophysics. Department of Chemistry, 6th April 2018.

Lee, N. 2018. The silent threat to our society and nature - the ongoing decline of insects - what can we do? Umeå Arctic Seminar, 12 april 2018.

Lee, N. 2018. LONA dagarna – pollinerande insekter i Västerbotten. Umeå 25-26 augusti 2018,

Lee, N. 2018. Parkernas dag – vilda pollinatörer och deras betydelse, Umeå kommun. Umeå, 28 augusti 2018.

Lee, N. 2018. Astroekologi, ekologiska visioner till sin yttersta spets, på Bildmuseet i Umeå i samband med utställningen Ekolo-

giska visionärer. Umeå Universitet, 7 oktober 2018, kl. kl. 14.00 i Flexhallen, Bildmuseet.

Lee, N. 2018. Vår tillgång till föda hänger på insekterna. Kunskapsveckan för skollärares vidareutbildning vid Umeå universitet. 30 oktober 2018, Natuschka Lee, Umeå Universitet.

Lee, N. 2018. Pollinerande insekters hotade situation. Naturskyddsföreningen i Umeå, 5 november 2018.

Lee, N. 2018. Astroekologi. Svensk Biblioteksörening region Västerbotten. 7 december 2018, Umeå, Umeå universitetsbibliotek.

Lee, N. 2018. Participant at the Soapbox Science Event in Umeå 26 maj 2018, organized by SLU and UmU, Soapbox Science Umeå 2018.

Lee, N. 2018. Popular science event on the day of astronomy (Astronomins dag) at the Tekniska museet i Stockholm, 29-30/9 2018, "Cities in Space"

Nilsson, O. 2018. Seminar about progress in forest genetic, breeding and biotechnology. The Swedish Forest Industries Research Agenda, Stockholm, January 10.

Nilsson, O. 2018. Genetiskt modifierade växter och växtmutanter. Låter farligt, men vad är det? SLU "Vårt att veta-seminarium", Umeå March 14.

Nilsson, O. 2018. Genetiskt modifierade växter och växtmutanter. Låter farligt, men vad är det? Minervagymnasiet, Umeå May 2.

Nilsson, O. 2018. Seminar about progress in forest genetic, breeding and biotechnology. Skogsindustrierna, Stockholm, June 14.

Nilsson, O. 2018. Seminar about progress in forest genetic, breeding and biotechnology. Meeting with Finnish Forest Industries, Helsinki, November 27.

Collaboration with industry and/or other parts of society

• **Wang, Xiao-Ru:** "Seed orchard genetics of Scots pine and Norway spruce" - a Skogforsk and UPSC jointly funded PhD project.

• **Wang, Xiao-Ru:** "Assessment and recommended standards for genetic composition and diversity of Swedish seed orchards" - Föreningen Skogsträdsförädling funded project in collaboration with Skogforsk.

• **Wang, Xiao-Ru:** "Genetic diversity in Swedish conifer forests: are there reasons for concern?" - Formas funded project in collaboration with Skogforsk

• **Lee, N:** Paper industry, SSC in Obbola

• **Lee, N:** Norrmejerier in Umeå

- **Lee, N:** Naturskyddsföreningen in Umeå and Stockholm
- **Lee, N:** Nordbiföreningen
- **Lee, N:** Nordens Ark
- **Lee, N:** Umeå kommun Gator och Parker
- **Lee, N:** Sveriges riksförbund för biodlare
- **Lee, N:** Studieförbundet Vuxenskolan

Other funding

- Formas, 2019-2021. Genetic diversity in Swedish conifer forests: are there reasons for concern? 3M kr.
- Carl Tryggers, 2019-2020. The levels of standing genetic variation in natural and breeding populations of Scots pine in Sweden. 690 kkr
- 2018 2500K SEK: FORMAS Engineering secondary metabolites in aspen.
- 2018 10000K NOK. NRF (co-applicant). Characterization and evolution of the gene regulatory network underlying wood development.

Investments in research infrastructure

- Fluorescence in situ hybridization (FISH) research and teaching facility – start up of FISH applications in plant microbiology and other research fields, including teaching on a COST course organized by UPSC (Benedicte Albrechtsen) "DIMPA".

In 2018, preparations of the startup of two new networks have been made, with start in 2019:

- Arctic Earth and Space network (within the Arcum network – and the whole Arctic region)
- Arthropodum – a new network on arthropod research in Umeå (UmU and SLU)

Education

- PhD theses, MSc theses, Bachelor theses

Andersson, Sara. (Female) 2018. MSc thesis: Post-glacial colonization of Scots pine and Norway spruce in Sweden: An aDNA analysis from lake sediments. Umeå Universitet. Dept. of Ecology and Environmental Science. Xiao-Ru Wang supervisor

Albrechtsen BR: Co-supervision of Marta Agostinelli; 13 December 2018 dissertation from SLU, Alnarp main supervisor Johanna Wittzell. Project title: Does resistance to fungal disease limit symbiotic fungi in forest trees?

Biyue Tan, PhD April 2

018, "Genomic selection and genome wide association studies to dissect quantitative traits in forest trees". Pär Ingvarsson supervisor.

Chrobok, Daria 2018. Doctoral thesis: To "leaf" or not to "leaf": Understanding the metabolic adjustments associated with leaf senescence. Umeå University. Fysiologisk Botanik, UPSC. ISBN: 978-91-7601-900-9. Olivier Keech supervisor

Haas, Julia. (Female) 2018. Abiotic stress and plant microbe interaction in Norway spruce.

Umeå University, URN: urn:nbn:se:umu:diva-152835, ISBN: 978-91-7601-970-2.

Han, Ngyen, MSc theses 60 p, September 2018 till May 2019. Nitrogen fixing bacteria in plants. Natuschka Lee Co-supervisor

Albrechtsen BR: Supervision of Masters projects: **Sara Westman** (60hp end June 2019); **Cecilia Ström** (30hp end June 2019), **Johan Hanson** (30 hp ongoing)

- Supervision and teaching

Albrechtsen BR: Architect behind and responsible for Design-Build-Test Course for Bio-resource engineers. First group of seven students through in January 2019.

Albrechtsen BR: International co-lab and event organisation: Cost training School Dimpa

Albrechtsen BR: Summer training program: Three UMU master students on Aspen studies.

Albrechtsen BR: Responsible for the course: Genetics and biotechnology in forest production systems.

Albrechtsen BR: Responsible for the course: Plant Production Systems.

Albrechtsen BR: Responsible for the courses: "Design"; substitute for Energi-teknisk biologi.

Albrechtsen BR: Preparation of teaching tools: "Three-Way Interactions for Healthy Plants" Teaching tools in Biology – an innovation from the Plant Cell

Albrechtsen BR: Supervision of Masters projects: Sara Westman (60hp end June 2019); Cecilia Ström (30hp end June 2019), Johan Hanson (30 hp ongoing)

Xi Wang, Pär Ingvarsson main supervisor, expected date of defense: March 2020, tentative title: "Analysis of whole-genome re-sequencing data from Norway spruce"

Helena Eklöf (nee. Dahlberg), Pär Ingvarsson main supervisor, expected date of defense, December 2020, tentative title: "Effects of tree breeding on genetic diversity within and among stands on Norway spruce"

Jansson S. Main supervisor for PhD-candidate Pushan Bag. Tentative title: How could spruce needles be green in the winter. Expected date for dissertation: March, 2020

Jansson S. teaching on PhD course in Science communication, Umeå university 1/10 2018

Jansson S. teaching on "Plant molecular biology and molecular breeding", Umeå university. 15 ECTS Umeå

Jansson S. teaching on "Animal and plant physiology", Umeå university. 15 ECTS Umeå

Jansson S. teaching on "Inledande ingenjörskurs i bioteknik", Umeå university. 7.5 ECTS Umeå

Keech, Olivier. Teaching on "Plant Cell and Molecular Biology" (5BI214), 15 ECTS, Umeå.

Keech, Olivier. Teaching on "Organism biology" (5MO013), 7.5 ECTS, Umeå.

Keech, Olivier. Teaching on "Energy biology" (5BI148; 5BI195), 4.5 and 7.5 ECTS, respectively. Umeå.

