# ANNUAL REPORT
# 2019

## TREES FOR THE FUTURE
## CROPS FOR THE FUTURE/TC4F

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# Trees and crops for the future, TC4F Annual report 2019

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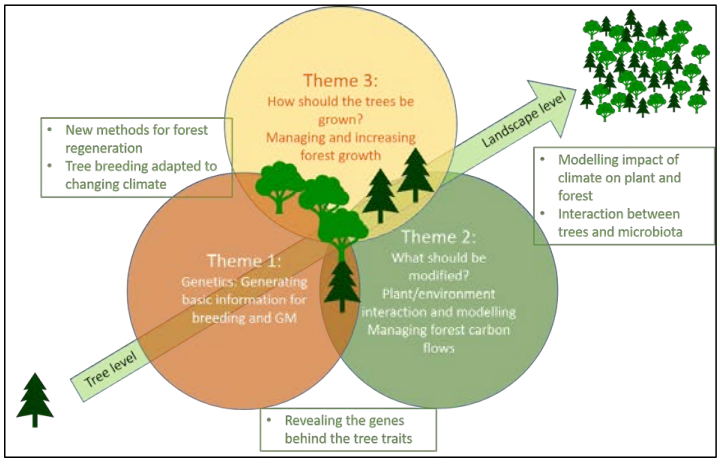
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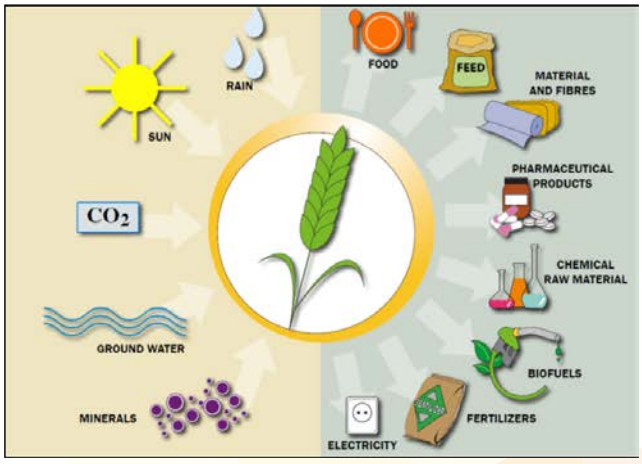
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# Chairmen of the boards / Göran Ståhl & Håkan Schroeder

**The research programme Trees and Crops for the Future (TC4F) is funded by the Swedish Government as a Strategic Research Area. SLU coordinates the programme, in which Umeå University and Skogforsk also substantially contribute. TC4F develops knowledge to support society's shift from fossilbased to biobased economies through research at the frontiers of plant molecular biology, genetics, plant breeding, silviculture, and agriculture, combined with cross-disciplinary research.**

**The year 2019 has been the first during which the programme has been run within a new organiza-tional structure, separating it into two sub-programmes: Trees for the future (T4F) and Crops for the future (C4F). The motivation for the modified structure is to enable better links between TC4F and new activities in the neighbourhood of the programme. One outstanding activity of this kind is SLU Grogrund, a centre for plant breeding funded by the Swedish Government and run by SLU in collabo¬ration with plant breeding and food companies. The centre develops plant materials for competitive and sustainable agriculture and horticulture in the entire country.**

**An important programme management activity during 2019 has been to initiate preparations for the third phase of TC4F. This phase is due to start in 2021, Self-evaluations have been completed and preliminary plans for the period 2021-2025 outlined. A challenge in this planning is to balance continuity and renewal.**

**Lastly we would like to express our gratitude to the programme managers - professor Eva Johansson (C4F), and professors Annika Nordin and Karin Ljung (T4F) - as well as to all the theme leaders and researchers in TC4F for making 2019 another very successful year.**

**Göran Ståhl**
T4F, Chairman of the board

**Håkan Schroeder**
C4F, Chairman of the board

# T4F Program director / Annika Nordin

## T4F – Trees for the Future

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 more current and prioritized today, than when the program started in 2009 as a strategic research area designated by the government. The overarching goal of TC4F – producing new knowledge on plant-based systems for biomass production and products is widely recognized in relation to significant events and debates in science and society.

The current program period is in 2020 coming to an end, and 2019 has been a year of preparations for the future.

For the Trees for the Future (T4F) part of the program the preparations have focused on how to further develop common infrastructures, both in the field and in the lab. Within themes 1 and 2, the Bioinformatics Platform and the Tree Transformation Platform at Umeå Plant Science Centre are such infrastructures. On one of the common field research sites in Rosinedal, researchers from several projects presented their work in August 2019 in the frame of the SPPS2019 conference organized by the Scandinavian Plant Physiology Society. All three themes have strengthened their affiliations with forestry industry by providing large genetic data sets and genetic information for operational tree breeding (theme 1), scientific data about optimal tree nutrition, fertilization and establishment of optimal microbial soil communities (theme 2) as well es new, hybrid growth models for Nordic forests of Scotch Pine and Norway spruce and research about impact and recovery of forest fire sites (theme 3). Overall, T4F structures are providing bridges between fundamental research and applied forestry.

An important challenge is also to prepare for new key recruitments in upcoming research areas. The overarching goal of T4F is the benefit excellent research across SLU in general and across the faculty of forest science in particular.

# C4F Program director / Eva Johansson

## C4F – Crops for the Future

C4F is the sub-program within TC4F focusing on the development of sustainable new plant-based products through the use of modern technologies to contribute to a circular bioeconomy in Sweden. The year 2019 has been a productive and successful year for C4F, not least by the positive development of SLU Grogrund – inaguared by the Minister of Rural Affaires in September 2019, and the start and set-up of the Plant Protein Factory, two activities with their origin in C4F. These examples clearly show the role C4F has as a seed-bed for novel large projects and activities emerging within C4F and then evolving into large projects with potential to contribute as gate-changers within the society. Additional potential projects that has developed towards the evolving stage in 2019 are i) the protein based superabsorbent project, ii) the potato protein for food project, iii) the plant produced pheromone project and iv) the plant produced hemoglobin project. Long-term funding contribution from C4F has also resulted in yin-yang varieties of rice and barley close to release as novel varieties in 2019, with specific yield and quality characters, and high wax ester lines of crambe lines for possible production in the USA. Similarly as during previous years, a strong emphasis have been given in 2019 to method development in areas such as genome editing, autophagy regulation and use of synchrotron technologies.

Research areas within C4F have become increasingly important during later years, not least because of the understanding of an increased need of crops for food production to an increasing world population simultaneously with a need to sustainably produce a large amount of other products also from green biomass and natural resources. In 2019, the need of C4F based research became even more apparent with the large manifestations for sustainable use of our world and the increasing desire of local production to secure national and regional human need in a unpredictable world.

Photo: Anke Carius

# THEME REPORTS AND RESEARCH PORTRAITS

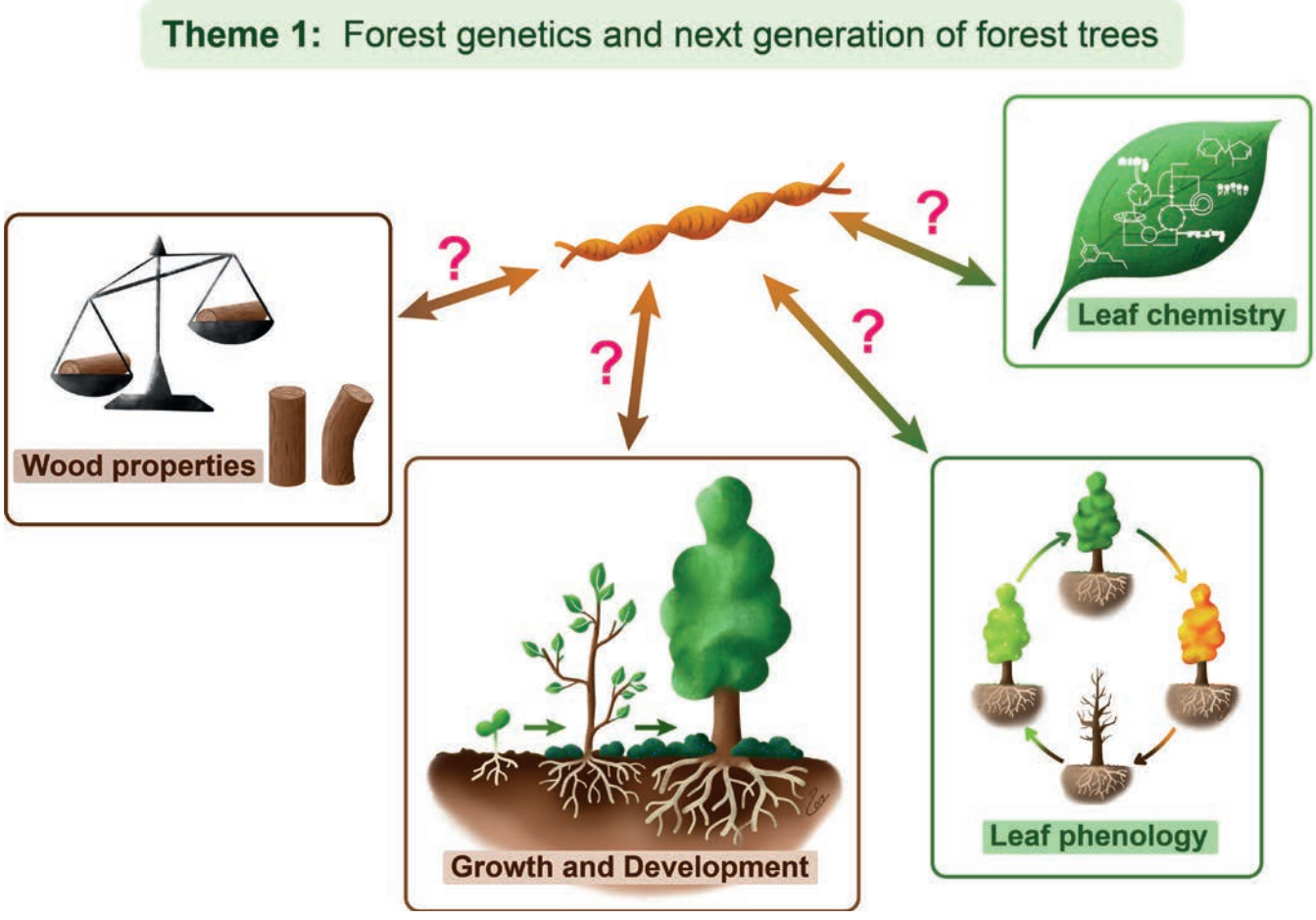
THEME LEADER: STEFAN JANSSON

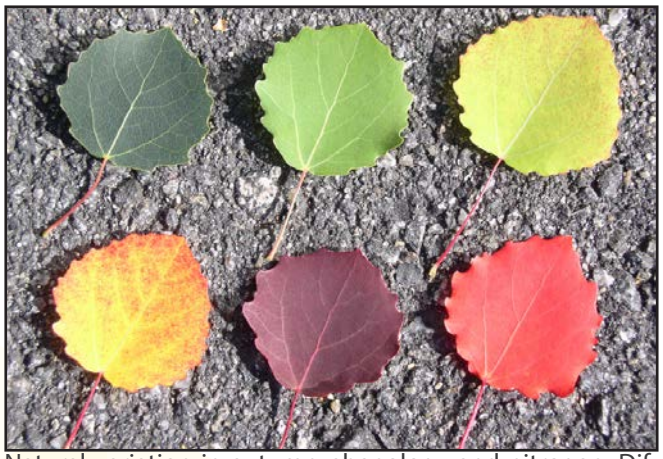
# Theme 1 - Forest genetics and next generation of forest trees

*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.*

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 used by most research groups connected to UPSC but the research output of these groups is not listed, only activities of research group that got direct support from TC4F.





Natural variation in autumn phenology and nitrogen. Different coloration in autumn leaves of three different aspen genotypes in two different fertilization regimes.
*Photo: Lars Björkén*

As a result of a significant focus on "capacity building", several of the most important achievements during 2019 forms the basis of future work inside and outside the program. For example, the ultra-dense genetic map of the Norway Spruce genome (Bernhardsson et al, 2019) is a very significant achievement in its own right, as in particular the size of the genome and the huge fraction of repetitive elements that complicates such studies. But the publication of this map confirms that the genetic and genomic resources available for Norway spruce are outstanding among conifers, and the resources combined is the fundament of many basic science projects utilizing Norway spruce as model system, The databases built in the project, (see e.g. Wegrzyn et al. 2019) has enabled focused studies on genes important for bud development (Akhter et al. 2019), wood development (Blokhina et al 2019) and photosynthesis (Grebe et al. 2019).

But, perhaps more importantly for Sweden as a country, is that the same genetic and genomic resources give important tools to the operational tree breeding by Skogforsk, that already have been started to be utilized in the breeding program. Significant work is also ongoing, mainly funded by other sources but built on the competences of T4F researchers, to bring the genomic resources of Scots pine to a similar level. There has been significant progress also here, although the efforts have not yet resulted in publications.
In addition, T4F researchers have been involved in similar kinds of development of genomic resources for other tree species (Jia et al. 2019, Jin et al. 2019, Liu et al. 2019, Xu et al. 2019) and have contributed with reviews describing the development of the field (Myburg et al. 2019, Street 2019).

Full activity in the Bioinformatics facility.
*Photo: Anke Carius*

T4F researchers have also been deeply involved in the development of spatial transcriptomics in trees (Giacomello et al. 2019). This technique is likely to become a very important tool for the analysis of, for example, developmental processes in trees. Like previous years, the visibility of the activities of the theme has also come through abundant participation in the societal debate.

RESEARCH PORTRAIT: MICHAEL GUNDALE

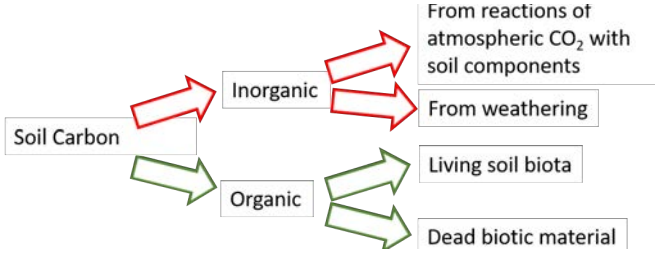
# Time to look at the whole forest!

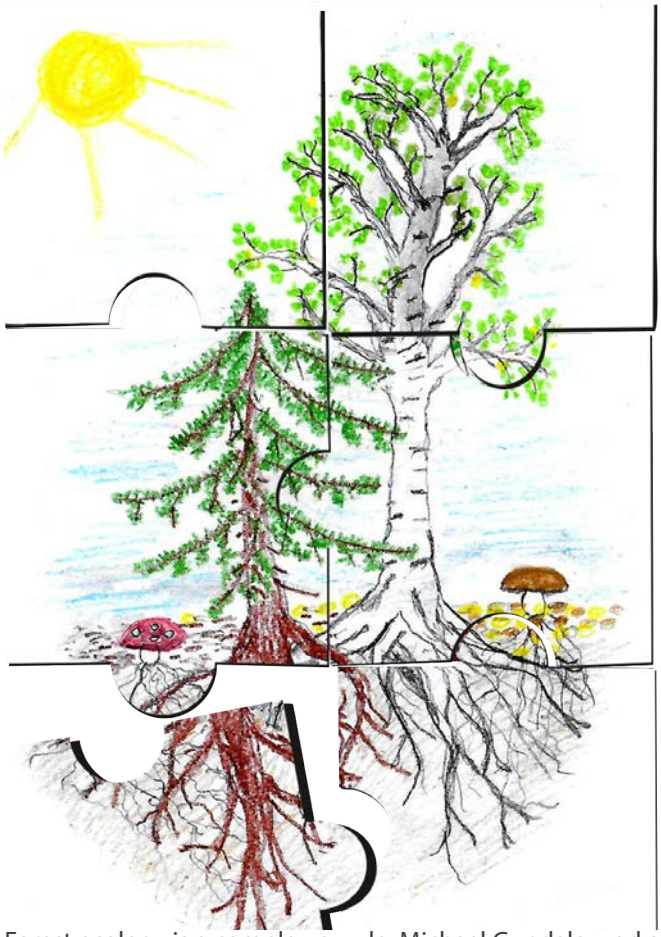
*Meet Michael Gundale who has been involved in TC4F as a junior theme member from the beginning of the program almost 10 years ago. As he just became a full professor recently, he is now getting more involved in shaping the next program period for the part of the program now called T4F; Trees for the Future. As the spokesperson and coordinator for the T4F writing group, a consortium created to plan the next 5-year program period, Michael has now a central role for the development of the program. Find out what Michael's research interests are and read about his goals for T4F.*

Michael is a forest ecologist who is fascinated with understanding and solving the complex puzzle of the biosphere. One research area Michael has worked on is growth of *Pinus contorta*, which he considers a model species to study exotic species introductions. It is a native tree species to the Northwestern USA, where Michael studied at the University of Montana, earning an undergraduate degree in wildlife biology and a PhD in Forestry.