Persson, Torgny. Organization of conference "Clonal forestry and breeding for resistance to pests and pathogens" 12-14 June 2018 in Höör, Sweden,

<http://nordicforestresearch.org/healgencar/past-events/se-cond-conference/>

Lee, Natuschka: Chaisse-Leal, Laurie, 2 month ERASMUS internship on plant microbiology and on tardigrade biology (Nov-Dec 2018)

Lee, Natuschka: Guetemme, Colin, 1 month, ERASMUS internship on the microbiology of the honeybee (April 2018)

Lee, Natuschka: Jonsson, David, 1 month summer 2018, on tardigrade biology and pollination ecology

Lee, Natuschka: Jonsson, Mimmi, , 1 month summer 2018, outreach project on science in general (the nature trail "Tidsresan")

Lee, Natuschka: Karlsson, Nils, , 1 month summer 2018, on plants for pollinating insects

Lee, Natuschka: Petit, Solenne, 1 month, ERASMUS internship on the microbiology of the honeybee (April 2018)

Lee, Natuschka: Pierce, Antoine, 3 month ERASMUS internship on the microbiology of feather moss (May-August 2018)

Lee, Natuschka: Åström, Cecilia, 15 p internship (undergraduate thesis) on the microbiology of the honeybee (Nov 2018 to Jan

2019)

Street NR. Main supervisor for PhD-candidate Terbeineic, Barbara. Tentative title: Leaf development and natural variation in Swedish aspen. Expected date for dissertation: March 2019.

Street NR. Main supervisor for PhD-candidate Mannapperuma, Chanaka. Tentative title: A design philosophy-based approach to developing genomics data visualization resources. Expected date for dissertation: Oct 2019.

Street NR. Main supervisor for PhD-candidate Schiffthaler, Bastian. Tentative title: Co-expression network-based insights to gene regulation in aspen. Expected date for dissertation: June 2020.

Street NR. Main supervisor for PhD-candidate Schneider, Andreas. Tentative title: The microbiomes of Swedish forest trees under the influence of environment and different nitrogen fertilisation. Expected date for dissertation: June 2022.

Street NR. Main supervisor for Master student Gustafsson, Louise. Title: Comparative transcriptomics of aspen and Norway spruce wood development. 15 ECTS.

Street NR. Course organiser and teaching for the course "Functional Genomics: Theory", (5BI211), 7.5 ECTS, Umeå University.

Street NR. Course organiser and teaching for the course "Applied Functional Genomics", (5BI212), 7.5 ECTS, Umeå University.

Street NR. Teaching on the course "Plant Biology for Future Forestry" (SG0242) 7.5 ECTS, SLU, Umeå.

Wang, Xiao-Ru. Main supervisor for PhD-candidate Alexis Sullivan. Tentative title: Phylogeography of Norway spruce. Expected date for dissertation: June, 2019.

Wang, Xiao-Ru. Main supervisor for PhD-candidate Hanhan Xia. Tentative title: Biogeography and adaptive evolution of *Pinus tabulaeformis*. Expected date for dissertation: June, 2019.

Wang, Xiao-Ru. Main supervisor for PhD-candidate Alisa Kravtsova. Tentative title: Seed orchard genetics of Scots pine and Norway spruce. Expected date for dissertation: March, 2022.

Wang, Xiao-Ru. Main supervisor for PhD-candidate Bea Andersson. Tentative title: Genetic and ecological dynamics of hybrid speciation. Expected date for dissertation: Oct. 2022.

Wang, Xiao-Ru. Main supervisor for MSc student Jenny Olsson. Tentative title: Genetic diversity in Scots pine in Scandinavia. Expected date for dissertation: May, 2019.

Wang, Xiao-Ru. Teaching at the course "Genetics and Evolution", 15 ECTS, Umeå University.

Wang, Xiao-Ru. Teaching at the course "Evolutionary Biology", 15 ECTS, Umeå University.

Theme 2 - Growth and interaction with the environment - current and future

Scientific publications

During 2018 Theme 2 has published 19 peer-reviewed scientific articles in international journals.

Akhter, S., Kretschmar, W.W., Nordal, V., Delhomme, N., **Street, N.R.**, Nilsson, O., Emanuelsson, O., Sundström, J.F. 2018. Integrative analysis of three RNA sequencing methods identifies mutually exclusive exons of MADS-box isoforms during early bud development in *Picea abies*. *Front. Plant. Sci.*, 9, 1625.

Bommarco, R., **Vico, G.**, Hallin, S. 2018. Exploiting ecosystem services in agriculture for increased food security. *Global Food Security*, 17, 57-63.

Colesie, C., Budel, B., **Hurry, V.**, Green, T.G.A. 2018. Can Antarctic lichens acclimatize to changes in temperature? *Global Change Biology*, 24,1123-1135.

Feng, X., Ackerly, D., Dawson, T., Manzoni, S., McLaughlin, B., Skelton, R., **Vico, G.**, Weitz, A., Thompson, S. 2018. Beyond isohydricity: the role of environmental variability on plant drought responses. *Plant, Cell & Environment*, in press. doi/10.1111/pce.13486

Feng, X., Ackerly, D., Dawson, T., Manzoni, S., Skelton, R., **Vico, G.**, Thompson, S.E. 2018. The ecohydrological context of drought and classification of plant responses. *Ecology Letters*, 21(11), 1723-1736.

González-Sanchis, M., **Ruiz-Pérez, G.**, Del Campo, A., García-Prats, A., Francés, F., Llull, C. 2018. Early eco-hydrological effects of forest management at catchment scale for Aleppo pine post-re regeneration stands. *Forest Ecology and Management*, 231, 653-665.

Grimberg, Å., Lager, I., **Street, N.R.**, **Robinson, K.M.**, Marttila, S., Mähler, N., **Ingvarsson, P.K.**, **Bhalerao, R.** 2018. Storage lipid accumulation is controlled by photoperiodic signal acting via regulators of growth cessation and dormancy in hybrid aspen. *New Phytologist*, 219, 619-630.

Haas, J.C., **Street, N.R.**, Sjödin, A., Lee, N.M., Högberg, M.N., Näsholm, T., **Hurry, V.** 2018. Microbial community response to growing season and plant nutrient optimisation in a boreal Norway spruce forest. *Soil Biology and Biochemistry*, 125, 197-209.

Jokipii-Lukkari, S., **Delhomme, N.**, Schiffthaler, B., Mannapperuma, C., Prestele, J., **Nilsson, O.**, **Street, N.R.**, Tuominen, H. 2018. Trans-

criptional roadmap to seasonal variation in wood formation of Norway spruce. *Plant Physiology*, 176, 2851-2870.

Kurepin, L.V., **Stangl, Z.R.**, Ivanov, A.G., Bui, V., Marin, M., Huner, N.P.A., Öquist, G., Way, D., **Hurry, V.** 2018. Contrasting acclimation abilities of two dominant boreal conifers to elevated CO₂ and temperature. *Plant Cell and Environment*, doi: 10.1111/pce.13158

Lin, Y-C., Wang, J., **Delhomme, N.**, Schiffthaler, B., Sundström, G., Zuccolo, A., Nystedt, B., Hvidsten, T.R., de la Torre, A., Cossu, R.M., Hoepfner, M.P., Lantz, H., Scofield, D.G., Zamani, N., Johansson, A., Mannapperuma, C., Robinson, K.M., Mähler, N., Leitch, I.J., Pellicer, J., Park, E-J., Van Montagu, M., Van de Peer, Y., Grabherr, M., **Jansson, S.**, **Ingvarsson, P.K.**, **Street, N.R.** 2018. Functional and evolutionary genomic inferences in *Populus* through genome and population sequencing of American and European aspen. *Proc Natl Acad Sci U S A*. doi: 10.1073/pnas.1801437115

Manfreda, S., McCabe, M., Miller, P., Lucas, R., Pajuelo Madrigal, V., Mallinis, G., Ben Dor, E., Helman, D., Estes, L., Ciruolo, G., Müllerová, J., Tauro, F., De Lima, M.I., De Lima, J., Frances, F., Caylor, K., Kohv, M., Maltese, A., Perks, M., **Ruiz-Pérez, G.**, Su, Z., **Vico, G.**, Toth, B. 2018. On the use of unmanned aerial systems for environmental monitoring. *Remote Sensing*, 10(4), 641.

Manzoni, S., Čapek, P., Porada, P., Thurner, M., Winterdahl, M., Beer, C., Brüchert, V., Frouz, J., Herrmann, A.M., Lindahl, B.D., Lyon, S.W., Šantrůčková, H., **Vico, G.**, Way, D.A. 2018. Carbon use efficiency from organisms to ecosystems – A synthesis of definitions, theories, and empirical evidence. *Biogeosciences*, 15, 5929-5949.

Menegat, A., Milberg, P., Nilsson, A.T.S., Andersson, L., **Vico, G.** 2018. Soil moisture and temperature during reproductive growth control seed dormancy in *Alopecurus myosuroides* Huds. *Ecology and Evolution*, 8(14), 7186–7194.

Ratke, C., **Terebieniec, B.**, Winstrand, S., Debra-Maceluch, M., Grahn, T., Schiffthaler, B., Ulvcrona, T., Özparpucu, M., Rüggeberg, M., Lundqvist, S-O., **Street, N.R.**, Jönsson, L., Mellerowicz, E. 2018. Downregulating aspen xylan biosynthetic GT43 genes in developing wood stimulates growth via reprogramming of transcriptome. *New Phytologist*, 219, 230-245.

Reza, S.H., **Delhomme, N.**, **Street, N.R.**, Ramachandran, P., Dalman, K., **Nilsson, O.**, Minina, E.A., Bozhkov, P.V. 2018. Transcriptome analysis of embryonic domains in Norway spruce reveals potential regulators of suspensor cell death. *PLOS ONE*, 13, e0192945.

Street, N.R. 2018. Genomics of forest trees In: Molecular Physiology and Biotechnology of Trees. Ed. Canovas FM.

Vico, G., Brunsell, N.A. 2018. Tradeoffs between water requirements and yield stability in annual vs. perennial crops. *Advances in Water Resources*, 112, 189-202.

Wang, J., Ding, J., Tan, B., **Robinson, K.M.**, Michelson, I.H., Johansson, A., Nystedt, B., Scofield, D.G., **Nilsson, O., Jansson, S., Street, N.R., Ingvarsson, P.K.** 2018. A major locus controls local adaptation and adaptive life history variation in a perennial plant. *Genome Biology*, 19, 72.

Popular scientific publications

Ruiz-Pérez, G. 2018. How green is a healthy plant? Environmental monitoring from the sky. Blog: *Envirobites*. <https://envirobites.org/2018/02/02/how-green-is-a-healthy-plant-environmental-monitoring-from-the-sky/>

Vico, G., 2018, Ödesfråga för fleråriga grödor, *Lantmannen*, 139(4), 52, in Swedish (title in English: On the fate of perennial crops).

Interviews and presence in media

Ruiz-Pérez, G. 2018. Popular Scientific Officer of the COST Action Harmonious in charge of the webpage <https://www.costharmonious.eu/> and several social media platforms such as FaceBook and Tweeter. Among other initiatives, has have edited and launched short videos targeting the general public. For example: <https://www.facebook.com/costharmonious/videos/724958177868950/>

Street, N.R. 2018. Aspforskare går i mål efter tio år, November 1. <https://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=7078013>

Scientific presentations

de Oliveira, G., Brunsell, N.A., Sutherlin, C.E., Crews, T.E., DeHaan, L.R., **Vico, G.** 2018. Carbon sequestration by a perennial Kernza wheatgrass crop, 33rd Conference on Agricultural and Forest Meteorology, Boise, Idaho, 14-18 May.

Echeverría, C., **Ruiz-Pérez, G.,** Francés, F. 2018. On the use of satellite soil moisture data in spatio-temporal model calibration for Mediterranean catchments. Poster presentation at the EGU General Assembly. Vienna (Austria), 8-13 April.

Echeverría, C., **Ruiz-Pérez, G.,** Francés, F. 2018. Spatio-temporal hydrological model implementation using remote-sensed soil moisture as main state variable for the Upper Turia catchment. Oral presentation at RSHS – Remote Sensing and Hydrology Symposium, Córdoba (Spain). 8-10 May.

Feng, X., Ackerly, D., Dawson, T.E., Manzoni, S., Skelton, R.P., Thompson, S.E., **Vico, G.** 2018. From ecohydrology to ecosystem change:

linking plant water use and plant water status during drought, AGU, Washington (DC), USA, 10-14 Dec (Invited).

Jämtgård, S., Brackin, R., Buckley, S., Swaine, M., Randewig, D., Robinson, N., Schmidt, S., Näsholm, T. 2018. Microdialysis - insights into nutrient supply at the soil-root interface. Presentation at 2nd International workshop Nutrient stewardship & Next-generation fertilisers, Heron Island, Australia. 15-19 December.

Manfreda, S., Ben Dor, E., Caylor, K., Ciralo, G., De Lima, I., Pedroso De Lima, J., Estes, L., Frances, F., Helman, D., Kohv, M., Lucas, R., Pajuelo Madrigal, V., Mallinis, G., Maltese, A., McCabe, M., Miller, P., Perks, M., **Ruiz-Pérez, G.,** Tauro, F., Toth, B. 2018. On the use of Unmanned Aerial Systems for environmental modelling. Oral presentation at the EGU General Assembly. Vienna (Austria), 8-13 April.

Manzoni, S., Feng, X., Thompson, S.E., **Vico, G.,** Katul, G. 2018. Optimality of plant water use strategies – an eco-hydrological perspective, Abstract EGU2018-5410, EGU General Assembly 2018, Vienna, Austria, 9-13 April (Invited).

Manzoni, S., Porada, P., Winterdahl, M., Beer, C., Brüchert, V., Capek, P., Frouz, J., Herrman, A., Lindahl, B., Lyon, S., Santruckova, H., Thurner, M., **Vico, G.,** Way, D.A. 2018. Philipp Porada 2018. Carbon-use efficiency across scales: are there general patterns from individual organisms to communities and ecosystems?, Abstract EGU2018-3994, EGU General Assembly 2018, Vienna, Austria, 9-13 April (Invited).

Manzoni, S., Čapek, C., Porada, P., Thurner, M., Winterdahl, M., Beer, C., Brüchert, V., Frouz, J., Herrmann, A., Lindahl, B., Lyon, S., Šantrůčková, H., **Vico, G.,** Way, D. 2018. Carbon use efficiency from organisms to ecosystems – A cross-disciplinary synthesis. Bolin Days 2018, Stockholm University, Stockholm, Sweden, 21-22 November.

Ruiz-Pérez, G., Vico, G. 2018. Which traits can prevent thermal damage and stimulate boreal forest productivity under a changing climate? Abstract EGU2018-8780, EGU General Assembly 2018, Vienna, Austria, 9-13 April.

Ruiz-Pérez, G., Launiainen, S., Vico, G. 2018. Which traits can prevent thermal damage and stimulate boreal forest productivity under a changing climate?. Poster presentation at the EGU General Assembly. Vienna (Austria), 8-13 April.

Street, N.R. 2018. Phenotypic possibilities from transcriptional plasticity. Gordon Research Conference 'Multiscale Plant Vascular Biology', June 2018, Mount Snow, Vermont, USA.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen and Norway spruce. PDBMBTS International Symposium Aug 2018, Beijing Forestry University, China.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen. Taiwan Society of Plant Biologist Annual Meeting Aug 2018, Tainan, Taiwan.

Street, N.R. 2018. Systems genetics and genomics insights into complex traits in aspen and Norway spruce. Acta Sinica Invited presentation, Aug 2018, Taipei, Taiwan.

Tamburino, L., Di Baldassarre, G., **Vico, G.** 2018. Yield, water scarcity and social attitudes: insights from an agent-based model, Winter Simulation Conference, Gothenburg, Sweden, 9-12 Dec.

Tamburino, L., **Vico, G.**, 2018. Modelling on-farm ponds for irrigated agriculture under different climates, Abstract EGU2018-12980, EGU General Assembly 2018, Vienna, Austria, 9-13 April.

Vico, G. 2018. Crop choice and water management for high and stable yields, Invited seminar in the Luxembourg Institute of Science and Technology (LIST) Water Lectures Seminar Series, Luxembourg, 9 October.

Vico, G., Porporato, A. 2018. Hydrologic risks in agriculture and water management for high and stable crop yields, Abstract EGU2018-9302, EGU General Assembly 2018, Vienna, Austria, 9-13 April.

Collaboration with industry and/or other parts of society

We are partners in large field trials to assess the influence of different nitrogen fertilizer sources on the conifer seedling microbiome under nursery growth conditions and following plantation in the field (**SweTree Nutrition, Holmen, Sveaskog, Skogsplantor** and others). **SweTree Technologies AB** is a partner of the CLAP project. Within that project, SweTree is interested in the potential for *Populus* spp. as biomass crops. This ongoing collaboration offers not only Theme 2, but also Theme 3, an additional industry partner to discuss results and opportunities for future collaborations. Within Theme 2 we have also initiated a collaborative project together with **Stora Enso** and **Skogforsk** to identify variation in frost sensitivity within the Norway spruce breeding program, an outcome stemming from our abiotic stress transcript profiling work, to aid in ongoing spruce breeding efforts to counter climate change.

Other funding

Jämtgård, S. (SLU), 2018-2020: "Development of new methodology for measuring how the rhizosphere affects plant nitrogen availability", Kempe foundation. Post doc funding. Amount 640 kkr. (JCK-1814).

Street, N.R. (UmU), 2018 2500K SEK: FORMAS Engineering secondary metabolites in aspen.

Street, N.R. (UmU), 10000K NOK. NRF (co-applicant). Characterization and evolution of the gene regulatory network underlying wood development.