When Michael came to Sweden 13 years ago, he was not only surprised to find that *P. contorta* was planted in Sweden, but also that these plantations were outperforming the North American *Pinus contorta* forests! When he started to investigate why it is apparently beneficial for this species to be moved away from its native environment, pieces of a complex puzzle of soil organisms and biotic stress revealed themselves as key factors. The fascination of how a tree is integrated into and influenced by its ecosystem guides his research still today.

Carbon storage in forest soils is currently one of Michael's most active research areas. How forest composition influences the amount of carbon stored in





Forest ecology is a complex puzzle. Michael Gundale works with investigating many pieces of the puzzle, including the role of soils and soil organisms.

the soil and at what rate it accumulates are currently central questions in his research program. Carbon sequestration by forests is one of the most promising means to mitigate climate change caused by carbon dioxide accumulation in the atmosphere, however, climate change will also change the composition of the forests and potentially also their ability to store carbon. T4F has in the last years created a network of researchers studying different ways to alter forest composition, for example by changing the genetics, choosing native or exotic tree species, or deciding to manage forests as monocultures or mixtures. All of these factors can potentially influence carbon accumulation in the soil, and Michael is looking forward to expanding his collaborations within the T4F network to gain a thorough understanding of what controls forest productivity and carbon storage. "In T4F, there is extensive knowledge about the single tree, but actually, we do not really know how a certain genotype will behave when it is planted at the scale of a whole forest!" So, it is time to look at the whole forest!

Skogforsk, a state owned forestry company in Sweden that is also involved in T4F, has recently shared more information about their long term field experiments with T4F researchers. Michael is especially excited about experiments where single genotypes have been established as whole forest stands and have been replicated. This gives researchers the opportunity to investigate how genes are expressed in a forest context, how biotic and abiotic differences in the environment affect forests that are genetically different.

Bridging basic research to application will continue to be one of the most important aims of T4F. Trees for the Future should be defined, developed, bred and thoroughly evaluated out in nature. As a tree is a sessile organism, it is very dependent of its surroundings, and it has only very limited possibilities to alter them. Michael's research is located at the basic foundational side of the research spectrum within T4F, but he hopes that his research will improve predictions for which type of forest composition at both the genetic, species, and community level are most optimal for maximum production and carbon sequestration under future climates. As climate change develops further, Gundale says, "It will be increasingly important to manage forests for a high level of resilience and productivity, as well as promote their role in sequestering carbon which will help stabilize the global C cycle and mitigate climate change."

*Text and Pictures: Anke Carius*

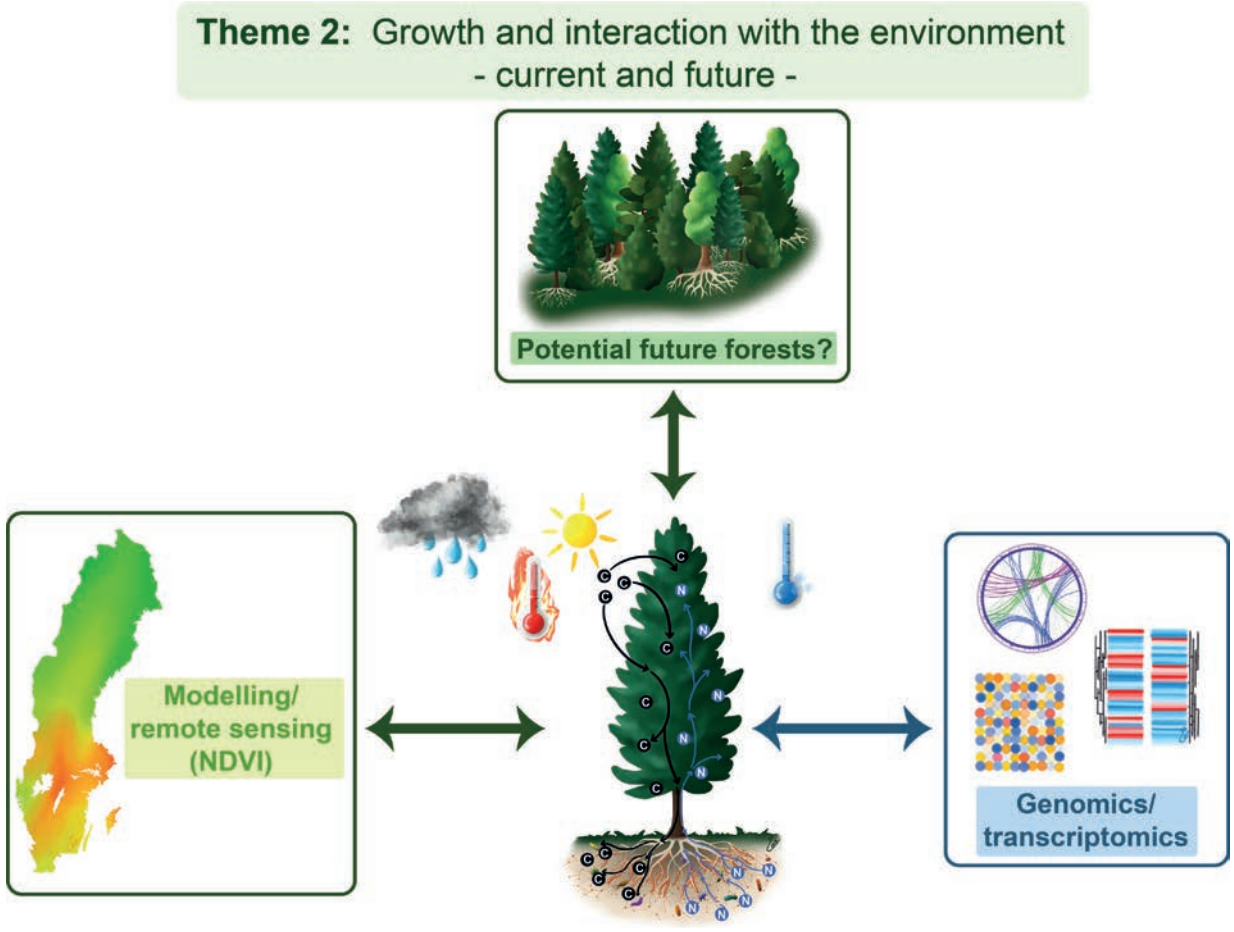
THEME LEADER: VAUGHAN HURRY

# 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 2019

In Theme 2 our goal is to increase the sustainable biomass yield from the existing forest estate. Future climates will be characterized by warmer and more variable air temperatures, higher atmospheric $CO_2$ concentrations, and more frequent water stress. To develop the knowledge base to achieve this goal, it is essential that we understand the responses of trees to these different biotic and abiotic factors stemming from plant-climate and plant-soil interactions: and to mathematically quantify the impacts of these different factors not only on tree growth but also on ecosystem biodiversity, resilience and robustness in response to change. Therefore, within Theme 2 we have been working at scales ranging from remote sensing data to the



molecular genetic, spanning not only forest tree responses but also the responses of the linked metacommunities. This ability to analyze the responses not only of forest trees but also of forest soil microbiomes and microtranscriptomes, now makes it possible for us to assess the linked functional consequences of these different trophic-level responses to climate change and forest management.

## Main findings/highlights

- We have developed and deployed methods for both metagenomics and metatranscriptomics to study the effects of atmospheric pollution (N-deposition) and forestry practice (fertilization) on the associated fungal and bacterial microbial communities of Norway spruce and Scots pine. This has generated important insight into shifting patterns of the fungal community associated with increased N inputs into Norway spruce and Scots pine forestry stands. This work has been extended using metatranscriptomics to obtain functional insight to the active processes within those communities (Haas et al 2018; Bonner et al 2019).

- The data and progress made within Theme 2 enabled us to attract by both SciLife Lab biodiversity co-funded sequencing grant and a WABI/NBIS long-term support bioinformatics projects. The metatranscriptomics work simultaneously assess treatment effects on gene expression in both the tree host and fungal species associated with the sampled tissues. (Schneider et al, in progress; Law et al., in progress). This work currently focusses on Norway spruce and is now being followed up for Scots pine.

- Soil microbes are induced to colonize plant roots as a result of the complex mix of compounds these roots exude into the rhizosphere. We have developed a technique to simulate root exudation in forest soil using microdialysis membranes to test the role of different exudates in attracting microbial partners to the root. The community established on the membranes is visualized with scanning electron microscopy and the micro-scale diversity of the fungi colonizing the membranes characterized with DNA sequencing (Swaine et al, in progress).

- We have made extensive use of the genomic resources developed by T1 to assayed abiotic stress responses in Norway spruce that will be key features in future efforts to breed to climate-resilient genotypes suited to future forestry. Namely, we have assessed the response of Norway spruce to elevated $CO_2$, elevated season warming (Robinson et al, in prep), drought (Haas et al in revision; see also Feng et al, 2018 & 2019) and cold/freeze acclimation (Vegara et al, in prep). This work is now integrated into the newly funded KAW genome project for Norway spruce and Scots pine. Associated with this, new experiments will be performed on Scots pine by a TC4F-funded PhD student (supervised by NS). This will further integrate activities in Themes 1 and 2 and will enable comparative network analyses both among the conifer species and between coniferous species and angiosperms.

- Using landscape-scale NVDI data (e.g. (Ruiz-Pérez et al, 2019) and molecular physiological studies (e.g. Yang et al, 2020) we have established the role of plant traits such as photosynthesis as essential for the avoidance of thermal damage under future warmer and drier climates by the boreal forest. Linked to these studies we have developed a stochastic modelling approach to study whether leaf-level CO2 assimilation is able to keep up with future warmer and more variable air temperature (Vico et al 2019).

## Societal value

The metagenomics protocols we established have been deployed to study how different fertilization sources and seedling planting/establishment strategies influence recruitment and integration of the fungal metacommunity into the rhizosphere of newly planted seedlings. This work is in collaboration with Holmen Skog AB and STT, therefore representing direct industrial application and benefit from the work developed in Theme 2.

# The forest research site Rosinedal

*In August 2019, researchers participating in the SPPS2019 conference, arranged by the Scandinavian Plant Physiology Society (SPPS) were invited to a special presentation of forest research by T4F. Directly on site in the Rosinedal Forest, six stations were set up, presenting research done on forest and forest trees.*

Presenting research on site is usually a bit old-fashioned, thinking back to forest excursions while during undergrad, walking about with a taxonomic key book identifying plants and insects on our way. However, having spent many hours in lecture halls watching technically advanced presentations, researchers who do not work in the field might have difficulty visualizing how forest research data is collected and what experiments actually look like.

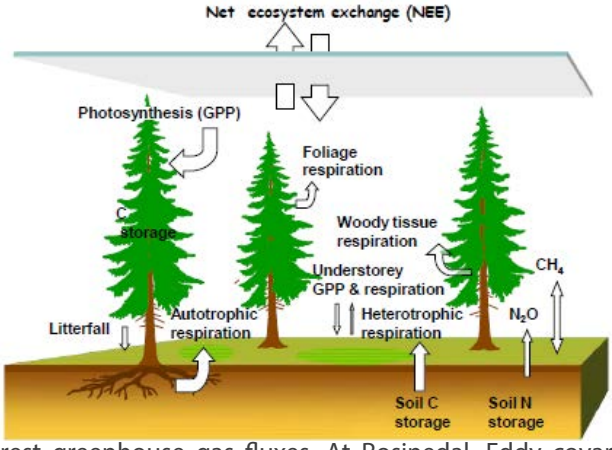
Bearing this in mind T4F researchers, in collaboration with SPPS, sprang into action to dust off the format of field excursions and connect it to modern teaching methods. QR codes that can be read by smartphones lead to a website providing background information on all experiments whilst researchers presented their work on site at six different stations.

The entrance to the Rosinedal Site, Torgny Näsholm (left) and a group of conference guests.

The QR-code to the website created for the excursion!

## Station 1: The Rosinedal Site: How does nitrogen supply, either through deposition or through fertilization, affect carbon sequestration in a mature pine forest in the boreal region?

The Rosinedal Site was established 2006 to investigate the effects of nitrogen fertilization on forest trees. Torgny Näsholm explained how the Rosinedal Site was created in 2006 (although the trees are around 100 years old) and what can be investigated there.

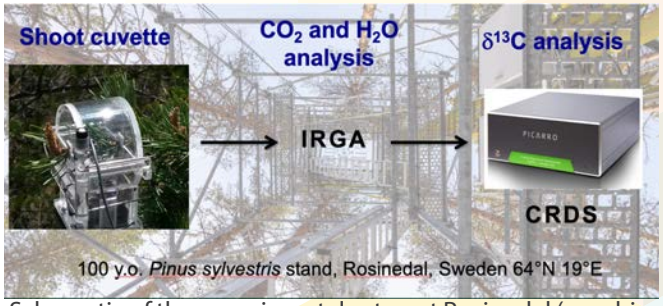



Forest greenhouse gas fluxes. At Rosinedal, Eddy covariance measurements provide information on how nitrogen addition affects $CO_2$ exchange between the stand and the atmosphere. In addition, the drivers of compartmental fluxes are studied on both trees, understorey and soil. Graphics Torgny Näsholm.

Microdialysis probe inserted into the organic layer in a boreal forest soil. Photo: Sandra Jämtgård

## Station 2: Microdialysis: insights into nutrient supply at the soil-root interface

At this station Sandra Jämtgård gave insight on how microdialysis is used at the Rosinedal Site to measure soil nutrient composition without disturbing its matrix. "Seeing what the root sees" gives researchers much more detailed and reliable information about the nutrients actually available to plants.




Schematic of the experimental setup at Rosinedal (graphics by Zsófia R. Stangl and Andreas Palmén)

## Station 3: Carbon uptake from leaf to stand scale

At station three, Zsófia Stangl and Antoine Vernay presented their research on the use of stable isotopes to quantify leaf- and canopy level carbon fluxes. The rate of $CO_2$ uptake in the field at leaf level is challenging to measure, especially diurnal and seasonal dynamics, as they crave high timely resolution. Zsófia and Antoine showed their experimental setup as they installed a gas exchange measurement system combined with a $^{13}C$ isotope analyser that measured $CO_2$ and $H_2O$ fluxes along with $^{13}C$ discrimination on six shoots over two growing seasons continuously.

Microdialysis unit connected to the soil probe. Photo: Anke Carius

## Station 4: Biomass allocation and soil carbon sequestration at low and high nitrogen availability

Station four presened a proxy of an experiment located at a nearby site to Rosinedal, Åheden. Researchers use data from Åheden, a long term nitrogen addition experiment, to better understand how different rates of nitrogen deposition affect the uptake of nitrogen and storage of carbon in boreal forests.

Benjamin Forsmark presenting his research in front of the gas exchange measurment tower in Rosinedal. Photo Anke Carius

## Station 5: Using amplicon sequencing and meta-transcriptomics to characterize microbial communities under varying soil nutrient availability

At station five, Andreas Schneider showed how microbial communities associated with trees develop under a tree's lifespan and in relation to nutrient optimization. Next generation sequencing is used to assess the composition of the microbial communities, sampled not only from roots and soil but also from needles and above tree tissue.

## Station 6: Impact of seasonality and soil nutrient alteration on the association between Norway spruce and ectomycorrhizal fungal communities

Simon Law and Alonso Serrano investigate the influence of fertilization on Norway Spruce and their ectomycorrhizal community. Roots and fungal communities from nutrient-deficient control plots were compared to corresponding samples from plots that have been fertilized with an optimised macro- and micronutrient regime for 25 years. Samples were taken throughout one growth season, and RNA sequencing, followed by PCA analysis showed a clear progression of genetic events forming the interaction between plant and fungus. Co-expression network analysis of Norway spruce root and fungal community expression data was carried out and the resulting networks were clustered to reveal underlying relationships between genes of different organisms. These results are beautifully visualized on the websites created for the Rosinedal excursion.

Researchers from all over Scandinavia and beyond were deeply impressed with the presentation of research in the forest context. Even local newspapers picked up on the event and praised the use of novel technology whilst presenting research on site in the forest.