Vico, G. (main applicant, SLU), "Innovative modelling approaches for the identification of boreal forest management strategies under a changing climate", Swedish Research Council for Sustainable Development (FORMAS), The National Research Programme on Climate: Future Pathways. Amount: 6.5 million SEK/635 k€ (2018-01820)

Vico, G. (G Messori (main applicant., Uppsala University, Sweden), "Large-Scale Atmospheric Variability driving changes in the Terrestrial Carbon Cycle and Storage", Swedish Research Council for Sustainable Development (FORMAS), Annual Open Call. Amount: 3 million SEK/290 k€ (2018-00968)

Education

- PhD theses, MSc theses, Bachelor theses

Haas, Julia. (Female) 2018. Abiotic stress and plant microbe interaction in Norway spruce. Umeå University, URN: urn:nbn:se:umu:diva-152835, ISBN: 978-91-7601-970-2.

- Supervision and teaching

Hurry, V. main supervisor of David Castro, PhD student at the Department of Plant Physiology and Forest Genetics (SLU). Expected date for dissertation: September 2020.

Hurry, V. main supervisor of Julia Haas, PhD student at the Department of Plant Physiology (UmU). Defended: December 2018.

Jämtgård, S. Course leader and lecturer: Ecology section in the course Ecology and Tree biology (2015-present) Forestry program, Faculty of forestry, SLU.

Street, N.R. Course organiser and teaching for the course "Applied Functional Genomics", (5BI212), 7.5 ECTS, Umeå University.

Street, N.R. Course organiser and teaching for the course "Functional Genomics: Theory", (5BI211), 7.5 ECTS, Umeå University.

Street, N.R. Main supervisor for Master student Gustafsson, Louise. Title: Comparative transcriptomics of aspen and Norway spruce wood development. 15 ECTS.

Street, N.R. Main supervisor for PhD-candidate Mannapperuma, Chanaka. Tentative title: A design philosophy-based approach to developing genomics data visualization resources. Expected date for dissertation: Oct 2019.

Street, N.R. Main supervisor for PhD-candidate Schiffthaler, Bastian. Tentative title: Co-expression network-based insights to gene regulation in aspen. Expected date for dissertation: June 2020.

Street, N.R. Main supervisor for PhD-candidate Schneider, Andreas. Tentative title: The microbiomes of Swedish forest trees under the influence of environment and different nitrogen fertilisation. Expected date for dissertation: June 2022.

Street, N.R. Main supervisor for PhD-candidate Terbeineic, Barbara. Tentative title: Leaf development and natural variation in Swedish aspen. Expected date for dissertation: March 2019.

Street, N.R. Teaching on the course “Plant Biology for Future Forestry” (SG0242) 7.5 ECTS, SLU, Umeå.

Vico, G. co-supervisor of Eirini Daouti, PhD student at the Department of Ecology, SLU, investigating weed seed predation. Expected graduation: 2021

Vico, G. co-supervisor of James Ajal, PhD student at the Department of Crop Production Ecology, SLU, investigating resource use and productivity of crop mixtures. Expected graduation: 2021

Vico, G. main supervisor of G. Ruiz-Pérez, postdoc at the Department of Crop Production Ecology, SLU, modelling boreal forest response to summer climatic extremes.

Vico, G. main supervisor of Herman Berghuijs, postdoc at the Department of Crop Production Ecology, SLU, modelling intercropping systems, part of the H2020 DIVERSIFY project.

Vico, G. main supervisor of Lucia Tamburino, postdoc at the Department of Crop Production Ecology, SLU, modelling the interactions and co-evolution of societies and managed ecosystems.

Vico, G. main supervisor of Xiangyu Luan, PhD student at the Department of Crop Production Ecology, SLU, investigating issues of water use for food security at local to global scales. Expected graduation: 2021

Vico, G. Course developer of the new master-level course “Sustainable plant production – from molecular to field scale” (BI1295), 15 ECTS, part of the new Master program in Plant Biology for Sustainable Plant production and the Master Program in Agronomy, SLU.

Vico, G. Course leader and main lecturer of the PhD-level course Stochastic processes and dynamical system theory with applications in ecology, agronomy and biogeochemistry, 5 ECTS, SLU

Vico, G. Course leader of and lecturer in the master-level course “Biology and production of agricultural plants” (BI1258), 10 ECTS SLU.

Vico, G. Lecturer in the undergraduate-level course Environmental physics – an introduction (MV0184), 7.5 ECTS, SLU

Vico, G. Lecturer on ‘Proposal writing’ at the workshop ‘How to become a postdoc?’, co-organized by the Research Schools in the Faculty of Natural Resources and Agriculture, SLU,

Theme 3

- Sustainable and adaptive forest management

Scientific publications

During 2018 Theme 3 has published 12 peer-reviewed scientific articles in international journals.

Böhlenius, H., Asp, H., Hjelm, K. 2018. Differences in AI sensitivity affect establishment of *Populus* genotypes on acidic forest land. PLOS ONE. Doi: /10.1371/journal.pone.0204461

Böhlenius, H., Holmström E., Fransson, T., Salk, C. 2017. Influence of cutting quality in production of containerized poplar plants. Forest, 8(5), 164, doi: 10.3390/f8050164

Ding, J., **Böhlenius, H.**, Rühl, M., Chen, P., Sane, S., Zambrano, J., Zheng, B., Eriksson, M., Nilsson, O. 2018. GIGANTEA -like genes Control Seasonal Growth Cessation in *Populus*. New Phytologist, 218(4), doi: 10.1111/nph.15087

Fanin, N., Kardol, P., Farrell, M., **Nilsson, M-C.**, Gundale, M.J., Wardle, D.A. 2019. The ratio of Gram-positive to Gram-negative bacterial PLFA markers as an indicator of carbon availability in organic soils. Soil Biology & Biochemistry, 128, 111-114.

Gundale, M.J., Wardle, D.A., Kardol, P., **Nilsson, M-C.** 2018. Comparison of plant-soil feedback experimental approaches for testing soil biotic interactions among ecosystems. New Phytologist, doi: /10.1111/nph.15367

Holmström, E., Goude, M., Nilsson, O., Nordin, A., **Lundmark, T., Nilsson, U.** 2018. Productivity of Scots pine and Norway spruce in central Sweden and competitive release in mixtures of the two species. Forest Ecology and Management, 429, 287-293.

Fanin, N., Gundale, M.J., Farrell, M., Ciobanu, M., Baldock, J.A., **Nilsson, M-C.**, Kardol, P., Wardle, D.A. 2018. Consistent effects of biodiversity loss on multifunctionality across contrasting ecosystems. Nature Ecology & Evolution, 2, 269-278.

Lett, S., Wardle, D.A., **Nilsson M-C.**, Teuber, L.M., Dorrepaal, E. 2018. The role of bryophytes for tree seedling responses to winter climate change: implications for the stress gradient hypothesis. Journal of Ecology, 106, 1142-1155.

Lett, S., **Nilsson, M-C.**, Wardle, D.A., Dorrepaal, E. 2017. Bryophyte traits explain climate-warming effects on tree seedling establishment. Journal of Ecology, 105, 496-506.

Prescott, C.E., Reid, A., Wu, S.Y., **Nilsson, M-C.** 2017. Decomposition rates of surface and buried forest floor material. Canadian Journal

of Forest Research, 47, 1140-1144.

Sokolowska, K., Turzanska, M., **Nilsson, M-C.** 2017. Symplasmic and apoplasmic transport inside feather moss stems of *Pleurozium schreberi* and *Hylocomium splendens*. Annals of Botany, 120, 805-817

Subramanian, N., **Nilsson, U.**, Mossberg, M., Bergh, J. 2018. Impacts of climate change, weather extremes and alternative strategies in managed forests. Écoscience, doi: 10.1080/11956860.2018.1515597

Interviews and presence in media

Böhlenius, H. Skog Alnarp "Poppel på kalkad skogsmark"

Böhlenius, H. Anläggning "Genombrott för snabbväxande lövträd"

Böhlenius, H. Lomma bladet "Poppel kan bli ett alternativ till Granen"

Böhlenius, H. Skogssverige "Poppel på kalkad mark"

Böhlenius, H. ATL "kalk får fart på poppeln"

Böhlenius, H. Landskogsbruk "Genombrott för snabbväxande poppel"

Böhlenius, H. Skogsaktuellt "ny forskning visar poppelns potential"

Böhlenius, H. ATL "Kalkning kan revolutionera skogsbruket"

Böhlenius, H. Skogen "Kalk sätter fart på popplen"

Holmström, E. Skog Alnarp. Grupper av björ bland granen

Goude, M. Skogsvärden. Mäter barrens bladarea för att se skogens framtid

Nilsson, U. Skogseko Lagg den rätta grunden

Nilsson, U. LandSkogsbruk Hjälpplantering hjälper dåligt

Nilsson, U. Bättre mallar för gallring på gång

Nilsson, O. Skog Alnarp. I Främlingshem förvånar tallen

Education

Supervision and teaching

Theresa Ibanez. PhD-student. Started 2017. Supervisors: **Marie-Charlotte Nilsson-Hegethorn**, Michael Gundale, David Wardle.

Martin Ahlström. PhD-student. Effect of silvicultural treatment on the risk for storm damage in managed forest stands in southern Sweden. Dissertation planned to spring 2020. Supervisor: **Urban Nilsson**.

Oscar Nilsson. PhD-student. Production of Scots pine and Norway spruce in Sweden. Dissertation planned to spring 2020. Supervisors **Urban Nilsson**, Karin Hjelm

Martin Goude. PhD-student. Hybrid growth models for Scots pine and Norway spruce in Sweden. Dissertation planned to winter 2021. Supervisors: **Urban Nilsson**, Ignacio Barbiato and Euan Mason

Mikolaj Lula. PhD-student. Regeneration of Scots pine in southern Sweden. Dissertation planned to autumn 2021. Supervisors: **Urban Nilsson**, Anna Jensen, Kristina Wallertz, Märtha Wallgren, Göran Örlander.

Mostarin Ara. PhD-student. Pre-commercial thinning in planted Norway spruce stands in southern Sweden. Dissertation planned to winter 2022. Supervisors: **Urban Nilsson**, Mattias Berglund, Nils Fahlvik, **Ignacio Barbiato**, Erika Olofsson.

Felicia Dahlgren. PhD-student. Regeneration of birch on clearcuts in Sweden. Dissertation planned to winter 2022. Supervisors: **Tomas Lundmark**, **Emma Holmström**.

Gustaf Ståhl. PhD-student. Climate smart forestry. Supervisor: **Tomas Lundmark**. Dissertation planned to winter 2022.

Alex Appiah Menza. PhD-student. Modelling growth of homogeneous and heterogeneous forests in Sweden. Supervisors: Hans Petersson, **Emma Holmström**, Kenneth Nyström. Dissertation planned to autumn 2022.

Master courses:

Emma Holmström was responsible for the master-course "Sustainable Forestry in Southern Sweden".

Marie-Charlotte Nilsson-Hegethorn was responsible for development of the master-programme "Plant biology for sustainable production".

PhD-course. Ecophysiological concepts and applications of managed forests (9 credits)

PhD-course. Forest tree and stand growth and dynamics: Multiple effects and problems when analyzing data (5 credits)

PhD-course. Conflicting demands on the European forests (5 credits).

Theme 4

- Other renewable plant resources, non-food crops

Scientific publications

During 2018 Theme 4 has published 23 peer-reviewed scientific articles in international journals.

Alander, B., **Capezza, A.J.**, Wu, Q., **Johansson, E.**, Olsson, R.T., Hedenqvist, M.S. 2018. A facile way of making inexpensive rigid and soft protein biofoams with rapid liquid absorption. *Ind Crops Prod*, 119, 41-48.

Andersson, M., **Turesson, H.**, Arrivault, S., Zhang, Y., **Fält, A-S.**, Fernie, A.R., **Hofvander, P.** 2018. Inhibition of plastid PPase and NTT leads to major changes in starch and tuber formation in potato. *Journal of Experimental Botany*, 69, 1913–1924.

Andersson, M., **Turesson, H.**, Olsson, N., **Fält, A-S.**, Olsson, P., Gonzalez, M., Samuelsson, **Hofvander, P.** 2018. Genome editing in potato via CRISPR-Cas9 ribonucleoprotein delivery. *Physiologia Plantarum*, 164, 378-384.

Andrade, F.D., Newson, W.R., Bernardinelli, O.D., **Rasheed, F.**, Cobo, M.F., Plivelic, T.S., de Azevedo, E.R., **Kuktaite R.** 2018. An insight into molecular motions and phase composition of gliadin/glutenin glycerol blends studied by ¹³C Solid-state and ¹H Time-domain NMR. *Journal of Polymer Science Part B: Polymer Physics*, 56: 739-750.

Avin-Wittenberg, T., Baluška, F., **Bozhkov, P.V.**, **Elander, P.H.**, Fernie, A.R., Galili, G., Hassan, A., Hofius, D., Isono, E., Le Bars, R., Masclaux-Daubresse, C., **Minina, E.A.**, Peled-Zehavi, H., Coll, N.S., Sandalio, L.M., Satiat-Jeunemaitre, B., Sirko, A., Testillano, P.S., Batocho, H. 2018. Review of autophagy-related approaches for improving nutrient use efficiency and crop yield protection. *J Exp Bot*, 69, 1335-1353.

Bozhkov, P.V. 2018. Plant autophagy: mechanisms and functions. *J Exp Bot*, 69, 1281-1285.

Ceresino, E.B., **Kuktaite, R.**, Sato, H.H., Hedenqvist, M.S., **Johansson, E.** 2018a. Impact of gluten separation process and transglutaminase source on gluten based dough properties. *Food Hydrocolloids*, 87, 661-669.

Ceresino, E. B., Melo, R.R., **Kuktaite, R.**, Hedenqvist, M.S., Zucchini, T.D., **Johansson, E.**, Sato, H.H. 2018b. Transglutaminase from newly isolated *Streptomyces* sp. CBMAI 1617: production optimization, characterization and evaluation in wheat protein and dough systems. *Food Chem.*, 241, 403-410.

Diuk Andrade, F., **Newson, W.R.**, Bernardinelli, O.D., **Rasheed, F.**, Cobo, M.F., Plivelic, T.S., Ribeiro deAzevedo, E., **Kuktaite, R.** 2018. An insight into molecular motions and phase composition of gliadin/glutenin glycerol blends studied by ¹³C solid-state and ¹H time-domain NMR. *Journal of Polymer Science Part B: Polymer Physics*. 2018 May 1, 56, 739-50. doi: /10.1002/polb.24586

Edvardsson Björnberg, K., Zetterberg, C., Hansson, S.O., Andreasson, E. **Zhu, L-H.** 2018. Consistent risk regulation? Differences in the European regulation of food crops, *Journal of Risk Research*. doi: /10.1080/13669877.2018.1501594

Elander, P.H., **Minina, E.A.**, **Bozhkov, P.V.** 2018. Autophagy in turnover of lipid stores: trans-kingdom comparison. *J Exp Bot*, 69, 1301-1311.

Grimberg, Å., **Lager, I.**, Street, N.R., Robinson, K.M., Marttila, S., Mähler, N., Ingvarsson, P.K., Bhalerao, R.P. 2018. Storage lipid accumulation is controlled by photoperiodic signal acting via regulators of growth cessation and dormancy in hybrid aspen. *New Phytol.* 219, 619-630.

Holm, L., Malik, A.H., **Johansson, E.** 2018. Optimizing yield and quality in malting barley by the governance of field cultivation conditions. *J Cereal Sci*, 82, 230-242.

Minina, E.A., Moschou, P.N., Vetukuri, R.R., Sanchez-Vera, V., **Cardoso, C.**, Liu, Q., **Elander, P.H.**, **Dalman, K.**, Beganovic, M., Yilmaz, J.L., Marmon, S., Shabala, L., Suarez, M.F., Ljung, K., Novák, O., Shabala, S., Stymne, S., Hofius, D., **Bozhkov, P.V.** 2018. Transcriptional stimulation of rate-limiting components of the autophagic pathway improves plant fitness. *J Exp Bot*, 69, 1415-1432.

Muneer, F., **Johansson, E.**, Hedenqvist, M.S., Plivelic, T.S., **Kuktaite, R.** 2018. Impact of pH-mediated modification on protein molecular profile and structure-function relationship in potato protein-wheat gluten based biocomposites. *Int. J. Mol. Sci.* 20(1), 58. doi: 10.3390/ijms20010058

Muneer, F., **Johansson, E.**, Hedenqvist, M.S., Plivelic, T.S., Markedal, K.E., Petersen, I.L., Sorensen, J.C., **Kuktaite, R.** 2018. The impact of newly produced protein and dietary fiber rich fractions of yellow pea (*Pisum sativum* L.) on the structure and mechanical properties of pasta-like sheets. *Food Res Int.* 106, 607-618.

Nsibande, B.E., Gustavsson, K.-E. **Zhu, L-H.** 2018. Analysis of health-associated phytochemical compounds in seven *Hypoxis* species. *American Journal of Plant Sciences*, 9, 571-583. doi: /10.4236/ajps.2018.94044.