*Text: Anke Carius*


Below-canopy eddy-covariance tower offer the monitoring of undertorey carbon fluxes. (above)

A group of researchers focussing on Sandra Jämtgård's (facing the camera) presentation of a soil micro dialysis unit (right)


Station 2

THEME LEADER: URBAN NILSSON

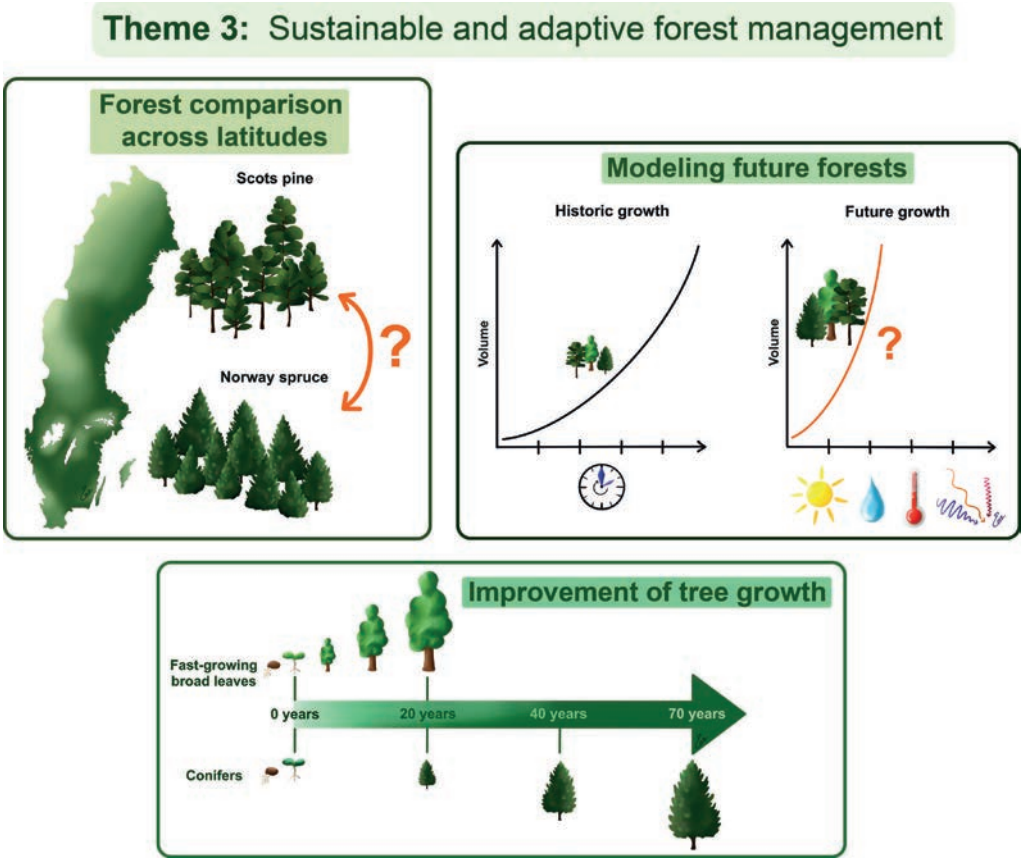
# Theme 3
# - Sustainable and adaptive forest management

*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 Theme 3 during 2019

During 2019, activities in Theme 3 was concentrated on continuing projects that were started during previous years of the TC4F but some new research was also initiated. Four PhD-students were ongoing.

The first student, Oscar Nilsson, is studying silviculture in Scots pine and Norway spruce in southern Sweden. During the first half of **2019**, Oscar has been in North Carolina and worked on nitrogen-fixation in Scots pine. The second PhD-student, Theresa Ibanez, is studying regeneration in the fire-area outside Sala and has been busy collecting data from the field experiments. She has also finished a green-house study that was analyzed and reported during 2019. The third PhD-student, Martin Goude, have completed empirical growth models and is currently building a hybrid growth model for Scots pine and Norway spruce in Sweden. The fourth PhD-student, Gustav Ståhl, started during 2018 and will be working with carbon sequestration. A MSc-student Erik Sundström performed his Master thesis at the Sala-burn in 2018, and the international internship student Marie-Lou Novene also performed her 6 month research training period within our theme.



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

## Main findings in 2019

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. A 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 are underway and will be established during 2020.

An important project within theme three is silviculture in mixed forests. With data from a survey-study, a manuscript on ground vegetation development have been submitted for publication. In order to compare growth of Norway spruce and Scots pine, we have also analyzed Äbin-data, NFI-data and data from tree species experiments. These results, which show that Scots pine is growing unexpectedly well on fertile site in southern Sweden have been reported in excursions and will be reported in scientific literature during 2020. Data from the Sala site shows that seedling regeneration (in particular that of spruce) following fire benefits from soil microbiota that are supported by alive overstory trees, and that biotic soil components may be of larger importance than that of soil abiotic properties resulting from fire. Work has also revealed the development of a new method to quantify tree root biomass in fire disturbed field soils with qPCR, as well as validated experimental approaches to work with soil biota under controlled conditions.

## In what way is research in Theme 3 contributing 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 stake-holder 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. During 2019, we have collaborated with the FRAS- and Becfor-projects in two excursions 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) has contributed to public information through interviews with media and public seminars. 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. This work has also yielded funding from FORMAS (one project granted during 2019 and one starting in 2020).

# A new model for boreal forest growth

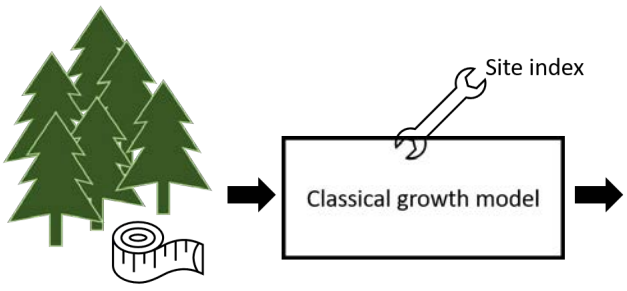
*Hybrid PULS modelling of Scots Pine and Norway Spruce applies an approach previously used on fast growing trees to predict the growth of boreal forest with Photosynthetic Active Radiation (PAR) as a driving factor. To apply this method, it is an advantage to include data of the total leaf area of the trees; then the Absorbed Photosynthetic Active Radiation (APAR) can be used and make the model more precise . Martin Goude has already published a method for this and has now begun to tackle the modelling part of his PhD-project.*

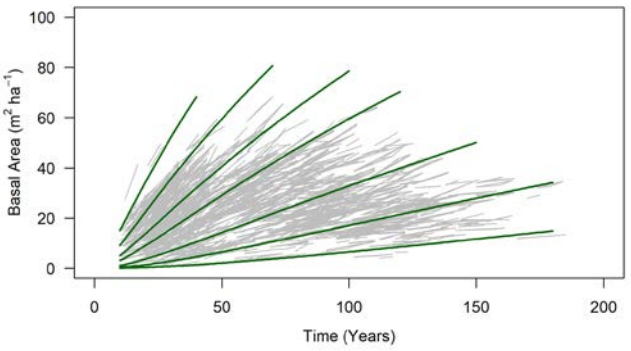
Martin Goude grew up on a farm in Blekinge with both animals and forestry. To continue his education towards forestry after school seemed to be a natural progression for him. He started his undergrad studies towards "Jägmästare", (forestry), in Umeå and worked with forest inventory in the research plots in Vindeln. This was when his interest awakened in what can be done with forest inventory data. As he moved south to continue his master studies, he and Urban Nilsson created a master thesis project based on their common interests.

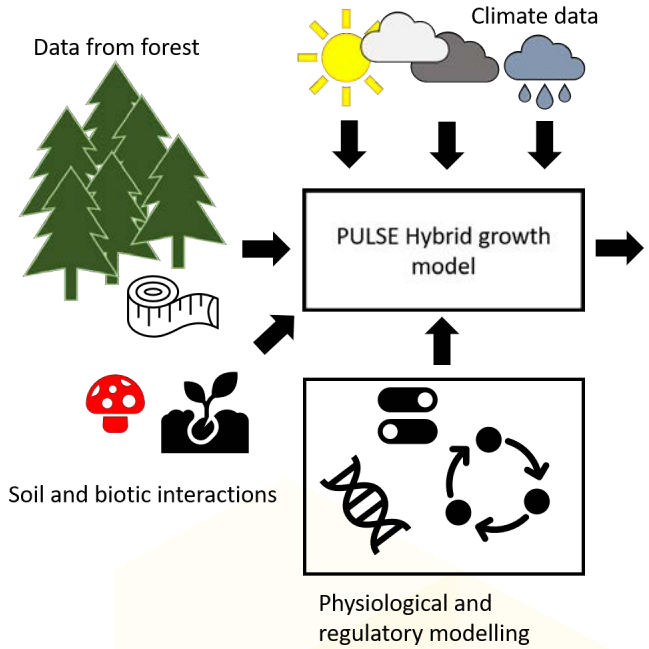
Martin's ongoing PhD project focuses on developing a new, innovative model for boreal forest growth that integrates climate data and makes predictions not only under constant conditions but also for a changing climate. Classical growth models, that are currently in use offer only little opportunity to modify the conditions under which the forest grows. Calculations are made in a so-called black box, meaning that the user can modify certain parameters but does not see how they are integrated throughout the modelling process. Martin thrives after a model that is capable of integrating more detailed information, such as temperature, solar radiation and other climate data, and allows the user to modify these parameters to predict different scenarios.

Further, the current models are based on forest inventories that are performed every 5 years, so predictions can only give information about broad time intervals. To improve this, and to be able to give accurate predictions for both 1-year periods and 100-year periods, Martin is developing a model that predicts the yield of a forest based on solar radiation instead of time as a driving force. "The importance of photosynthesis is generally underestimated in forest growth models" says Martin, but obviously one can wait many years but without any light and photosynthesis there will not be a forest. "That it is possible to do things in a different, smarter way was quite an eye opener for me", he claims.

The shape of the time based basal area model for Norway spruce. The green lines illustrate the shape of the model curve at different site productivity. The grey lines represent the data of growth periods used to fit the model.
*Bild: Anke Carius, Graph: Martin Goude*



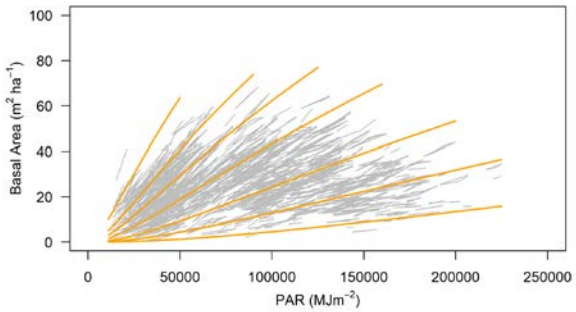






Publications by Euan Mason about Hybrid Yield models integrating radiation into growth models in leaf forests in New Zealand provide knowledge and inspiration for Martin's modelling approach.

Hybrid models integrate at least two different data sets, in this case data from the national forest inventory as well as data from weather stations to simulate the climate. For guidance on how these data sets should interact, regulatory and physiological models provide structure. This greatly increases model complexity but also its accuracy.

*Spruce trees, Photo: Anke Carius*




The shape of the hybrid PULS basal area model for Norway spruce. The yellow lines illustrate the shape of the model curve at different site productivity. The grey lines represent the data of growth periods used to fit the model. On the x-axis we have Photosynthetic Active Radiation (PAR) which is driving the model.
*Bild: Anke Carius, Graph: Martin Goude*

Martin's models will be able to greatly contribute to T4Fs aims to take basic research to application as he uses data from basic research to model forest growth. The model can then be used to predict the performance of a forest under different conditions. In applied forestry, models of this type will help to choose the tree species or genotype for a location, appropriate support for the trees such as fertilization or liming and to make economic predictions. Of course, further development is needed, and Martin hopes to later be involved in modelling of mixed forest growth. "A lot of forests in Sweden are mixed forests, so this topic is very relevant!" Martin says.

*Text: Anke Carius,*

# Spruce or Pine trees, what should it be?

*Oscar was born in Linköping and grew up on his parents' farm in northern Skåne. At ten years old, the family moved to Stockholm. During those years, Oscar did not feel any connection to forestry work and forestry at all. After school Oscar was playing ice hockey and working at the side. "After a time, I realized that I would not become an NHL superstar" Oscar laughs, "so it was time to get a real education".*

By then Oscar had become interested in forestry, so he chose to study towards a degree as a "Jägmästare" in Umeå. After three years he continued his studies in Alnarp in the Euroforester programme. There, Oscar's interest shifted towards forestry outside of Sweden, so he joined a student exchange program and travelled to North Carolina, where he pursued a full year of courses. For his Master project, Oscar travelled to South Africa to study pine plantations. Oscar achieved a dual master's degree in forestry, from both SLU and the University of North Carolina State University.

Oscar in one of his experiments, on a site where the organic soil had been removed prior to planting. Tiny spruce trees in the foreground, larger pine trees around him.

Whilst working as a field technician and in industry (Stora Enso) for a while, Oscar realized that he was most inspired by the research he had done during his master project so he started to look for a PhD project to pursue a scientific career in forestry. However, there were almost no PhD projects offered in silviculture at the time, so it took Oscar some years to find his PhD project within TC4F. Now, 4 years into his project, there are much more projects available to pursue a PhD in forestry, which is a result of T4F's boost to silviculture research groups in Alnarp.

Oscar's PhD topic is to compare the growth of Scots pine and Norway spruce on the same site. Even though the standing stock in Sweden, and consecutively wood industry is dominated by these two species, hardly any studies have been conducted comparing them on the same site. Usually, they grow on different sites and then the comparison is done.

For Oscar's project, pine and spruce were planted together on two sites; one rich in nutrition and the other one deficient. This was done on two sites in Västerbotten and on four sites in Southern Sweden, so Oscar could gather comparison data from six different sites in total. Additionally, the soil was prepared in different ways before planting, for example by removing all organic material or deep blending the soil, completely mixing the top 60 cm of the ground (deep soil cultivation). The results after 5-6 years showed that pine has an astonishing capability to grow well in almost any soil, independent of the site preparation method, whereas spruce will struggle as soon as the nutritional value of the soil is not optimal. Spruce thrives only in soils with high organic material content and nutrition. "On the nutritionally poor site in Västerbotten, where all the organic material had been taken away, the spruce trees are still really tiny, they almost did not grow at all! ", Oscar emphasizes. Blending the soil about 60 cm deep, seems to be beneficial for both trees. Although at first spruce trees grew a bit slower than the reference without

soil treatment, they recovered and performed best on this soil treatment in all fields. In the north, this lag phase took significantly longer, and the positive effect became visible even later.

It is quite difficult to use a growth experiment with trees as a PhD project as the general time for a PhD thesis only is four years. In this case, the experiments had already been started by a previous PhD student. Oscar calls this a lucky coincidence as the results of the comparison first became significant after 4-5 years when he evaluated the experiment. A couple of years earlier, the results were not detectable in this way, yet. However, letting the experiment run longer than he has now will not give very useful results either, as the trees stand quite tight and now start to compete over resources.

Looking for the root cause: Oscar digging up roots for nitrogen fixation analysis

In another part of his project, Oscar now analyses why pine seems to have so much better performance independent of the site they are planted on. Oscar suspects that differences in nutritional uptake systems could be responsible for the aforementioned results, so he analysed some experiments with $^{15}N$ marked nitrogen fertilization, to detect whether he can find a correlation between nitrogen uptake and the data from his growth experiments. Further, he collected roots to investigate them for nitrogen fixating microorganisms. His preliminary results are exciting; it seems like Oscar is on the right track there to find a cause for the differences in growth for the two trees.

In Främlingshem, Gävle, Oscar was also involved in an experiment with a mixed forest of pine and spruce that already is 53 years old. For this field site, treatments of either spruce, pine or a mixture of both were established with ten replications over a large area when the previously seeded mixed stands were pre-commercially thinned.

"In the beginning it was assumed that both species would grow approximately equally well, but the experiment showed that this is not at all the case. Pine grew about 126% better, the difference is huge", says Oscar. "In northern Sweden, controlled experiments have shown that this is even the case for rich soils; only in very rich soils spruce can compete with pine. This is very interesting, and not really what we were taught in our studies. This is also not the same result that surveys data of forests show. So the 1 million crowns question is: Why are the results from the experiments not the same as the results reported from the real forest?"

Already now, foresters can appreciate from Oscar's experiments that it is a good idea to plant the individual spruce seedlings relatively close to the nutritous organic material, whilst pine on the other hand grows well even without access to the nutrition provided from the organic material.

Oscar loves the scientific work with the forest and would without hesitation do a second PhD project if it were possible. Fortunately, there are other possibilities to continue working on his current subject. "To start comparing the two most important tree species for forest industry in Sweden and to discover then that there actually is hardly any scientific data from experiments is really exciting and of course opens up many doors for further investigations. It was quite a revelation that the general "school opinion", as for example "on ground with blueberry bushes you should plant spruce" is not actually based on much scientifically." Oscar exclaims, "Actually, we don't really know on which soil to plant which tree." With this question, Oscar works close to the heart of the Trees for the Future project and can hopefully help future forestry from myth to measure.