Rasheed, F., Plivelic, T., **Kuktaite, R.**, Hedenqvist, M., **Johansson, E.** 2018. Unravelling the structural puzzle of the giant glutenin polymer – An interplay between protein polymerization, nanomorphology, and functional properties in bioplastic films. *ACS Omega*, 3, 5584-5592.

Üstün, S., Hafrén, A., Liu, Q., Marshall, R.S., **Minina, E.A.**, **Bozhkov, P.V.**, Vierstra, R.D., Hofius, D. 2018. Bacteria exploit autophagy for proteasome degradation and enhanced virulence in plants. *Plant Cell*, 30, 668-685

Vazques, D., Berger, A., Prieto-Linde, M.L., **Johansson, E.** 2018. Can nitrogen fertilization be used to modulate yield, protein content and bread-making quality in Uruguayan wheat? *J Cereal Sci.*, 85, 153-161. doi: /10.1016/j.jcs.2018.12.001.

Ye, X., Hedenqvist, M., **Langton, M.**, Lendel, C. 2018. On the role of peptide hydrolysis for fibrillation kinetics and amyloid fibril morphology, *RSC Adv.*, 8, 6915. doi: 10.1039/c7ra10981d

Ye, X., Junel, K., Gällstedt, M., **Langton, M.**, Wei, X-F., Lendel, C., Hedenqvist, M. 2018. Protein/protein nanocomposite based on whey protein nanofibrils in a whey protein matrix., *ACS Sustainable Chemistry & Engineering*, 6, 5462-5469. doi: 10.1021/acsuschemeng.8b00330.

Zhao, X., **Andersson, M.**, **Andersson, R.** 2018. Resistant starch and other dietary fiber components in tubers from a high-amylose potato. *Food Chem.*, 251, 58-63.

Popular scientific publications

Johansson, E., Samuelsson, M., **Andersson, M.** 2018. Potatisproteiner med högre denatureringstemperatur - en möjlighet via CRISPR/Cas9. Fakta från Växtförädling och Partnerskap Alnarp, LTV-fakultetens faktablad (in press).

Kuktaite, R., **Muneer, F.**, Newson, W.R., Hedenqvist, M.S., **Johansson, E.** 2018. Future plastics from potato and wheat: Let the chemistry “play”. Fakta från Växtförädling och Partnerskap Alnarp, LTV-fakultetens faktablad 2018:18.

Newson, W.R., **Johansson, E.** 2018. Biobased binding material for plant growth substrates. Fakta från SLU Partnerskap Alnarp, LTV-fakultetens faktablad 2018:6.

Nynäs, A-L. 2018. White proteins from green leaves in food applications – A literature study. Alnarp: Sveriges Lantbruksuniversitet. Introductory paper at the Faculty of Landscape Architecture, Horticulture and Crop Production Science, 2018:1.

Sun, C., **Andersson, R.** 2018. Förädling av stråsäd med hjälp av ett molekylärt ying-yangsystem. *Sveriges Utsädesförenings Tidskrift*: in press.

Interviews and presence in media

Grogrund – SLUs centrum för förädling av livsmedelsgrödor. Re-surs. 4 June 2018.

Svensk förädling ska trygga jobb inom växtodling. *Lantbruk och Skogsland*. 23 June 2018.

Startar nytt centrum för växtförädling. *Lokaltidningen Lommabladet*. 28 June 2018.

Klimatförändringar tvingar fram nya grödor. *Svt.se*. 8 Aug 2018.

Bönders situation efter torkan – så ska vi konsumenterna agera. *TV4*, 21 Aug 2018.

Vegetariska biffar av gröna blad ska odlas i Alnarp. *Sydsvenskan* 26 dec 2018.

Första växtproteinfabriken hamnar i Skåne. *SVT*, 26 Dec 2018.

Ny svensk satsning på vegetariskt protein. *Nya MSN Sverige*, 26 Dec 2018.

Ny fabrik på SLU ska utvinna vegetariskt protein. *SvD*, 26 Dec 2018.

Ska byggas på Sveriges lantbruksuniversitet. *Feber*, 27 Dec 2018.

Ny svensk satsning på vegetariskt protein. *ATL Lantbrukets Affärstidning*, 27 Dec 2018.

Hofvander, P. 2018. *Lantbruksnytt*

Sun, C. 2018. Prisivinnande SLU-forskning ger mer ris – med mindre klimatpåverkan. *SLU Holding*, October 23. <https://www.slu-holding.se/forskare/457-prisivinnande-slu-forskning-ger-mer-ris-med-mindre-klimatpaverkan>

Research and design project GLEATHER GLUBBER, Dutch design week at Eindhoven 2018, What Matter_S 2018.10.20-10.28 GLEATHER GLUBBER. Petra Lilja, **Ramune Kuktaite**, **Bill Newson**. <https://www.formdesigncenter.com/en/utställningar/dutch-design-week/>

Andersson, R. 2018-01-29. Ny potatis med långsamma kolhydrater. Radio interview, P4 morgon: SR Radio Uppland. (direktsändning från studion)

Andersson, R. 2018-01-30. Ny potatis med långsamma kolhydrater. Radio interview, P4 morgon: SR Radio Sörmland. (direktsändning via telefon)

Andersson, R. 2018-02-01. Ny potatis med långsamma kolhydrater. Radio interview, P4 morgon: SR Radio Västernmanland. (direktsändning via telefon).

Scientific presentations

Capezza, A.J., Johansson, E., Newson, W.R., Olsson, R.T., Hedenqvist, M.S. 2018. Novel absorbent materials obtained from Plant proteins, talk and poster, BEPS, New York, 13-15 August.

Capezza, A.J., Johansson, E., Newson, W.R., Olsson, R.T., Hedenqvist, M.S. 2018. Novel absorbent materials obtained from Plant proteins, talk and poster, Nordic Polymer Days, Copenhagen, 25-27 May.

Berndtsson, E., Andersson, R., Johansson, E., Andersson, A., Gustavsson, K-E., **Olsson, M.E.** 2018.. Characterisation of dietary fibre and polyphenols in broccoli side streams. (Poster). 7th Dietary fibre conference, Rotterdam, 4-6 June.

Bozhkov, P. 2018. Frontiers in Plant Science Seminar. Autophagy in plant fitness. Can we grow better plants by manipulating autophagy? May 2018, Stockholm University, Sweden.

Dauphinee, A.N., Cardoso, C., Dalman, K., Olsson, J.A., Lindberg, S., Robert, S., **Bozhkov, P.V., Minina, E.A.** 2018. Revealing plant autophagy with chemical genetics. Talk. 21st European Network for Plant Endomembrane Research (ENPER) Meeting. Vienna, Austria. September 4-7.

Dauphinee, A.N., Cardoso, C., Dalman, K., Olsson, J.A., Lindberg, S., Robert, S., **Bozhkov, P.V., Minina, E.A.** 2018. Unravelling plant autophagy mechanisms using chemical genetics. Talk. 2018 COST Transautophagy Network Meeting (working group 3). Montpellier, France. August 8.

Dauphinee, A.N., Cardoso, C., Dalman, K., Olsson, J.A., Lindberg, S., Robert, S., **Bozhkov, P.V., Minina, E.A.** 2018. Unravelling plant autophagy mechanisms using chemical genetics. Poster. 12th Congress of International Plant Molecular Biology (IPMB). Montpellier, France. August 5-10.

Dauphinee, A.N., Cardoso, C., Dalman, K., Olsson, J.A., Lindberg, S., Robert, S., **Bozhkov, P.V., Minina, E.A.** 2018. Drugs and trafficking: implementation of chemical genetics to investigate molecular machinery of plant autophagy. Talk. 2nd Nordic Autophagy Society (NAS) Conference. Riga, Latvia. August 30-September 3.

Elander, P., Ohlsson, J., Bozhkov, P., Minina, A. 2018. Investigating the role of autophagy in plant lipid turnover. Poster. Nordic Autophagy Society conference, Riga, Latvia. August 29-31.

Elander, P., Ohlsson, J., Bozhkov, P., Minina, A. 2018. Investigating the role of autophagy in plant lipid turnover. Poster. International Plant Molecular Biology conference, Montpellier, France. August 6-9.

Hofvander, P., Wang, H., Ding, B., Jian-Qing Dai, J-Q., Tara J. Na-

zarenus, T.J., Edgar B. Cahoon, E.B., Stymne, S., Löfstedt. C. 2018. Insect pheromone precursors in Camelina oil and their use in chemical conversion for pest management. (talk). 23rd International symposium on plant lipids. Yokohama, Japan, July 8-13.

Jeppson, S., Demski, K., **Carlsson, A.S., Zhu, L-H.,** Stymne S., **Lager, I.** 2018. Characterisation of two DGAT2 isoforms from *Crambe abyssinica* expressed in yeast. (Poster) 23rd International symposium on plant lipids. Yokohama, Japan, July 8-13.