*Text: Anke Carius; Pictures: Oscar Nilsson (private)*

C4F LEADERS: EVA JOHANSSON AND LI-HUA ZHU

# C4F- Crops for the Future

*The program contributed to emerging of new research areas such as bio-based composites for food and non-food uses, potential medical uses of plant-produced proteins and renewable sources of plant produced insect pheromones for pest management. The plant protein factory (Fig. 1) has been equipped and started. SLU Grogrund has started 10 novel projects in 2019.*

## Overall progress in 2019

In 2019, all subprojects within C4F have progressed well. A large number of peer-reviewed articles of high quality have been published, while a number of manuscripts are in the pipeline for publication soon. Some new PhD students have been recruited and newly funded research grants associated with the C4F program have been initiated. Research outcomes and associated outreach activities deal with new knowledge and information on novel potential uses of plant oils, proteins, starches and other compounds which can be used as food, feed and different industrial applications.

## Detailed research findings and progress

The understanding of how proteins can be functionalized to receive different properties, among them superabsorbent properties has taken tremendous steps forward and have resulted in four scientific articles published in 2019 (Fig 2 and 3), two patent application and one Vinnova UDI step one project. New results have been obtained in the area of plant components such as, protein, starch and fibers, innovative uses in composites and the importance of raw material "design" and physiochemical properties for making them suitable in targeted nutritious foods and "green" composites.

Fig. 1 Protein factory is in operation in 2019, where the green tissues left in production fields can be processed for extraction of important compounds for various applications. Photos by William Newson (left) and Sara Kyrö Wissler (right).

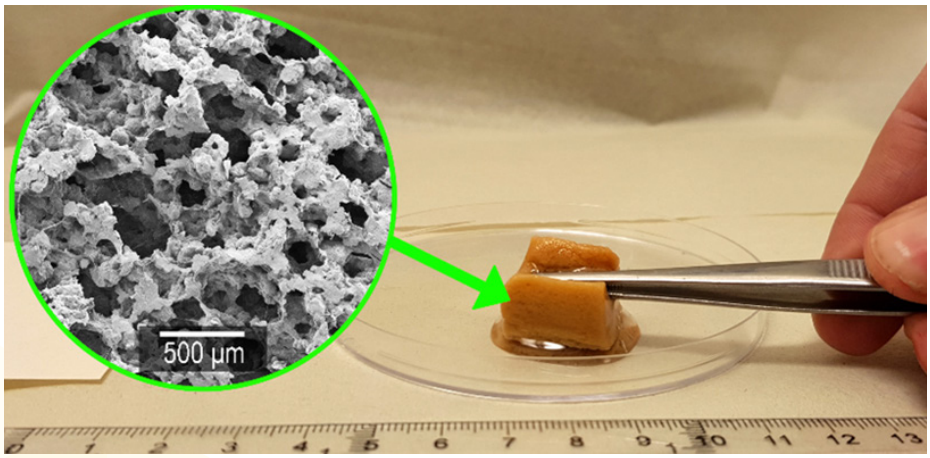



Fig 2. Bio-based sponges based on wheat gluten side-streams displaying high water uptake has been produced, showing petroleum-based sponges used for cleaning purposes and demonstrates that bio-based plastics have high market opportunities for more sustainable products in the future. Photo by Antonio José Capezza.

Novel two types of protein based fiber materials showed outstanding results in terms of absorbing properties and microstructure, and high potential of being used in absorbing health care products.
Protein nano fibrils (PNF) originated from proteins extracted from lupine, mung beans, faba beans have been characterized and a manuscript on PNF is under preparation.

The incorporation of PNF films was tried, but the results were inconsistent with trouble shooting ongoing. The non-protein part of faba beans has been investigated regarding the polysaccharide composition. One article has been published and manuscripts are in the pipeline of submission or draft regarding the above mentioned research activities.
New improved breeding lines have been developed in rice and barley, namely WRI1 rice, FATB rice and Yin-yang barley. Those lines can be used as proof of concept to develop new cereal varieties in breeding programs for oil production, biotic stress tolerance and high yield as well as high dietary fiber content. AtWRI1 can increase oil content in rice endosperm from 0.9% to 1.6% and a manuscript about this is under preparation.

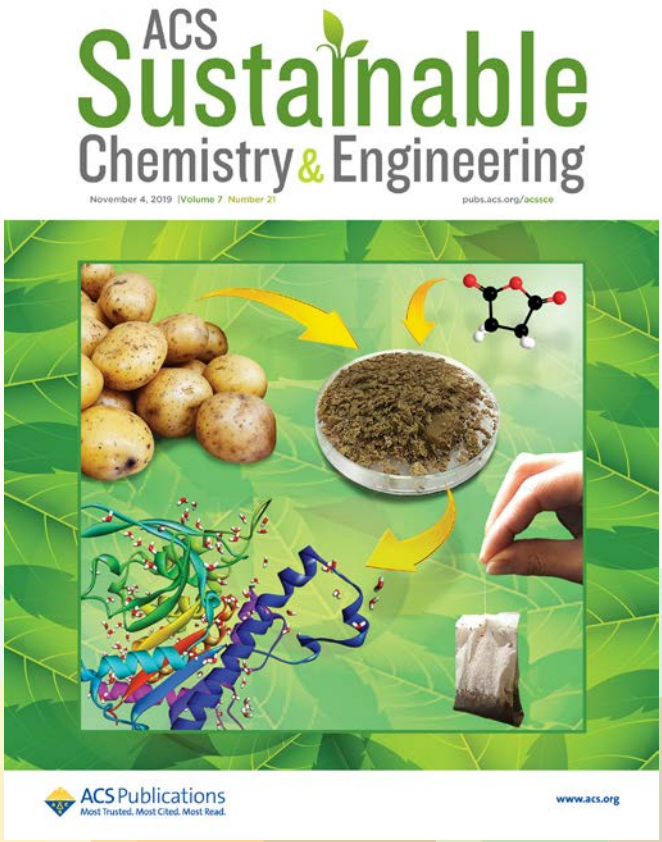



Fig 3. Potential utilization of biopolymers such as wheat gluten for the industrial production of porous materials that could perform in applications where fast and high liquid swelling are needed in daily-care products e.g. sanitary pads. Copyright of the photo belongs to American Chemistry Society.

The FATB type genes play an important role in oil production and is associated with improving biotic stress tolerance. A yin-yang barley line with improved yield has passed a field trial test for new variety registration.

Genome editing has been used as a method to redirect carbon flow by modifying promoters of transcription factors (TFs). A couple of manuscripts have been either published or in the pipeline of submission or preparation. These manuscripts deal with functions of some important TFs involved in seed development including seed structure, seed filling and seed maturation. One manuscript structurally dissects a family of double AP2 domain TFs, which are of importance for flowering, embryo development and seed metabolism. (Fig 5)

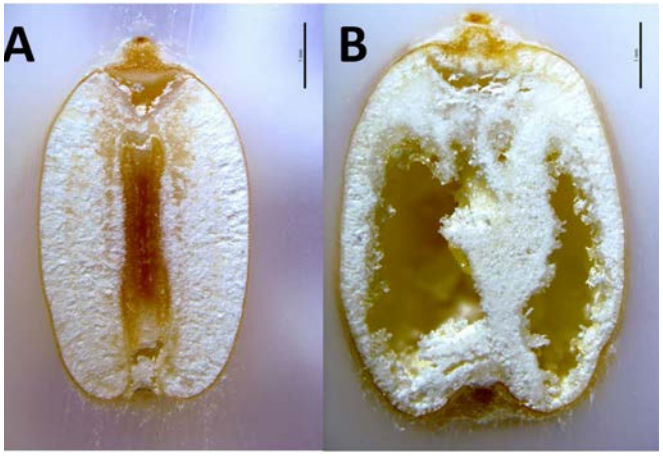



Fig 5. Transgenic wheat with oil production in endosperm. Sliced developing wheat kernels showing inner fluid-filled compartment for GM (right) expressing oat transcription factor WRI1 compared with WT (left). Scale bar: 1 mm. Photos by Per Snell.

Seed production and extraction in the pheromone project has been scaled up, which enabled us to perform mating disruption tests for two different major pests. One manuscript has been submitted on tobacco production of 14:1 and 16:1 fatty acids for pheromone compound development. The main research effort is the production of pheromone precursors as fatty acid constituents (12:1-16:1) in Camelina sativa seed oil.

Fig. 4. Transgenic FATB lines of rice growing in phytotron. Photos by Chuanxin Sun

Field cultivation of camelina with 16:1 has been scaled up for mating disruption tests. Manuscripts for the different biosynthesis strategies where in addition to normal seed oil, wax esters (WE) have been developed with the added benefit of carrying fatty alcohols being true pheromone blend constituents are under preparation.

To increase WE production level, the FAR gene from Marinobacter and a chloroplast-targeted WE synthase gene (PES2; from Arabidopsis) were tested. Single 35S:FAR transformants displayed a characteristic lethal phenotype with stunted growth and necrotic leaves. Weak and medium overexpressors were possible to grow to maturity. Crosses between 35S:FAR x 35S:PES2 were initiated during 2019 and WE analyses is ongoing. To simplify selection of double expressors, 35S:FAR.hyg x PES.kan crosses with different selectable markers are underway.

Studies on WE utilization during seed germination and WE accumulation during seed development was studied and the results are published. Due to the strict GM regulation in Europe and strong interest from US colleagues, a field trial on the crambe WE transgenic lines was performed in US to exploit the possibility to produce WE in US.

We have successfully established an efficient protocol for protoplast regeneration and a working protocol for protoplast transfection for Lepidium campestre (Fig. 5). These protocols are essential for CRISPR/Cas9 induced mutation lines without external DNA integration into

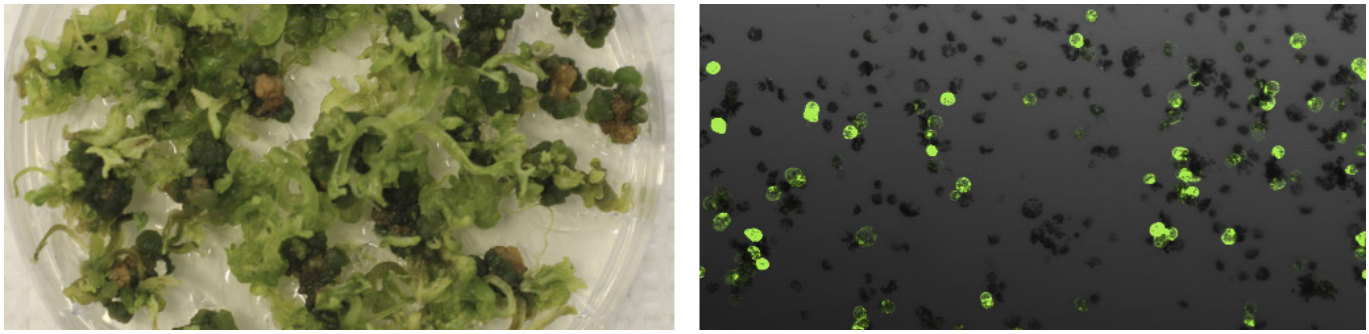


Fig. 5. Shoots (left) regenerated from protoplasts of *Lepidium campestre* and transfected protoplast expressing the marker gene GFP (right). Photos by Li-Hua Zhu (left) and Sjur Sandgrind (right).

the plant genome. Manuscript on this work is under preparation. We have also studied application of the protoplast regeneration protocol for lepidium in other oil species including Arabidopsis with minor or small modifications and the results appear working for most of them.

Integration of genetic and chemical tools for modulating autophagy with luminous reporters has been used for monitoring autophagic flux with the ultimate goal to advance better understanding of the autophagy regulation in crops. Manuscript on discovery of TFs activating autophagy-related (ATG) genes in Arabidopsis is in preparation. The results of establishment of the first chemical screening pipeline for the identification of specific plant autophagy modulators have been published. Structure-activity analysis of the identified plant autophagy-modulating compounds for subsequent photoaffinity labeling and target identification in vivo is ongoing.

Fig 6. Successful expression of functional human myoglobin (right: protein extraction) in tobacco leaves. Photos by Selvaraju Kanagarajan (left) and Magnus Carlsson (right).

Studies on hemoglobin in 2019 have been focused on myoglobin (Mb) (Fig 6) and A1M genes to explore the possibility to express these proteins in tobacco for potential nutritional or medicinal applications. The results showed the functional proteins could be produced in both cases. The manuscript on Mb has been submitted and manuscript on A1M is in preparation.

## In what has the research contributed to social benefit?

The ultimate goal of research activities within C4F is to contribute to social benefits in one way or another. Some projects are at present being transferred to UDIs or EIPs, one way to transfer TC4F knowledge into product-based projects, thus benefiting to the society. Moreover, the new knowledge obtained on composite materials can be further explored in development of nutritious food (protein rich and dietary fiber rich) and bio-based textile materials.

Faba beans is a good plant-based protein alternative to soy-products and gluten, studies on protein nutritional values in faba beans would stimulate potential increased commercial production in Sweden due to its high nutritional profile.

Newly bred Yin-Yang barley lines and transgenic rice lines could be either used directly in future production or for further breeding in improving yield and reducing the use of fungicides and pesticides. This research has achieved two international patents. One Yin-Yang barley line has passed a field trial test in 2019 and will be tested for VCU in 2021 for being registered as a new variety.

Novel transgenic lines of crambe and lepidium with improved oil qualities contribute to increased plant oil production. Colleagues in US are interested in taking over the production of GM crambe lines expressing wax esters. One Swedish company is highly interested in lepidium oil for HVO biodiesel production.

Program leader Eva Johansson

Theme leader and vice program leader Li-Hua Zhu

Capacity building in carbon allocation through doctoral education was complete where one PhD student defended his thesis at the end of 2019 and started to work at MariboHilleshög immediately after. Plant based production of insect pheromones contribute to social benefits through providing non-toxic and renewable products against insect damages in production, being more sustainable than pesticides. The general public is aware of the pivotal role of autophagy in medicine, including human aging and prevention of neurodegenerative diseases. We strive to convey information about the importance of studying plant autophagy for improving crop growth and defense.

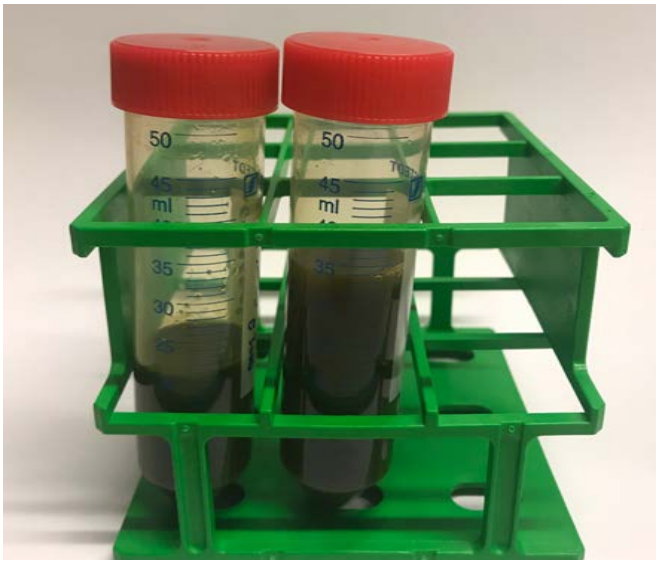
Successful expression and characterization of functional heme-binding proteins in plants contribute to social benefits through providing plant-based proteins for nutritional and medicinal applications in future. We have been reached by one company for potential investment in the projects after they have read got the information about the project through social media.


# Materials engineer William Newson is developing methods for extracting new products from plants

*With a background as an engineer in materials science and a postgraduate education from SLU in Alnarp, William Newson has expert knowledge on how to use biomass for the production of new biomaterials. He develops methods for extracting proteins from agricultural residues.*

William Newson is a materials engineer and researcher at the Department of Plant Processing at SLU in Alnarp. He is an expert in extracting and utilizing proteins from leaves and other plant parts like oilseed meal and other proteins that are left over when food is produced. He sees great environmental benefits and financial opportunities in using these residual products.

– It is largely about using the plants' proteins to make new bio-based degradable materials, such as bioplastics and superabsorbents. But it is also about using the proteins as additives in food and feed for animals. There is a great demand for proteins for sustainable vegetable foods, he explains.




Green juice from leafy biomass

Leaves from sugar beet plants, carrots and beets, and residues after pressing oil from seeds of oil plants, are examples of sources that could replace fossil-based materials in the production of diapers, cosmetics and various plastic items in interior decoration or medical equipment.