Johansson, E., Kuktaite, R., Markgren, J., Rasheed, F. 2018. Gluten proteins and their structure-function relationships (invited talk). Gluten Workshop, CIMMYT, Mexico, 13-18 March.

Jolayemi, O.L., Malik, A.H., Ekblad, T., **Olsson, M., Johansson, E.** 2018. Enhancing sugar beet growth by use of biostimulant. Nord-Plant Conference, University of Helsinki, Finland, 24-25 October.

Jolayemi, O.L., Malik, A.H., Ekblad, T., **Olsson, M., Johansson, E.** 2018. Hydrolyzed wheat gluten enhance growth and development of sugar beet. Plant Biologicals Network, University of Copenhagen, Denmark, 14-15 November.

Kuktaite, R., Muneer, F., Ceresino, E.B., Hall, S., Plivelic, T.S., Repo-Carrasco-Valencia, R., **Johansson, E.** 2018. If we could design plant protein structures and tune properties in processed food (talk). Neutrons and food, Sydney, 16-19th October.

Lager, I., Stymne, S., Yilmaz, J.L., Wang, H-L., **Jeppson, S.** 2018. Facile isolation of wax esters from oils produced by transgenic plants. (Poster) 23rd International symposium on plant lipids. Yokohama, Japan, July 8-13.

Li, X., Zhu, L-H. 2018. Evaluation of a hybrid line of *Crambe abyssinica* with improved wax ester quality. (Poster) 23rd International symposium on plant lipids. Yokohama, Japan, July 8-13.

Markgren, J., Rasheed, F., Hedenqvist, M.S., Johansson, E. 2018. Exploring the monomeric character of the gliadin proteins in wheat, poster., Gordon Research Conference on Protein Folding Dynamics, USA Texas, 6-12 Jan.

Markgren, J., Rasheed, F., Hedenqvist, M.S., Skepö, M., Johansson, E. 2018. To polymerize or to not polymerize- that is the question for intrinsically disordered wheat proteins., Protein Science Day, Lund, 6 Oct.

Nynäs, A-L., Newson, W.R., Langton, M., Johansson, E. 2018. Isolation of proteins from green leaves for use in food applications, talk, EFFoST, France, 6-8 November

Nynäs, A-L., Newson, W.R., Langton, M., Johansson, E. 2018. Isolation of proteins from green leaves for use in food applications. EFFoST Nantes 6th of November 2018

Snell, P., Grimberg, Å., Carlsson, A.S., Hofvander, P. 2018. WRINKLED1 is subject to evolutionary conserved negative auto-regulation. (Poster) 23rd International symposium on plant lipids. Yokohama, Japan, July 8-13.

Popular scientific presentations at meetings or excursions

Herneke, A., Hanyu, B. Proteinskiftet, SciFesten scientific event for families and school children in Uppsala, March 2018.

Herneke, A., Johansson, D. Gammal böna på framtidens talrik, Matologi event arranged by Future food at SLU. Scientific event focusing on food. Stockholm August 2018.

Newson, W.R. Agri-Based Bioeconomy at SLU, workshop presentation at "Bioeconomy-led development: Opportunities through Nordic-Southern Cone countries cooperation, 2018" - INTAL Buenos Aires, Argentina, October 19, 2018.

Newson, W.R. Plant Product Quality Group: Material Science and Protein Initiatives, presentation to incoming MSc students, September 4, 2018, Alnarp.

Newson, W.R. Plant Product Quality Group: Material Science and Protein Initiatives, presentation to members of Öhmans investment fund, August 22, 2018, Alnarp.

Collaboration with industry and/or other parts of society

Collaboration with **SLU Grogrund, Lyckeby Starch AB, Syngenta, ISCA Technologies, LRF, Lantmännen, KTH- Kungliga Tekniska högskolan, Chalmers University of Technology, RISE, SCA Hygiene Products AB, Lund University.**

Other funding

Proteinkvalitet i veteliner med främmande kromosomfragment (project together with Lantmännen with funding from Partnerskap Alnarp).

Proteinkvalitet, en fenotypdel vid genomisk selektion i vårvete (project together with Lantmännen with funding from Partnerskap Alnarp).

Vinnova UDI Step 2 project "Plant Protein Factory" total budget 20 millions SEK. 13 industrial partners., Atria, CRY Invest, Glucanova, Greenleaf Medical, Inekogruppen, Indocore Food & Biotech, Ingredient, Kemi-Intressen, Marimat, (cosmetics company - confidential), Speximo, Gasum and Sydgrönt.

Partnerskap Alnarp project "Recovery of food protein from underutilized agricultural green leaves" 2 industrial partners., Thylabisco and Gasum.

Design project in "What Matter/s" a project joining scientists and designers supported by SPOK, Art & Science Initiative & the Form/Design Center. Materials produced were shown at Dutch design week 2018.

Formas Livsmedel 2018: Texturized legume-based food product by recombining fractions, 7 500 000 SEK

FORMAS 2018. Eliminating anti-nutritional factors in the rapeseed meal for both feed and food uses. 3000000 SEK.

FORMAS 2018. Characterisation of enzyme DGAT in rapeseed, a key enzyme for seed oil quality and quantity. 2 946 933.

FORMAS 2018. Starch content, granule size and structure as breeding goal in potato through understanding of mechanisms for initiation and differentiation of starch synthesis. 3000000 SEK

Formas Livsmedel 2018. (Effektiviserat nyttjande av en industriell sidostrom för cirkulär biobaserad ekonomi - livsmedelsklassificerat protein av premiumkvalitet. 7 498 000 SEK

Investments in research infrastructure

Rheometer

Education

- PhD theses, MSc theses, Bachelor theses

Muneer, Faraz. (Male) 2018. Doctoral Thesis: Novel uses of biopolymers in composites, from chemistry to processing of materials and food. Alnarp: Sveriges Lantbruksuniversitet. Acta Universitatis agriculturae Sueciae, 1652-6880., 2018:44. ISBN: 978-91-7760-228-6

Ehsanzamir, Sohail. Master Thesis: Gelation of faba bean protein isolates: effect of ionic strength, pH and extraction procedure date: January, 2018. <http://urn.kb.se/resolve?urn=urn:nbn:se:slu:psilon-s-9355>

Elaine Cerecino defended PhD-thesis in Brasil with thesis in Portuguese

- Supervision and teaching

Eva Johansson. Main supervisor for PhD-candidates Joel Markgren, Anna-Lovisa Nynäs and Antonio Capezza, co-supervisor for PhD-candidate Faraz Muneer, Elaine Ceresino and Emilia Berndtsson.

Marie Olsson. Main supervisor for PhD-candidate Emilia Berndtsson.

Ramune Kuktaite. Main supervisor for PhD-candidate Faraz Muneer and co-supervisor for PhD-candidate Elaine Ceresino.

Daniel Johansson. Main supervisor for Master student Ehsanzamir, Sohail. Title: Gelation of faba bean protein isolates: effect of ionic strength, pH and extraction procedure date: January, 2018. Master thesis.

Daniel Johansson and Maud Langton. Supervisors for Hanyue, Bai (Clair). Nano-fibrils in mung bean protein films, Supervisor Internmentship from China Agricultural University, Beijing, China.

Daniel Johansson. Main supervisor for Barbotin, Ericka., Protein based materials for packaging Exchange student from Agrosup, Dijon, France.

Maud Langton. Co-supervisor for Anna-Lovisa Nynäs PhD-student at SLU.

Emilia Berndtsson. Teaching at the course "Postharvest - biologi och teknologi efter skörd" (BI1235). 15 ECTS. Alnarp.

Emilia Berndtsson. Teaching at the course "Maten i dagens och morgondagens samhälle - en introduction". (TD0008). 15 ECTS. Alnarp.

Antonio Capezza. Co-supervisor for Bachelor student David Glad. Title: A natural-based absorbent polymer based on potato protein: Functionalized via dry acylation with high scalability. 15 ECTS.

Ramune Kuktaite. Supervising two internship students from France, 1 June-30 Sept 2018

William Newson. Supervising one internship student from France, 1 May-31Aug 2018.

Li-Hua Zhu, Selva Main and Rui Guan. Main and co-supervisors for PhD-candidate Sjur Sandgrind. Tentative title: Oct. 2022.

Li-Hua Zhu and Selva. Main and co-supervisor for PhD-candidate Magnus Carlsson. Tentative title: Plant expression systems for production of human hemoglobins as blood substitutes. Expected date for dissertation: Dec. 2019.

Per Hofvander, Anders Carlsson and Åsa Grimberg. Main and co-supervisors for PhD-candidate Per Snell. Tentative title: Genetic and metabolic regulation of oil and other storage products in higher plants. Expected date for dissertation: October, 2019.