– We extract proteins from biomass that are left over after taking advantage of the parts of the plant for which you originally grow the crop. Kale and other leafy vegetables that are damaged or sorted away because they have the wrong size, are also valuable sources of protein.

In the larger perspective, the goal of William Newson's research is to help develop the circular bio-based economy, with sustainable production and new jobs as a result.

## Materials engineer and plant scientist

Before starting as a doctoral student at SLU in Alnarp, William Newson worked as an engineer in the plastics industry. He moved to Sweden from his home country Canada in 2009 to read his postgraduate education here, and continued as a postdoctoral fellow and then as a researcher at SLU.

He combines different chemical and physical methods to extract the proteins from the biomass. The different methods result in biomaterials with different qualities in terms of strength, flexibility, absorption capacity and other properties.

Processing hall of the Plant Protein Factory, for turning green biomass into fractions: fiber, green protein, white protein and brown juice.

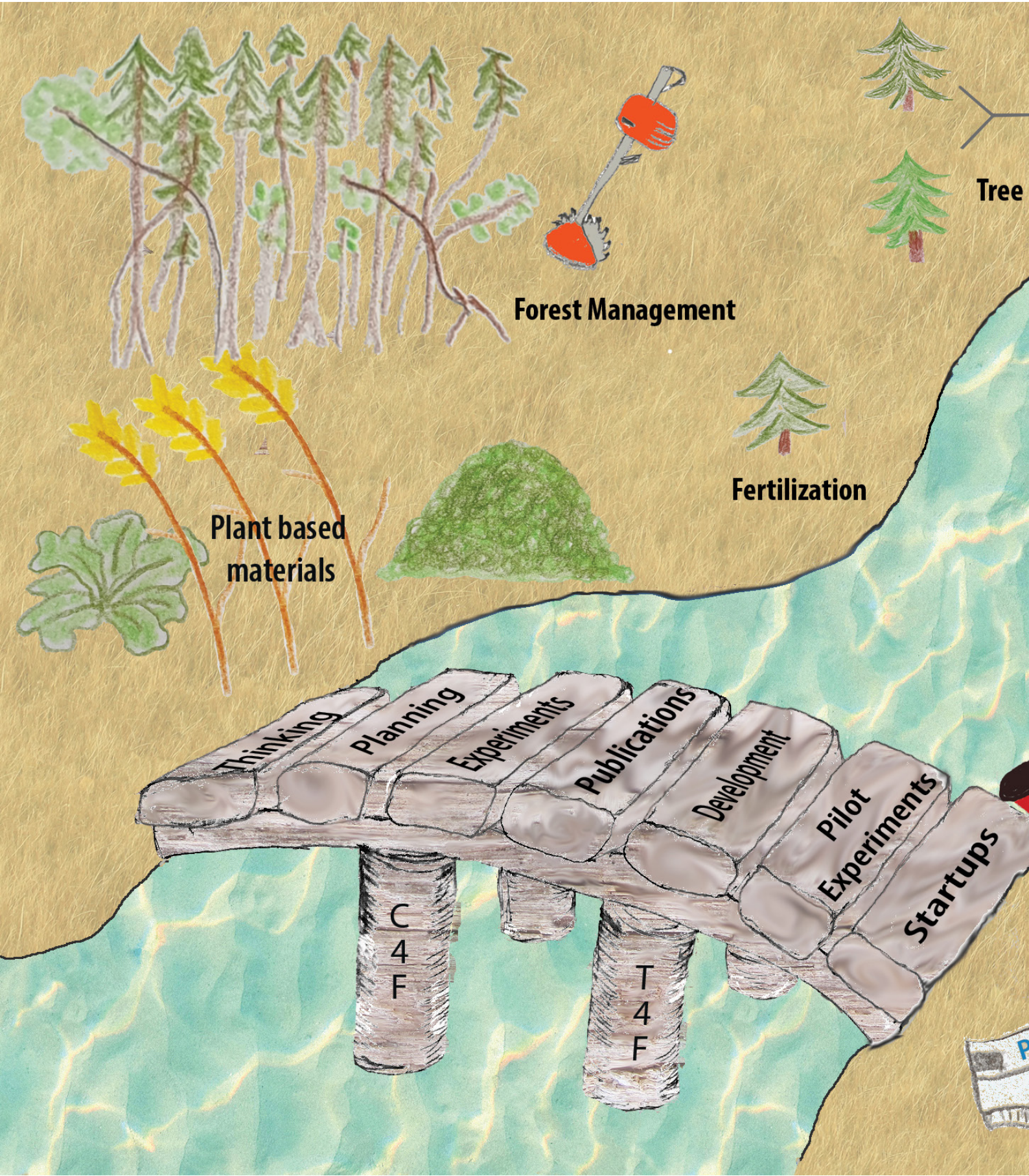
– Method development is about piece by piece building up a greater understanding of what we can do with a plant-based starting material. At the beginning of my career change, from industry back to academia, it was new for me to work with bio-based materials. Just about everything I know about plants, I've learned in Alnarp. At the same time, I have contributed my technical expertise as an engineer in traditional material science.

Time in the industry has given William Newson a practical focus. He is used to thinking in terms of patents and practical applications outside the purely scientific side of things.

He thrives well in Sweden.– For a person from Canada, it is relatively comfortable to move to Sweden, and this is probably because the values that exist in society here are similar to those found in Canada. In addition, Alnarp is a great place to work. I live a few kilometers away and one goal I had when moving to Sweden was to be able to bike to work every day, and I can.

*Text: Lisa Beste*
*Photos: William Newson*

Fractionation of leafy biomass juice. From left: fine fibres, green protein precipitate, clarified juice to go on to protein precipitation.


Tree
Forest Management
Fertilization
Plant based materials
Thinking
Planning
Experiments
Publications
Development
Pilot Experiments
Startups
C 4 F
T 4 F


# Bridging Basic Research to Application in TC4F

The research program TC4F takes fundamental research to application in many different ways. Here, some examples are illustrated.

In theme 1 specific tree breeding leads to specific traits in trees that then are raised in optimized plant schools for plantation in the forests of the future.

Theme 2 developed new fertilization methods that now can be applied to ensure the best tree growth and development. Theme 3 focuses on forest maintainance and develops new methods for forest brushing, even for mixed forests.

Program part C4F develops many plant related products, for example superabsorbent materials from wheat protein and plant based oils and fuels.

# TC4F publications and activities 2019

*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 2019 Theme 1 has published 13 peer reviewed scientific articles in international journals. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.


1. Akhter S, Kretzschmar WW, Nordal V, **Delhomme N**, **Street NR**, **Nilsson O**, Emanuelsson O, Sundström JF (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

2. **Bernhardsson C**, Vidalis A, Wang Xi, Scofield DG, Shiffthaler B, Basion J, **Street NR**, García Gil MR, **Ingvarsson PK**. (2019) An Ultra-Dense Haploid Genetic Map for Evaluating the Highly Fragmented Genome Assembly of Norway Spruce (Picea abies). G3 9:1623-1632.

3. Blokhina O, Laitinen T, Hatakeyama Y, **Delhomme N**, Paasela T, Zhao L, **Street NR**, Wada H, Kärkönen A, Fagerstedt K (2019) Ray parenchymal cells contribute to lignification of tracheids in developing xylem of Norway Spruce. Plant Physiol 181:1552–1572

4. Bonner MT, Castro D, **Schneider AN**, Sundström G, Hurry V, **Street NR**, **Näsholm T** (2019) Why does nitrogen addition to forest soils inhibit decomposition? Soil Biol Biochem 137:107570.

5. Giacomello S, **Delhomme N**, Niitylä T, Tuominen H, **Street NR**. (2019) High spatial resolution transcriptome profiling in tree species. Annual Plant Reviews 2:1-31

6. Grebe S, Trotta A, Bajwa AA, Suorsa M, Gollan PJ, **Jansson S**, Tikkanen M, Aro EM (2019). The unique photosynthetic apparatus of Pinaceae - Analysis of photosynthetic complexes in Norway spruce (Picea abies) J Exp Bot. 70:3211-3225

7. Jia KH, Zhao W, Maier PA, Hu XG, Jin YQ, Zhou SS, Jiao SQ, El-Kassaby Y, Wang T, **Wang X-R**, Mao J-F. (2019) Landscape genomics predicts climate change vulnerability for the widespread Platycladus orientalis (Cupressaceae). Evol Appl DOI: 10.1111/eva.12891.

8. Jin Y-Q, Zhao W, Liu S-S, El-Kassaby Y, **Wang X-R**, Mao J-F. (2019) Genome-wide variant identification and high-density genetic map construction using RADseq for Platycladus orientalis (Cupressaceae). G3: Genes, Genomes, Genetics 9: 3663-3672.

9. Liu YJ, **Wang X-R**, Zeng Q-Y. (2019) De novo assembly of white poplar genome and genetic diversity of white poplar population in Irtysh River basin in China. Science China Life Science 62: 609-618.

10. Myburg AA, Hussey SG, Wang JP, **Street NR**, Mizrachi E (2019) Systems and Synthetic Biology of Forest Trees: A Bioengineering Paradigm for Woody Biomass Feedstocks. Front Plant Science 10:775

11. Wegrzyn JL, Staton MA, **Street NR**, Main D, Grau E, Herndon N, Buehler S, Falk T, Zaman S, Ramnath R, Richter P, Sun L, Condon B, Almsaeed A, Chen M, Mannapperuma C, Jung S, Ficklin S (2019) Cyberinfrastructure to Improve Forest Health and Productivity: The Role of Tree Databases in Connecting Genomes, Phenomes, and the Environment. Front Plant Science 10:813

12. Xu C-Q, Liu H, Zhou S-S, Wang S, Zhao W, Chen F, Sun Y-Q, Nie S, Jia K-H, Jiao S-Q, Zhang D-X, Zhang R-G, Yun Q-Z, Guan W-B, Wang X-W, Bennetzen JL, Maghuly F, Porth I, Van de Peer Y, **Wang X-R**, Ma Y-P, Mao J-F. (2019) Genome sequence of Malania oleifera, an endangered tree with great value for nervonic acid production. GigaScience 8:1-14.

13. **Street NR** (2019). Genomics of forest trees In: Molecular Physiology and Biotechnology of Trees. Vol. 89. Ed. Canovas FM. Academic Press, London, UK. ISBN: 9780128154656

14. Bouffier L, Klápště J, **Suontama M**, Dungey HS, **Mullin TJ**. 2019. Evaluation of forest tree breeding strategies based on partial pedigree reconstruction through simulations: Pinus pinaster and Eucalyptus nitens as case studies. Canadian Journal of Forest Research, 2019, 49(12): 1504-1515, https://doi.org/10.1139/cjfr-2019-0145.

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20. Rosvall O, Bradshaw RHW, Egertsdotter U, Ingvarsson PK, **Mullin TJ**, Wu H. (2019). Using Norway spruce clones in Swedish forestry: implications of clones for management, Scandinavian Journal of Forest Research, 34:5, 390-404, https://doi.org/10.1080/02827581.2019.1590631.

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## Popular scientific publications

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**Jansson S**. Bort med etiketten, Norrmejerier. Västerbottenskuriren 18/7 2019. https://www.vk.se/ 2019-07-18/debatt-bort-med-etiketten-norrmejerier

**Jansson S**. Koordinator för Adolfsson H, Erik Alexandersson E, Bengtsson S, Göran K Hansson GK, Lars Hultman L, Ingvarsson P, Iverfeldt Å Karlsson, Knutson Wedel M, **Nilsson O**, Pettersson E, von Schantz T, Söderbergh Widding A, Teeri T (2019) Förändra EUs regelverk som bromsar växtförädling. https://www.upsc.se/documents/News/News_2019/2019-07-25_Oppet-brev-om-GMO-lagstiftning.pdf

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## Interviews and presence in media

**Jansson S** interviewed in Carina Nilsson. Hybridaspar kan bidra till klimatomställning. Hallandsposten 27/2 2019. https://www.hallandsposten.se/nyheter/laholm/hybrid aspar-kan-bidra-till-klimatomst%C3%A4llning-1.13666267

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**Jansson S** interviewed in Hur kommunicerar träd? - Trädprofessorn Stefan Jansson. Gäst i Morgonpasset i P3 19/3 2019, Sveriges radio https://sverigesradio.se/sida/ avsnitt/1271073?programid=4765

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**Jansson S** cited in https://mobil.unt.se/blogg/vad-vi-vet/ grona-rad-ar-dyra/?blog=1164516&entry=5214272

**Jansson S** interviewed in Jennie Aquilonius: Växter som väcker känslor. Intervju/porträtt i Universitetsläraren 27/5 2019.https://universitetslararen.se/2019/05/27/vaxter-som-vacker-kanslor/

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**Jansson S** interviewed in Universiteten: EU bromsar viktig växtforskning. Västerbottens Folkblad 29/7 2019. https:// www.folkbladet.nu/2019-07-29/universiteten-eu-bromsar-viktig-vaxtforskning

**Jansson S** interviewed in Protest mot regler för gentekniken CRISPR/Cas9. Vetenskapsradion, Sveriges radio 25/7 2019. https://sverigesradio.se/sida/artikel. aspx?programid=406&artikel=7269042

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**Jansson S** interviewed in Genmodifierad mat kan bli livsavgörande. TV4 Nyheter 27/8 2019. https://www.tv4.se/nyheterna/klipp/genmodifierad-mat-kan-bli-livsavg%C3%B6rande-12495481

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**Jansson S** interviewed in Skogens påfåglar? Morgon i P4 Dalarna med Hanna och Stina. https://sverigesradio.se/avsnitt/1367973

**Jansson S** interviewed in Professor tror det dröjer innan forskning från Umea nobelprisas SVT Nyheter 7/10 2019. https://www.svt.se/nyheter/lokalt/vasterbotten/professor-tror-det-drojer-innan-forskning-fran-umea-nobelprisas

**Jansson S** interviewed in Nobelveckan har börjat – hopp för Umeåforskare. Västerbottens Folkblad. 7/10 2019. https://www.folkbladet.nu/2019-10-07/nobelveckan-har-borjat-hopp-for-umeaforskare

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**Jansson S** cited in El FUTURO DE LA ALIMENTACIÓN Agmoderna 4/10 2019. http://agmoderna.com.ar/agricultura-moderna/el-futuro-de-la-alimentacion/

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**Jansson S** cited in http://www.fodevarefokus.dk/fremtiden-for-gmo-i-den-okologiske-sektor/

**Jansson S** cited in Owen Paterson. The EU is the enemy of science, innovation and technology. Post-Brexit, we can finally lead the world. The Telegraph 13/11 2019. https://www.telegraph.co.uk/news/2019/11/13/eu-enemy-science-innovation-technology-post-brexit-can-finally/

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**Jansson S** cited in Ogm in Italia, i radicali fanno una merenda "proibita" a Montecitorio con il riso Crispr Snack. Puntarella Rossa 16/9 2019. https://www.puntarellarossa.it/2018/09/16/ogm-in-italia-i-radicali-fanno-una-merenda-proibita-a-montecitorio-con-il-riso-crispr-snack/

**Jansson S** interviewed in Berit Viuf. Kan genredigerede planter være økologiske? Techst 5/12 2019. https://techst.dk/kan-genredigerede-planter-vaere-oekologiske/

**Jansson S** cited in 'Miracle fruit' from modern tree of knowledge. The day 2/12 2019. https://theday.co.uk/stories/miracle-fruit-from-modern-tree-of-knowledge

**Jansson S** cited in European Ruling Could Slow Africa's Push for Crispr Crops. Young African dec 2019. https://youngafrikan.com/european-ruling-could-slow-africas-push-for-crispr-crops/

## Scientific presentations

Hall D, Kravtsova A, Zhao W, **Wennström U**, **Persson T**, Andersson Gull B, **Wang X-R** (2019). Hardiness and the influence of background pollen in a Pinus sylvestris seed orchard. Conference presentation. IUFRO Seed Orchard conference, Nanjing, China, 14-16 Oct. 2019

**Jansson S** (2019) Natural variation in aspen. Presentation at Molecular Evolution and Genetics of Adaptation, Symposium Uppsala 13/3 2019.

**Jansson S** (2019) How gene editing could be regulated. Presentation at Global Harmonization Initiatives konferens i Leiden, Holland 26/3 2019.

**Jansson S** (2019) What can genome editing deliver for agriculture? Föredrag på ALLEA symposium "Genome editing for crop improvment". Bryssel, Belgien 6/11 2019

**Jansson S** (2019) Phenotyping at UPSC. Presentation at 1st NordPlant annual meeting, Lund 20/11 2019

**Jansson S** (2019) Gene-edited plants on the plate - The "CRISPR cabbage story" Föredrag på Symposiet Medical and agricultural perspectives on new genome editing technologies. Pufendorfinstitutet Lund 21/11 2019.