Anders Carlsson, Ida Lager and Li-Hua Zhu. Main and co-supervisors for PhD-candidate Simon Jeppsson. Tentative title: Production of green technical plant oils through the biotechnological modification of oil biosynthesis in the oil crop *Crambe*.

Peter Bozhkov and Elena Minina. Main supervisor and co-supervisor for PhD-candidate Pernilla Elander. Tentative title: The role of autophagy in plant lipid deposition and turnover. Expected date for dissertation: February, 2021.

Anna Åsman and Elena Minina. Supervisors for Master student Sofiana Fajriah Rahmah. Tentative Title: CRISPR/Cas9 for gene knock-in. 30 ECTS.

Peter Bozhkov. New PhD course organizer and teacher. Course "Advances in Enzyme Regulation", 5 ECTS, SLU.

Peter Bozhkov and Elena Minina. Undergraduate course organizer and teacher, respectively. Course "Biochemistry", 7.5 ECTS, SLU.

Per Hofvander. Teaching at the course "Odling och användning av trädgårdsprodukter (BI1234), 15 ECTS, Alnarp.

Per Hofvander. Teaching at the course "Research Design for PhD-students (PLG0041), 3 ECTS, Alnarp.

Ida Lager, Per Hofvander, Åsa Grimberg. Teaching at the course "Växtbiokemi (Plant Biochemistry) (BI1146), 15 HEC, Alnarp.

William Newson. Co-supervisor for PhD candidate Antonio Capezza, Tentative title: Novel Biodegradable Superabsorbent Materials obtained from different plant proteins. Expected date for dissertation: September 2020.

William Newson. Co-supervisor for PhD candidate Anna-Lovisa Nynäs, Tentative title: Proteins from green biomass for food applications. Expected date for dissertation: November 2020.

William Newson. Co-supervisor for PhD candidate Anja Herneke. Tentative title: Functionalization of nanofibers from plant based proteins. Expected date for dissertation: January 2021.

Li-Hua Zhu. Teaching at the courses Applied Plant Biotechnology, 15 HEC, Plant Physiology, 15 HEC and Advanced Plant Breeding and Genetic Resources, 15 HEC, Alnarp.

Ida Lager, Sungyong Kim, Rui Guan and Li-Hua Zhu. Teaching at the courses Genetics and Plant Breeding, 15HEC, Alnarp.

Economy - Overview over all themes

In 2018, TC4F received 27 mio SEK of funding which were distributed according to the budget. 24 mio SEK (87,8%) were used.

Total summa i programmet (tkr)

2018

27245

Fördelade medel (tkr) 2018

Koordinering	1 338
Tema 1 -(2) (Stefan/Torgny)	6 250
Tema 2 - (1)(Vaughan/Nat)	6 985
Tema 3 (Urban)	6 400
Tema 4 (Eva/Li-hua) inkl forskarskolan	6 272
SUMMA 27 245	

Använda medel (tkr) 2018

Koordinering	1 618
Tema 1 - 2 (Torgny/Vaughan)	4 900
Tema 2 - 1 (Stefan)	5 213
Tema 3 (Urban)	7 808
Tema 4 (Eva/Li-hua) inkl forskarskolan	4 374
SUMMA	23 913

Andel använda medel, % i förhållande till budget 87,8

Personnel in TC4F 2018

Theme 1 - Forest genetics and next generation of forest trees

Name	Gender & Position	Part of full time financed by TC4F
Stefan Jansson	M, Professor	0
Kathryn Robinson	F, Researcher	50%
Pushan Bag	M, PhD student	0
Jenna Lihavainen	F, Postdoc	0
Nazeer Fataftah	M, postdoc	0
Pär Ingvarsson	M, professor	0
Carolina Bernhardsson	F, postdoc	0
Xi Wang	F, PhD student	0
Helena Eklöf	F, PhD student	0
Xiao-Ru Wang	F, Professor	0
David Hall	M, Förste forskningsingenjör	0
Wei Zhao	M, Postdoc	0
Alisa Kravtsova	F, PhD student	0
Alexis Sullivan	F, PhD student	25%
Natuschka Lee	F, researcher/associate professor	0
Ove Nilsson	M, Professor	0
Olivier Keech	M, Associate-Professor	8%
Bengt Andersson Gull	M, professor	15%
Johan Westin	M, researcher	25%
Sara Abrahamsson	F, researcher	5%
Gunnar Jansson	M, researcher	5%
Johan Kroon	M, researcher	5%
Torgny Persson	M, researcher	25%
Ulfstand Wennström	M, researcher	15%
Timothy Mullin	M, researcher	5%
Nathaniel Street	M, Associate professor	80%
Andreas Schneider	M, PhD student	0

Theme 2 - Growth and interaction with the environment - current and future

Name	Gender & Position	Part of full time financed by TC4F
Vaughan Hurry	M, Professor	0
Guiomar Ruiz-Pérez	F, PostDoc	65%
Giulia Vico	F, Docent	30%
Nathaniel Street	M, Assoc. Professor	80%
Alexander Vergara	M, Postdoc	100%
Alonso Serrano	M, Computer engineer	100%
David Castro	M, PhD student	10%
Mark Swain	M, Postdoc	100%
Torgny Näsholm	M, Professor	0
Mark Bonner	M, postdoc	10%
Annika Nordin	F, Professor	25%
Andreas Schneider	M, PhD student	10%
Sandra Jämtgård	F, Researcher	0

Theme 3 - Sustainable and adaptive forest management

Name	Gender & Position	Part of full time financed by TC4F
Marie-Charlotte Nilsson-Hegethorn	F, Professor	0
Tomas Lundmar	M, Professor	0
Urban Nilsson	M, Professor	0
Emma Holmström	F, Researcher	0
Euan Mason	M, Professor	20%
Henrik Böhlenius	M, Docent	40%
Ignacio Barbeito	M, Researcher	50%
Oscar Nilsson	M, PhD student	100%
Martin Goude	M, PhD student	100%
Theresa Ibanez	F, PhD student	100%
Gustav Ståhl	M, PhD student	100%

Theme 4 - Other renewable plant resources, non-food crops

Name	Gender & Position	Part of full time financed by TC4F
Li-Hua Zhu	F, Professor, theme leader	0
Eva Johansson	F, Professor, Program director, Vice Program director	25%
Sven-Erik Svensson	M, PhD student	35%
Ramune Kuktaite	F, Researcher	0
William (Bill) Newson	M, Postdoc	12%
Joel Marklund	M, PhD student	0
Maria Luisa Prieto-Linde	F, Lab technician	0
Faraz Muneer	M, PhD student	0
Elaine Ceresino	F, PhD student	0
Anna-Lovisa Nynäs	F, PhD student	100%
Antonio Capezza	M, PhD student	0
Emilia Berndtsson	F, PhD student	50%
Marie Olsson	F, Professor	0
Anders Ekholm	M, Lab technician	0
Selvaraju Kanagarajan	M, Researcher	56%
Emelie Ivarson	F, Postdoc	0
Sungyong Kim	M, Postdoc	0
Magnus Carlsson	M, PhD student	30%
Xueyuan Li	M, Research assistant	45%
Annelie Ahlman	F, Lab technician	0
Roger Andersson	M, Professor	0
Xue Zhao	F, PhD student	30%
Per Hofvander	M, Researcher	20%
Åsa Grimberg	F, Researcher	40%
Mariette Andersson	F, Researcher	0
Anders Carlsson	M, Professor	0
Helle Turesson	F, Research engineer	0
Ann-Sofie Fält	F, Lab technician	10
Mirela Beganovic	F, Lab technician	10%
Per Snell	M, PhD student	0
Folke Sitbon	M, Professor	0
Salim Hossain Reza	M, Researcher	60% (6 months)
Chuanxin Sun	M, Researcher	15%
Yunkai Jin	M, Postdoc	20%
Maud Langton	F, Professor	0

Theme 4 - cont.

Jing Li	F, Postdoc	0
Daniel Johansson	M, Postdoc	0
Anja Herneke	F, PhD student	0
Bai Hanyu (Clair)	F, Internship	0
Erica Barbotin	F, Exchange student	0
Peter Bozhkov	M, Professor	0
Catarina Cardoso	F, Postdoc	0
Kerstin Dalman	F, Research engineer	0
Adrian Dauphinee	M, Postdoc	0
Pernilla Elander	F, PhD student	0
Elena Minina	F, Researcher	50%
Anna Åsman	F, Postdoc	10%

Trees and Crops for the Future, TC4F

Trees and Crops for the Future – TC4F – develops knowledge on sustainable plant production and plant based product development within agricultural and boreal forest systems with the main objective to support the development of a new circular bioeconomy in Sweden.