**Jansson S** (2019) CRISPR in basic and applied plant biology. Presentation at the 2019 Scheele symposium, CRISPR-Cas and gene therapy. Swedish Pharmaceutical Society, Stockholm 27/11 2019.

Kravtsova A, Hall D, Zhao, W., Wennström, U., **Wang X-R** (2019). Genetic diversity of seed orchard crops of Scots pine (Pinus sylvestris) and Norway spruce (Picea abies) in Sweden. Conference presentation. IUFRO Seed Orchard conference, Nanjing, China, 14-16 Oct. 2019

**Nilsson O**. (2019). Photoperiodic regulation of tree phenology. Saclay Plant Sciences annual meeting. Invited speaker. Paris, France. 2/10, 2019.

**Nilsson O**. (2019). Photoperiodic regulation of tree phenology. Turku/Helsinki Centre of Excellence. Invited speaker. Helsinki, Finland. 7/11, 2019.

**Street NR** (2019). Genetic architecture of leaf shape physiognomy in Populus tremula. Departmental presentation, Institute of Forest Genetics, Thunen Institute, Germany, 12/3 2019.

**Street NR** (2019). Metatranscriptomics analysis of nutrient enrichment in Norway spruce. Departmental presentation, SLU, Sweden, 12/3 2019.

Calleja-Rodriguez, A , Pan, J , Chen, Z, **Abrahamsson S**, Wu, HX. First indication of improved selection efficiency using genomic selection in Scots pine. Poster presented at the IUFRO Tree Biotechnology Conference, Raleigh, North Carolina, USA, 23-28 June 2019.

Calleja-Rodriguez, A, **Suontama M**, Chen, Z, Wu, HX. Influence of non-additive genetic variance in prediction of genomic breeding values for growth in Scots pine (Pinus sylvestris, L.). Poster presented at the IUFRO Tree Biotechnology Conference, Raleigh, North Carolina, USA, 23-28 June 2019.

Hall D, Kravtsova A, Zhao W, **Wennström U**, **Persson T**, Andersson Gull B, Wang X-R. 2019. Hardiness and the influence of background pollen in a Pinus sylvestris seed orchard. IUFRO WP 2.09.01 Seed orchard Conference, Nanjing, China.

Kravtsova A, Hall D, Zhao W, **Wennström U**, Wang X-R. 2019. Genetic diversity of seed orchard crops of Scots pine (Pinus sylvestris) and Norway spruce (Picea abies) in Sweden. IUFRO WP 2.09.01 Seed orchard Conference, Nanjing, China.

## Popular scientific presentations at meetings or excursions

**Jansson S** (2019) Gensaxen och EUs GMO-lagstiftning. Föredrag på Kunskapsnoden, Grand Hotel, Stockholm 24/1 2019. https://www.umu.se/forskning/popularvetenskapliga-arrangemang/kunskapsnoden/

**Jansson S** (2019) CRISPRig grönkål och andra GMO-grödor. Föredrag konferens Fakta och värderingar, vad styr politiken för de gröna näringarna. KSLA https://v-a.se/2019/04/fakta-och-varderingar-vad-styr-politiken-for-de-grona-naringarna/

**Jansson S** (2019) Fältförsök med genmodifierade hybridaspar (och lite CRISPR-kål). Föredrag på Gentekniknämnden 14/2 2019.

**Jansson S** (2019) Huvudorganisatör för symposiet "How can basic plant science contribute to feeding the world?. KVA Stockholm 27/8 2019. https://kva.se/sv/kalendarium/how-can-basic-plant-science-contribute-to-feeding-the-world

**Jansson S** (2019) GMO-debatten. Föredrag Vetenskap och allmänhet, Umeå 17/9 2019.

**Jansson S** (2019) Genmodifierad mat. Kortföredrag på Nobelmuseet 7/10 2019. https://m.youtube.com/watch?v=MQgxIkNanFE&feature=youtu.be

**Jansson S** (2019) GMO-diskussionen. Föredrag på Restauranghögskolan, Umeå 17/10 2019.

**Jansson S** (2019) 'Organic GMOs' – Is this the future of sustainability? Föredrag på Nordic organic fair, Malmö 13/11 2019.

**Nilsson O**. (2019). De nya stora skogsforskningsprogrammen. Skogsindustriernas FoU-dag. Stockholm 9/1, 2019.

**Nilsson O**. (2019). Genetisk och skogsbioteknisk forskning vid UPSC. Skogens dag på Grand Hotel. Stockholm 23/1, 2019.

## Collaboration with industry and/or other parts of society

- Study visit to UPSC from the heads of silviculture at Sveaskog. March 21, 2019.
- Study visit to UPSC by the Minister for Research and Higher education, Matilda Ernkrans, March 21, 2019.
- Study visit to UPSC from the heads of research at the German plant breeding company KWS. June 12, 2019.
- Study visit to UPSC from the Italian food company Ferrero Rocher to study the automatic tree phenotyping platform. November 19, 2019.
- **Wang X-R**: Hardiness variation in Scots pine seed

orchard crops and association with genetic diversity - a joint investigation with Skogforsk.

- **Wang X-R**: Assessment and recommended standards for genetic composition and diversity of Swedish seed orchards - in collaboration with Skogforsk.
- **Wang X-R**: Genetic diversity in natural stands and production forests - collaboration project with Skogforsk.

## Education

a) PhD theses, MSc theses, Bachelor theses

Kalman, Teitur. (Male) 2019. MSc thesis: Expressional patterns of LTR-TE in Norway spruce.

Mihai, Ionut. (Male) 2019. MSc thesis: Using meta-transcriptomics to identify seasonal dynamics of the fungal community associated with Norway spruce.

Noel, Delphine. (Female). 2019. MSc thesis: Meta-transcriptomics analysis of root-associated fungi of Norway spruce.

Olsson, Jenny. (Female) 2019. MSc Thesis: Genetic diversity and hardiness in Scots pine from Scandinavia to Russia. Umeå Univ. diva2:1325184. (Best MSc thesis Award by Bo Rydins Stiftelse)

Osterman, Johanna. (Female) 2019. MSc thesis: Developing gene-specific markers for the future oilseed crop field cress (Lepidium campestre).

Terebieneic, Barbara. (Female) 2019. PhD thesis: Using systems genetics to explore the complexity of leaf shape variation in Populus tremula.

Van Zalen, Elena. (Female). 2019. MSc thesis: An evolutionary perspective of wood development in Norway spruce and Eurasian aspen through comparative analysis of gene inference networks.

Xu, Chaoqun. (Male) 2019. PhD Thesis: Photosynthetic physiological and transcriptome basis of high altitude adaptation in Pinus densata. Beijing Forestry Univ.

Xia, Hanhan. (Female) 2019. PhD Thesis: Landscape genomics of Pinus tabuliformis Carr. and its evolutionary history. Beijing Forestry Univ.

b) **Supervision and teaching**

**Jansson S**. Föreläsning på kursen Plant biotechnology and molecular breending, Umeå universitet, Jan-Mar 2019.

**Jansson S**. Föreläsning på kursen Plant biology SLU, Jan 2019.

**Jansson S**. Föreläsning Introduktionskurs för Civilingenjörer i Bioteknik, Umeå Universitet Sep 2019.

**Jansson S**. Föreläsning på Måltidsekologprogrammet, Örebro Universitet Sep 2019.

**Street NR**: Functional Genomics. Course organizer and teaching.

**Street NR**: Applied Functional Genomics. Course organizer and teaching.

**Street NR**: Plant Biology and Biotechnology. Teaching.

**Street NR**: Plant Biology for Future Forests. Teaching.

**Street NR**: Bioinformatics and Genome Analysis. Teaching.

**Street NR**: Plant Biology for Sustainable Production. Teaching.

**Street NR**: WWSC summer school. Teaching

**Wang X-R**: Main supervisor to 3 PhD students and 1 MSc student at UMU, co-supervisor to 6 PhD projects at UmU.

**Wang X-R**: Teaching "Genetics and Evolution", 15 ECTS, Umeå University.

**Wang X-R**: Teaching "Evolutionary Biology", 15 ECTS, Umeå University.

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

**During 2019 Theme 2 has published 18 peer reviewed scientific articles in international journals. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.**


1. **Yang Q**, Blanco N*, Hermida-Carrera C, Lehotai N, **Hurry V***, Strand Å* (2019) Two dominant boreal conifers use contrasting mechanisms to reactivate photosynthesis in the spring. Nature Comm. DOI:10.1038/s41467-019-13954-0 *co-corresponding authors
2. **Forsmark B, Nordin A**, Maaroufi N, Lundmark T, Gundale MJ 2020. Low and high nitrogen deposition rates in northern coniferous forests have different impacts on aboveground litter production, soil respiration, and soil carbon stocks. Ecosystems 2020.
3. Blaško R, **Forsmark B**, Gundale MJ, Lundmark T, **Nordin A** 2020. Impacts of tree species identity and species mixing on ecosystem carbon and nitrogen stocks in a boreal forest. Forest Ecol. Manag.
4. Maaroufi NI, **Nordin A**, Palmqvist K, Hasselquist NJ, **Forsmark B**, Rosenstock NP, Wallander H, Gundale MJ 2019. Anthropogenic nitrogen enrichment enhances soil carbon accumulation by impacting saprotrophs rather than ectomycorrhizal fungal activity. Glob. Change Biol.
5. Blokhina O, Laitinen T, Hatakeyama Y, **Delhomme N**, Paasela T, Zhao L, **Street NR**, Wada H, Kärkönen A, Fagerstedt K (2019) Ray parenchymal cells contribute to lignification of tracheids in developing xylem of Norway Spruce. Plant Physiol 181:1552–1572
6. Bonner MT, **Castro D, Schneider AN**, Sundström G, **Hurry V, Street, NR, Näsholm T** (2019) Why does nitrogen addition to forest soils inhibit decomposition? Soil Biol Biochem 137:107570.
7. **Bernhardsson C**, Vidalis A, Wang Xi, Scofield DG, Shiffthaler B, Basion J, **Street NR**, García Gil MR, **Ingvarsson PK**. (2019) An Ultra-Dense Haploid Genetic Map for Evaluating the Highly Fragmented Genome Assembly of Norway Spruce (Picea abies). G3 9:1623-1632.
8. Wegrzyn JL, Staton MA, **Street NR**, Main D, Grau E, Herndon N, Buehler S, Falk T, Zaman S, Ramnath R, Richter P, Sun L, Condon B, Almsaeed A, Chen M, Mannapperuma C, Jung S, Ficklin S (2019) Cyberinfrastructure to Improve Forest Health and Productivity: The Role of Tree Databases in Connecting Genomes, Phenomes, and the Environment. Front Plant Science 10:813
9. Myburg AA, Hussey SG, Wang JP, **Street NR**, Mizrachi E (2019). Systems and Synthetic Biology of Forest Trees: A Bioengineering Paradigm for Woody Biomass Feedstocks. Front Plant Science 10:775
10. Giacomello S, **Delhomme N**, Niittylä T, Tuominen H, **Street NR** (2019) High spatial resolution transcriptome profiling in tree species. Annual Plant Reviews 2:1-31
11. **Street NR** (2019). Genomics of forest trees In: Molecular Physiology and Biotechnology of Trees. Vol. 89. Ed. Canovas FM. Academic Press, London, UK. ISBN: 9780128154656
12. Livsey J, Kätterer T, **Vico G**, Lyon SW, Lindborg R, Scaini A, Manzoni S (2019) Do alternative irrigation strategies for rice cultivation decrease water footprints at the cost of long-term soil health?, Environmental Research Letters,14, 7
13. Ruiz-Pérez G, Launiainen S, **Vico G** (2019). Role of plant traits in photosynthesis and thermal damage avoidance under warmer and drier climates in boreal forests, Forests 2019, 10,5, 398
14. Messori G, Ruiz-Pérez G, Manzoni S, **Vico G** (2019). Climate drivers of the terrestrial carbon cycle variability in Europe, Environmental Research Letters, 14, 6
15. Sutherlin CE, Brunsell NA, de Oliveira G, Crews TE, DeHaan LR, **Vico G** (2019). Contrasting physiological and environmental controls of evapotranspiration over Kernza perennial crop, annual crops and C4 and mixed C3/C4 grasslands, Sustainability, 11,6, 1640
16. **Vico G**, Way DA, **Hurry V**, Manzoni S (2019), Can leaf net CO2 assimilation acclimate to keep up with warmer and more variable temperatures?, Plant, Cell & Environment, 42,6, 1913-1928

17. Feng X, Ackerly D, Dawson T, Manzoni S, McLaughlin B, Skelton R, **Vico G**, Weitz A, Thompson S (2019), Beyond isohydricity: the role of environmental variability on plant drought responses, Plant, Cell & Environment, 42,4,, 1104-1111

18. **Vico G** and Davis KF (2019), Ecohydrology of agroecosystems – Interactions between local and global processes, Chapter 19 in D'Odorico P, Porporato A, Wilkinson Runyan C, Dryland Ecohydrology, Springer, New York City, 2nd ed

## Popular scientific publications

Lämås, T, Roberge, J-M, Felton, A, Gustafsson, L, Jonzén, J, Lundmark, T, **Nordin A**, Olsson, H, Ranius, T, Sandström, E 2015. Generell naturhänsyn och frivilliga avsättningar: mängden död ved och grova träd i framtidens skogslandskap. Fakta Skog, Nr 10, 2015. ISSN: 1400-7789.

## Interviews and presence in media

**Hurry V** Hur länge står granen så grön och grann i stugan– och i skogen? Dagens Nyheter, 22 December, 2019.

## Scientific presentations

**Forsmark B** 2019. Biomass allocation and soil carbon sequestration at low and high nitrogen availability. Poster presentation at SPPS conference excursion August 2019 in Vindeln.

**Street NR** 2019. Metatranscriptomics and Norway spruce genome dynamics. Departmental presentation. SLU Uppsala, Uppsala, Sweden. Oct 9.

**Vico G**, Forests under drought… and heat, Skogsstyrelsen, Katrineholmn, Sweden, November 25th, 2019

**Vico G**, Water management for high and stable crop yields, University of Bologna, Italy, March 4th, 2019

**Vico G** (2019), Challenges and opportunities for sustaining crop production under future climates, Climate resilient food production in 2050, what will that look like?, SLU, Uppsala, Sweden, 24 September (Invited keynote speaker)

Ajal J, Jäck O, **Vico G**, Weih M (2019), Trait combinations for efficient nitrogen utilization in pea-barley and wheat-faba bean plant teams field-grown in Sweden, European Conference on Crop Diversification 2019, Budapest, Hungary, 18-21 September

Berghuijs HNC, Weih M, Van der Werf W, **Vico G** (2019) Can the APSIM crop growth model simulate the growth of pure cultures and intercrops of wheat and fababean in temperate zones in Europe?, European Conference on Crop Diversification 2019, Budapest, Hungary, 18-21 September

**Vico G**, Way DA, **Hurry V.**, Manzoni S (2019). Can net photosynthesis acclimate to rising and more variable temperatures?, Translational Photosynthesis Conference 209: Innovations in Agriculture for Food Security, Brisbane, Australia, 30 June-3 July (Invited talk)

**Vico G**, Brunsell NA (2019) Water requirements and yield stability in annual vs. perennial crops, Conference "Is the future of agriculture perennial?", Lund, Sweden, 6-10 May (Invited Talk)

**Vico G**, Ruiz-Pérez G (2019) Spring phenology and risk of late frost – a probabilistic evaluation, EGU General Assembly 2019, Vienna, Austria, 8-12 April

Breinl K, Di Baldassarre G, Mazzoleni M, **Vico G** (2019), Analysing shifts in the timing of extreme dry spells at global scale, EGU General Assembly 2019, Vienna, Austria, 8-12 April

Livsey J, Kätterer T, **Vico G**, Lyon S, Lindborg R, Manzoni S (2019), Water efficient rice production - Short-term benefits at the expense of long-term fertility?, EGU General Assembly 2019, Vienna, Austria, 8-12 April

## Popular scientific presentations at meetings or excursions

**Jämtgård S** 2019. Leftovers or a buffet? – What do roots experience in forest soil? Worth knowing a series of lunch lectures at the SLU Library, Umeå, November 11, 2019.

## Collaboration with industry and/or other parts of society

- Joint projects with Holmen Skog AB looking at fungal metacommunity structure of Norway spruce and Scots pine seedlings under contrasting N treatments.

## Other funding that has been received partially or fully due to the TC4F research

- **Street NR**. 2019 3300K SEK: VR Chromatin dynamics in Norway spruce.
- **Street NR** (co-applicant). 2019 71000K SEK: KAW. Norway spruce and Scots pine genome assembly
- 2019-2021: "Large-Scale Atmospheric Variability driving changes in the Terrestrial Carbon Cycle and Storage". Applicants: G Messori (main applicant; Uppsala University, Sweden), **G Vico**, G Ruiz-Pérez (SLU), C Beer, S Manzoni (Stockholm University, Sweden). Financer: Swedish Research Council for Sustainable Development (FORMAS), Annual Open Call. Amount: 3 million SEK/290 k€ (2018-00968)

## Education

a) **PhD theses, MSc theses, Bachelor theses**

**Forsmark B** 2020. Impact of nitrogen deposition on carbon stocks in coniferous forest soils -Insights from experiments with low and high nitrogen addition rates. PhD thesis SLU 2020.
**van Zalen E** 30 ECTS. 2019. Master's thesis. Identification of gene regulatory modules for abiotic stress responses in Norway spruce by machine learning.

**Mihai S** 30 ECTS. 2019. Master's thesis. Seasonal patterns of transcript abundance in root associated fungal communities of Norway spruce roots.

b) **Supervision and teaching**.

**Nordin A.** Co-supervisor for PhD-candidate Benjamin Forsmark. Impact of nitrogen deposition on carbon stocks in coniferous forest soils -Insights from experiments with low and high nitrogen addition rates. Date for dissertation: February 14, 2020.

**Nordin A.** Main-supervisor for MSc-candidate Tinkara Bizjak. N2-fixing in needles of pine in a N addition experiment. Date for dissertation: September, 2020.

**Nordin A**. Course organizer and teaching at the course "Ekologi och trädbiologi", (SG0023), 15 ECTS, SLU.

**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 PhD-candidate Canovi, Camilla. Tentative title: Identifying functions of long non-coding RNAs in Norway spruce. Expected date for dissertation: June 2023.

**Street NR**. Main supervisor for PhD-candidate van Zalen, Elena. Tentative title: Applications of machine learning for improving candidate gene selection in abiotic stress of Norway spruce and Scots pine. Expected date for dissertation: Sept 2023.

**Vico G** Main supervisor for 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** Co-supervisor for Martin Goude, PhD student at the Southern Swedish Forests Research Center, Faculty of Forest Sciences, SLU, investigating Swedish forests adaptation to climate change.

**Vico G** Co supervisor for 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** Co supervisor for Eirini Daouti Lamprini, PhD student at the Department of Ecology, Faculty of Natural Resources and Agricultural Sciences, SLU, investigating weed seed predation. Expected graduation: 2021

**Street NR**. Course organiser and teaching on the course "Functional Genomics: Theory", (5BI0211), 7.5 ECTS, Umeå University.

**Street NR**. Course organiser and teaching on the course "Applied Functional Genomics", (5BI0212), 7.5 ECTS, Umeå University.

**Street NR**. Teaching on the course "Bioinformatics and Genome Analysis", (5MO115), 7.5 ECTS, Umeå University.

**Street NR**. Teaching on the course "Introduction to Plant Biology for Sustainable Production", (BI1294) 15 ECTS, SLU Uppsala.

**Street NR**. Teaching on the course "Plant biology – for future forestry", 7.5 ECTS, SLU Umeå.

**Street NR**. Teaching on the course "WWSC summer school", 2 ECTS, Umeå University.

**Street NR**. Teaching on the course "Inledande ingenjörskurs i Bioteknik", (5MO072), 7.5 ECTS, Umeå University.

**Jämtgård S**. Teaching on the course "Forest vegetation ecology" (SG0180), 7.5 ECTS, Swedish University of Agricultural Sciences, SLU.

**Jämtgård S**. Teaching on the course "Skogsekosystemets kemiska grunder" (G1F), 15 hp, Swedish University of Agricultural Sciences, SLU.

**Jämtgård S**. Teaching on the course "Nitrogen cycling in terrestrial and aquatic ecosystems", PhD course within the Research School Focus on soil, Swedish University of Agricultural Sciences, SLU, Uppsala. March, 2019.

**Vico G** Developer, course leader and lecturer of the new Master level course Sustainable plant production across scales: from molecular to field applications, 15 ECTS, SLU, Uppsala/Alnarp/Umeå, March-June 2019

**Vico G** Guest lecturer in the master-level course Sustainable Design of Water Resources Systems, 6 ECTS, University of Bologna, Italy, March 2019

**Vico G** Lecturer at the Stockholm University master-level course Ecohydrology – A Mediterranean perspective, 7.5 ECTS, held at the Navarino Environmental Observatory, Greece, June 2019

# Theme 3
# - Sustainable and adaptive forest management


1. Appiah Mensah A, Petersson H, Saarela S, **Goude M**, & **Holmström E** (2020). Using heterogeneity indices to adjust basal area – Leaf area index relationship in managed coniferous stands. Forest Ecology and Management, 458, 117699. doi:https://doi.org/10.1016/j.foreco.2019.117699

2. Cavard X, Bergeron Y, Paré D, **Nilsson M-C**, Wardle DA (2019) Disentangling Effects of Time Since Fire, Overstory Composition and Organic Layer Thickness on Nutrient Availability in Canadian Boreal Forest. Ecosystems 22: 33-48.

3. Fanin N, Kardol P, Farrell M, Kempel A, **Nilsson M-C Gundale M**, and Wardle DA (2019) Effects of plant functional group removal on structure and function of soil communities across contrasting ecosystems. - Ecology Letters, 22, 1095–1103. https://doi.org/10.1111/ ele.13266

4. Fransson P, **Nilsson U**, Lindroos O, Franklin O, Brännström Å 2019. Model-based investigation on the effects of spatial evenness, and size selection in thinning of Picea abes stands. Scandinavian Journal of Forest Research. 34:3. 189-199

5. Felton A, Petersson L, **Nilsson O**, Witzell J, Cleary M, Felton AM Lindbladh M (2019). The tree species matters: Biodiversity and ecosystem service implications of replacing Scots pine production stands with Norway spruce. Ambio. doi:10.1007/s13280-019-01259-x

6. **Goude M, Nilsson U** & **Holmström E** 2019. Comparing direct and indirect leaf area measurements for Scots pine and Norway spruce plantations in Sweden. European Journal of Forest Research. 138: 1033-1047. DOI:10.1007/s10342-019-01221-2

7. **Gundale MJ,** Wardle DA, Kardol, P and **Nilsson M-C** (2018) Comparison of plant-soil feedback experimental approaches for testing soil biotic interactions among ecosystems. - New Phytologist 221 Issue: 1 Pages: 577-587 https://doi.org/10.1111/nph.15367

8. Hedwall P-O, **Holmström E**, Lindbladh M, & Felton A (2019). Concealed by darkness: How stand density can override the biodiversity benefits of mixed forests. Ecosphere, 10(8), e02835. doi:10.1002/ecs2.2835

9. Hjelm K, **Nilsson U**, Johansson U & Nordin P 2019. Effects of mechanical site preparation and slash removal on long-term productivity of conifer plantations in Sweden. Canadian Journal of Forest Research.

10. **Holmström E**, Gålnander H, & Petersson M (2019). Within-Site Variation in Seedling Survival in Norway Spruce Plantations. Forests, 10(2:181). doi:doi.org/10.3390/f10020181

11. Lindbladh M, Petersson L, Hedwall PO, Trubins R, **Holmstrom E**, & Felton A (2019). Consequences for bird diversity from a decrease in a foundation speciesreplacing Scots pine stands with Norway spruce in southern Sweden. Regional Environmental Change, 19(5), 1429-1440. doi:10.1007/s10113-019-01480-0

12. **Nilsson O**, Hjelm K & **Nilsson U** 2019. Early growth of planted Norway spruce and Scots pine after site preparation in Sweden. Scandinavian Journal of Forest Research. DOI: 10.1080/02827581.2019.1659398

13. Sténs A, Roberge J-M, Löfmarck E, Beland Lindahl K, Felton A, Widmark C, Rist L, Johansson J, **Nordin A, Nilsson U**, Laudon H & Ranius T 2019. From ecological knowledge to conservation policy: a case study on green tree retention and continous-cover forestry in Sweden. Biodiversity and Conservation, 1-28.

14. Subramanian N, **Nilsson U**, Mossberg M, Bergh J 2019. Impacts of climate change, weather extremes and alternative strategies in managed forests. Écoscience, 26, 53-70

15. Pérez-Izquierdo L, Clemmensen KE, Strengbom J, Granath G, Wardle DA, **Nilsson M-C**, Lindahl BD Tree survival determines fungal community development after wildfire in boreal forest. Submitted.

16. Petersson L, **Holmström E**, Lindbladh M, & Felton A (2019). Tree species impact on understory vegetation: Vascular plant communities of Scots pine and Norway spruce managed stands in northern Europe. Forest Ecology and Management, 448, 330-345. doi:https://doi.org/10.1016/j.foreco.2019.06.011

17. Pretzsch H, del Río M, Biber P, Arcangeli C, Bielak K, Brang P, Dudzinska M, Forrester DI, Klädtke J, Kohnle U, Ledermann T, Matthews R, Nagel J, Nagel R, **Nilsson U**, Ningre F, Nord-Larsen T., Wernsdörfer H & Sycheva E. 2019. Maintenance of long-term experiments for unique insights into forest growth dynamics and trends: review and perspectives. European Journal of Forest Research 138, 165-185

18. **Pérez-Izquierdo L**, Clemmensen KE, Strengbom J, **Nilsson M-C**, and Lindahl B (2019) Quantification of tree fine roots by real-time PCR. Plant and Soil (online) https://doi.org/10.1007/s11104-019-04096-9

19. Wardle DA, **Gundale M**, Kardol P, **Nilsson M-C**, Fanin N. (2019) Impact of plant functional group and species removals on soil and plant nitrogen and phosphorus across a retrogressive chronosequence. J Ecol. 2019;00:000–000. https://doi.org/10.1111/1365-2745.13283

## Education

a) Supervision and teaching.

**PhD-students:**

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

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

Martin Ahlström. 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.

Felicia Dahlgren. Regeneration of birch on clear-cuts in Sweden. Dissertation planned to winter 2022. Supervisors: Tomas Lundmark, Emma Holmström.

Martin Goude. Hybrid growth models for Scots pine and Norway spruce in Sweden. Dissertation planned to winter 2021. Supervisors Urban Nilsson, Guilia Atttoci, Giulia Vico and Euan Mason

Theresa Ibanez. PhD-student. Started 2017. Supervisors: Nilsson, M-C, Gundale M, and D Wardle.

Axelina Jonsson. Modelling survival and establishment of planted and naturally regenerated Scots pine and Norway spruce. Supervisors: Urban Nilsson, Karin Hjelm and Tomas Lämås

Delphine Lariviere, SSFRC, SLU and Skogforsk. "Retention forestry in commercial thinnings." Assistant supervisor Emma Holmström. Started 2017

Mikolaj Lula. Regeneration of Scots pine in southern Sweden. Dissertation planned to autumn 2021. Supervisors Urban Nilsson, Anna Jensen, Kristina Wallertz, Märtha Wallgren, Renats Trubins and Göran Örlander

Oscar Nilsson. Production of Scots pine and Norway spruce in Sweden. Dissertation planned to spring 2020. Supervisors Urban Nilsson & Karin Hjelm

Magnus Persson, Linnéuniversity. "Increased efficiency in commercial thinnings." Assistant supervisor Emma Holmström. Started 2018

Lisa Peterson, SSFRC, SLU. "The loss of Scots pine in southern Sweden." Assistant supervisor Emma Holmström. Started 2015

Gustaf Ståhl. Climate smart forestry. Supervisor: Tomas Lundmark, Emma Holmström. Dissertation planned to winter 2022.

**Master Students:**

Erika Alm. 2019. Thinning response to weather variations in Norway spruce. Handledare: Urban Nilsson

Fustel T. Phenotypic differences between plus-tree progenies of Sitka spruce (Picea sitchensis) and a comparison with Norway spruce (Picea abies), SLU SSFRC NR 319

Aksels Edgars Loks. 2019. Appropriate experimental design and pre-commercial thinning in Norway spruce stands on former agricultural lands in Latvia. Handledare: Urban Nilsson

Marie-Lou Novene, internship student from France. Feb-July 2018. Handledare: Theresa Ibanez och Marie-Charlotte Nilsson Hegethorn.

Dagnija Saicane. 2019. Experimental design in a thinning and pruning experiment and thinning regimes in birch stands in Latvia. Handledare: Urban Nilsson

Rokas Satinskas. 2019. Economic and production consequenses of current forest management in mature Scots pine (Pinus sylvestris) forests in Lithuania. Handledare: Urban Nilsson

Erik Sundström. Brandhårdhetens påverkan på knäckesjukans omfattning på brandfältet i Sala. 2018. Handledare: Marie-Charlotte Nilsson Hegethorn och Jan Stenlid.

Varrik M. Natural regeneration after wind disturbance, SLU SSFRC NR 315. Supervisor Emma Holmström.

Andis Zvirgzdins. 2019. Modelling growth of Norway spruce on former agricultural lands in Latvia. Handledare: Urban Nilsson

## 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 "Forest Ecology and Sustainable Management".

## PhD-courses:

In-depth course in forest regeneration, 5.0 credits on PhD level. Examiner and teacher on the course. Course leader Kristina Wallertz. In total 12 PhD-students and 4 master students graduated in the course 2019.
https://www.slu.se/utbildning/program-kurser/kurser/?sprak=en&anmkod=P0062.1920

# C4F - Crops for the Future

## Scientific publications


1. Berndtsson E, Nynäs AL, **Newson W**, **Langton M**, Andersson R, **Johansson E**, **Olsson M**E. The underutilised side streams of broccoli and kale–valorisation via proteins and phenols. Sustainable governance and management of food systems: Ethical perspectives 2019 Sep 19 (pp. 74-81). Wageningen Academic Publishers.

2. **Capezza AJ**, Glad D, Özeren HD, **Newson WR**, Olsson RT, **Johansson E**, Hedenqvist MS (2019) Novel sustainable super absorbents: a one-pot method for functionalization of side-stream potato proteins. ACS Sust Chem Eng. https://doi.org/10.1021/acssuschemeng.9b04352

3. **Capezza AJ**, Wu Q, **Newson WR**, Olsson RT, Espuche E, **Johansson E**, Hedenqvist MS (2019) Superabsorbent and fully biobased protein foams with a natural cross-linker and cellulose nanofibers. ACS Omega 4:18257-18267.

4. **Ceresino EB**, **Kuktaite R**, Sato HH, Hedenqvist MS, **Johansson E** (2019) Impact of gluten separation process and transglutaminase source on gluten based dough properties. Food Hydrocolloids 87:661-669. Popular scientific publications (reports etc)

5. Capezza A, **Newson W**, Olsson R, Hedenqvist M, **Johansson E** (2019) Advances in the use of protein-based materials: towards sustainable naturally sourced absorbent materials. ACS Sust Chem Eng 7: 4532-4547.

6. Chen F, Xu Y, Ma B, Cui H, **Sun C***, Zhang M* (2019) Carboxyl-Functionalized Europium Nanoparticles-Based Fluorescent Immunochromatographic Assay for Sensitive Detection of Citrinin in Monascus Fermented Food. Toxins 11, 605.

7. Das O, Rasheed F, Kim NK, **Johansson E**, **Capezza AJ**, Kalamkarov AL, Hedenqvist MS (2019) The development of fire and microbe resistant sustainable gluten plastics. J Clean Prod 222:163-173.

8. Das O, Hedenqvist MS, **Johansson E**, Olsson RT, Loho TA, **Capezza AJ**, Raman RKS, Holder S (2019) An all-gluten biocomposite: Comparisons with carbon black and pine char composites. Comp Part A: Appl Sci Manufact 120:42-48.

9. **Dauphinee AN**, **Cardoso C**, Dalman K, Ohlsson JA, Berglund Fick S, Robert S, Hicks GR, **Bozhkov PV**, **Minina EA** (2019) Chemical screening pipeline for identification of specific plant autophagy modulators (Breakthrough technologies). Plant Physiol 181, 855–866 (Recommended by F1000Prime).

10. Gargiulo A, **Grimberg Å**, Repo-Carrasco-Valencia, R, Carlsson, AS, Melea, G 2019 Morpho-densitometric traits for quinoa (Chenopodium quinoa Willd.) seed phenotyping by two X-ray micro-CT scanning approaches; Journal of Cereal Science 90.

11. Jeppson S, Demski K, **Carlsson AS**, **Zhu L-H**, Banas A, Stymne S and Lager I 2019. Crambe hispanica Subsp. abyssinica Diacylglycerol Acyltransferase Specificities Towards Diacylglycerols and Acyl-CoA Reveal Combinatorial Effects That Greatly Affect Enzymatic Activity and Specificity. Front. Plant Sci. 10:1442. doi: 10.3389/fpls.2019.01442

12. **Li J**, **Pylypchuk I**, **Johansson D**, **Kessler VG**, **Seisenbaeva GA & Langton M**, Self-assembly of plant protein fibrils interacting with superparamagnetic iron oxide nanoparticles., Scientific Reports (2019) 9:8939 https://doi.org/10.1038/s41598-019-45437-z.

13. **Li X**, **Guan R**, Fan J and **Zhu L-H**. 2019. Development of Industrial Oil Crop Crambe abyssinica for Wax Ester Production through Metabolic Engineering and Cross Breeding. Plant and Cell Physiology, 60 (6): 1274-1283.

14. Kushwaha SK, **Grimberg Å**, **Carlsson AS**, **Hofvander P**. 2019. Charting oat (Avena sativa) embryo and endosperm transcription factor expression reveals differential expression of potential importance for seed development; Molecular Genetics and Genomics, 1-15

15. Ma B, Yu H, Fang J, **Sun C**, Zhang M* (2019) Employing DNA binding dye to improve detection of Enterocytozoon hepatopenaei in real-time LAMP. Scientific Reports, 9, 15860. doi: 10.1038/s41598-019-52459-0.

16. Mendoza A, **Moriana Torro R**, Hillborg H, Strömberg E. (2019). Super-hydrophobic zinc oxide/silicone rubber nanocomposite surfaces Surfaces and interfaces, 14 ss.146-157. DOI:10.1016/j.surfin.2018.12.008.

17. **Muneer F**, **Johansson E**, Hedenqvist MS, Plivelic TS, **Kuktaite R** (2019) Impact of pH modification on protein polymerization and structure-function relationships in potato protein and wheat gluten composites. Int J Mol Sci 20:58.

18. **Snell P**, **Grimberg Å**, **Carlsson AS**, **Hofvander P**. 2019. WRINKLED1 is subject to evolutionary conserved negative autoregulation; Frontiers in Plant Science 10, 387

19. Requena R, Jiménez-Quero A, Vargas M, **Moriana R**, Chiralt A, Vilaplana F. (2019). Integral Fractionation of Rice Husks into Bioactive Arabinoxylans, Cellulose Nanocrystals, and Silica Particles ACS Sustainable Chemistry and Engineering, 7 (6), ss.6275-6286. DOI:10.1021/acssuschemeng.8b06692.

20. Rodriguez Furlan C, **Minina EA**, Hicks GR (2019) Remove, recycle, degrade - Regulating plasma membrane protein accumulation. Plant Cell doi: 10.1105/tpc.19.00433.

21. Tagami A, Gioia C, Laubert M, Budnyak T, **Moriana R**, Lindström M, Sevastanova O, (2019). Solvent fractionation of softwood and hardwood kraft lignins for more efficient uses: Compositional, structural, thermal, antioxidant and adsorption properties Industrial Crops and Products, 129 ss.123-134. DOI:10.1016/j.indcrop.2018.11.067.

22. Vazquez D, Berger A, Prieto-Linde ML, **Johansson E** (2019) Can nitrogen fertilization be used to modulate yield, protein content and bread-making quality in Uruguayan wheat? J Cereal Sci. 85:153-161

23. Ye X, Lendel C, **Langton M**, Olsson RT, Hedenqvist MS, 2019. Protein nanofibrils: Preparation, properties, and possible applications in industrial nanomaterials Chapter 2 in Industrial Applications of Nanomaterials. https://doi.org/10.1016/B978-0-12-815749-7.00002-5.

24. 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, Volume 6, Issue 4, 2 April 2018, Pages 5462-5469., DOI: 10.1021/acssuschemeng.8b00330.

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

26. Åhman I, **Kim S-Y** and **Zhu L-H**, 2019. Plant Genes Benefitting Aphids—Potential for Exploitation in Resistance Breeding. Front. Plant Sci. 10:1452. doi: 10.3389/fpls.2019.01452

## Popular scientific publications

**Pietiäinen S**, Hedin F, 2019. Gröt på nytt sätt. Cerealier 3, ss.21.

**Herneke A**, **Langton M**, 2019. 2 Protein ska förbättra texturen. Cerealier 1, ss12.

## Interviews and presence in media

Tåliga vetesorter genom effektivare metoder ska klara extremt klimat. Örebronyheter 29 June 2019.

**William Newson** and Anna-Lovisa Nynäs interview by Lennart Wikström, Nov 29, 2019 for Lantbrukets Affärer (publ. Jan 2020)

Plant Protein Factory visit by Minister for Rural Affairs, Jennie Nilsson with media, Sept 4, 2019

**Eva Johansson** and **William Newson** interview by Mats Karlsson, Feb 19, 2019, publ. 19 June 2019 https://www.forskning.se/2019/06/19/nu-gronskar-det-for-proteinerna/

**Sun C** 2019. Comments on Oliva et al. 2019. Broad-spectrum resistance to bacterial blight in rice using genome editing. Nature Biotechnology 37, 1344–1350. Radio interview: SR Radio Vetenskapsradion.

## Scientific presentations

Dauphine AN, **Cardoso C**, Dalman K, Ohlsson JA, Berglund Fick S, Robert S, Hicks GR, **Bozhkov PV**, **Minina EA**. 2019. Leveraging chemical genetics to investigate plant autophagy. Annual meeting of the Linnean Center for Plant Biology in Uppsala, November 14th.

Berndtsson E, Nynäs A-L, **Newson W**, **Langton M**, Andersson R, **Johansson E**, and **Olsson ME**, 2019. The underutilised side streams of broccoli and kale – valorisation via proteins and

phenols, Sept. 2019., 6th LEAAP International Symposium on Energy and Protein Metabolism and Nutrition

**Bozhkov PV**, 2019. Harnessing autophagic flux for improving plant fitness. Invited seminar. Weizmann Institute. Rehovot. Israel. September 24th.

**Dauphinee AN**, **Cardoso C**, Dalman K, Olsson JA, Lindberg S, Robert S, Hicks, G, **Bozhkov PV**, **Minina EA**, 2019. A Novel Systematic Approach to Identify Plant Autophagy Modulators. Nordic Autophagy Society Meeting. Utrecht, NL. May. 23rd-24th.

**Dauphinee AN**, **Cardoso C**, Dalman K, Olsson JA, Lindberg S, Robert S, Hicks, G, **Bozhkov PV**, **Minina EA**, 2019. Investigating plant autophagy with chemical genetics. Oil Crops for the Future (OC4F) Annual Meeting. Lund, SE. Mar. 14th.

**Guan R**, **Li X**, **Sandgrind S**, and **Zhu L-H**, 2019. Towards precision modification of cuticular wax in Brassica napus. 9th European Symposium on Plant Lipids. Marseille, France, July 7 - 10.

**Herneke A**, oral presentation Swedish Protein Material Network 7-8 March 2019

**Herneke A**, Oral presentation Chemical side at SLU, Uppsala, 21-23 August 2019

**Herneke A**, made pitch on Food Science Sweden Food Tech meeting in Lund/Alnarp 13-14 November 2019

**Herneke A**, Johansson D, Liu X, Lendel C, **Newson W**, **Langton M**, Mechanical properties of nanofibrils made from faba bean and mung bean protein, Poster presentation, The 20th Gums & Stabilisers for the Food Industry Conference., San Sebastian Spain, June 11-14 2019., First prize winner of poster presentations

**Kim S-Y**, **Zhu L-H**, & Åhman I, Barley β-1,3-glucanase's role in aphid resistance. Abstract for Botanical microscopy 2019. April 14-18, 2019, Oxford, UK.

**Lama S**, Vallenback P, Kuzmenkova M and **Kuktaite R**, 2019. Consequences of climate variation on Swedish wheat bread-making quality. Poster presentation at 1st International Wheat Congress, Saskatoon, SK, Canada, 21-26th July.

**Lama S**, Valleback P, Kuzmenkova M and **Kuktaite R**, 2019. Towards breeding of a climate resilient Swedish wheat with stable bread baking quality. Plant Breeding and Biotechnology Symposium, 11-13th June, Wageningen, Netherlands. Poster presentation.

**Langton M**, Oral presentation, Swedish Protein Material Network 7-8 March 2019

**Langton M**, 2019. Oral presentation on TC4F-meeting in Lund 20 Nov.

**Minina EA**, 2019. Chemical biology of plant autophagy. Invited talk. The 18th Congress of Spanish Society of Cell Biology. Badajoz, Spain, 15-18 October.

**Newson W**, 2019. Utilization of residues for the production of biomaterials, conference presentation, 4th Bio-Economy Conference, Anklam, DE, 7 Nov. https://biooekonomiekonferenz-mv.feg-vorpommern.de/index.php/programm/.

**Nilsson K**, **Moriana R**, Sandström C, Hedenqvist M, **Langton M**, Integral valorisation of Faba-beans molecular compounds to nutritional texturized food products, Poster presentation, The 20th Gums & Stabilisers for the Food Industry Conference , San Sebastian Spain, June 11-14 2019.

**Nilsson K**, **Moriana R** , Sandström C, Hedenqvist M, **Langton M**, Integral valorisation of Faba-beans molecular compounds to nutritional texturized food products, Poster presentation, BIOPOL-2019, Stockholm, June 17-19 2019

**Nilsson K** Oral Presentation, Chemical side at SLU Uppsala, 21-23 August 2019

**Nilsson K**, made pitch on Food Science Sweden Food Tech meeting in Lund/Alnarp 13-14 November 2019

**Elander PH**, **Minina EA**, **Bozhkov PV** 2019. The role of autophagy in plant lipid turnover. Gordon Conference. Plant Lipids: Structure, Metabolism and Function. Galveston, TX, USA. Jan 27 – Feb 1.

Prade T and **Newson W**, 2019. Intermediate crops as a sustainable feedstock for protein extraction, Bioeconomy Business Development & Innovation, Alnarp SE, 2019-06-18, https://www.slu.se/en/ew-calendar/2019/6/biobigg/.

**Pietiäinen S**, Moldin A, Ström A, Malmberg C, **Langton M**, 2019. Fractionation of wheat bran to create functional ingredients. Poster presentation at The Chemical Side of SLU, Uppsala, Sweden. August 21-23.

**Pietiäinen S**, Moldin A, Ström A, Malmberg C, **Langton M**, 2019. Fractionation of wheat bran to create functional ingredients. Pitch at Food Science Sweden Food Tech conference, Lund & Alnarp. November 13-14.

**Sandgrind S**, **Kanagarajan S**, **Li X**, **Guan R** and **Zhu L-H**, 2019. Precise breeding of oilseed species using the CRISPR/Cas9 system. 9th European Symposium on Plant Lipids. Marseille, France, July 7-10.

**Snell P, Grimberg Å, Hofvander P**, 2019. Arabidopsis LEAFY COTYLEDON1 and ABSCISIC ACID INSENSITIVE3 collaborate in the induction of WRINKLED1. Poster presentation at 9th European symposium on plant lipids, Marseille, France, July 7-10.

**Snell P, Grimberg Å, Hofvander P**, 2019 Co-expression studies of the LAFL-network reveal novel roles during late embryogenesis. Poster presentation at Plant Biology 2019, San Jose, USA. August 3-7.

**Sun C**, 2019. As one of the four invited speakers to give a keynote talk on the Symposium "Plant Breeding and Biotechnology" at Wageningen University, the Netherlands, June 11-13..

## Popular scientific presentations at meetings or excursions

- Utvinning av växtprotein på Alnarp. ATL Lantbrukets Affärstidning. 9 Jan 2019

- Klimatstabila grödor i fokus. Lantmannen nr 2 2019

- Äpplen för must och cider tas fram av SLU-foskare. Expertsvar.se. 4 Feb 2019

- Äpplen för must och cider tas fram av SLU-forskare. 5 Feb 2019

- Växtproteinfabrik på SLU Alnarp. SLU Future Food Nyhetsbrev, Feb 2019

- Proteinskiftet väntar. Agfo Weekly, 13 June 2019.

- Nu grönskar det för proteinerna. Forskning.se. 19 June 2019.

- Vetesorterna som ska klara ett extremt klimat. Forskning.se. 10 July 2019

- Ny växtfabrik ska tillverka proteiner till nya produkter. Lokaltidningen.se. 13 Jul 2019.

- Vi vill utveckla klimatstabilt vete som kan odlas i Sverige. Tidningen Syre. 25 Jul 2019.

- Professorn: Tar för lång tid att ställa om. Sveriges Radio. 13 Aug 2019.

- De forskar om grödor som tål framtidens klimat. Lantbruk och Skogsland. Sept 28, 2019

- Växtförädling för framtidens klimat. Månadens Skörd. Inspiration om säsongens bästa råvaror från ICA kvantum 10/2019

- Matologi event arranged by Future food at SLU. Scientific event focusing on food. Stockholm

- **Pietiäinen S**, Nilsson K, Harmancı B, 2019. From side streams to future food ingredients. Presentation at Matologi. Open public event arranged by SLU's Future food focusing on food waste and food research. Stockholm, September 21.

**Nilsson K**., 2019, Pitch: Faba beans food for future, Tylösand, 11-13 September 2019, First prize-pitch

## Collaboration with industry and/or other parts of society

- Chalmers University of Technology

- Förening u.p.a.

- ISCA Technologies

- KTH- Kungliga Tekniska högskolan

- Lantmännen

- Lilla Harie

- Lyckeby Starch AB

- LINXS- MAX IV and ESS network within the use of latest Infrastructure X-ray and neutron scattering methods

- LRF

- MariboHilleshög

- RISE

- Sveriges Stärkelseproducenter

## Other funding that has been received partially or fully due to the TC4F research

- Grogrund project: "Yin-yang basserade markörer för föräd-ling av spannmål" for 2019-2022

- Lantmännen Research Foundation: "Marker-assisted back-crossing of yin-yang barley with Lantmännen´s elite varie-ties" for 2020-2021.

- Vinnova Problöja, Vinnova Plant Protein Factory UDI steg 2 och Vinnova SSAP, steg 1.

## Investments in research infrastructure

- Co-applicant and received financing for latest Confocal La-ser Scanning Microscope.

- New HPLC equipment installed with autosampler

- Rheometer

- 3-D Printer

## Education

**a) PhD theses, MSc theses, Bachelor theses**

**Per Snell.** 2019. Dissecting the gene regulatory networks behind carbon allocation in plants. Dissertation: 13 December, 2019

**Mingliang Fe**i. (Male) 2019. Breeding of barley with high fructan in grain and study of the mechnism. Hunan Agricultural Unversity, China.

**b) Supervision and teaching**

**Bozhkov P** and **Minina E**. Main supervisor and co-supervisor, respectively, for PhD-candidate Elander, Pernilla. Tentative title: The role of autophagy in plant lipid turnover. Expected date for dissertation: April, 2021.

**Bozhkov P** and **Minina E**. Undegraduate course organizer and teacher, respectively. Course "Biochemitry", 7.5 ECTS, SLU.

**Carlsson A**. Co-supervisor for PhD-candidate Snell, Per. Title: Dissecting the gene regulatory networks behind carbon allocation in plants. Dissertation: 13 December, 2019.

**Johansson E**. Main supervisor for PhD-candidates Joel Markgren, Anna-Lovisa Nynäs and Antonio Capezza, Ashraf Rimsha, Okanlawon Lekan Jolayemi, Yuzhou Lan, co-supervisor for PhD-candidate, Elaine Ceresino and Emilia Berndtsson.

**Grimberg Å**. Co-supervisor for PhD-candidate Snell, Per. Title: Dissecting the gene regulatory networks behind carbon allocation in plants. Dissertation: 13 December, 2019.

**Grimberg Å.** Teaching at the course "Växtbiokemi (Plant Biochemistry) (BI1146), 7.5 ECTS, Alnarp.

**Guan R**. Co-supervisor for PhD candidate Sjur Sandgren. Tentative title: Genome editing of oil crops. Expected date for dissertation: 2022.

**Herneke A** and **Langton M**. Nano-fibrils in mung bean protein films., Supervisors for Liu, Xinran (Sherry) Internmentship from China Agricultural University, Being, China.

**Herneke A**. Main supervisor for master student Alice Dunge, title of master thesis: Mechanical properties of films made of faba bean protein nanofiber and non-fibrillated protein, spring 2019.

**Herneke A**. Main supervisor for master student Erica Joelsson autumn 2019.

**Herneke A** Teaching 1 lecture and 1 lab "Food Chemistry and Physics", 15ECTS, Ultuna.

**Hofvander P**. Main supervisor for PhD-candidate Snell, Per. Title: Dissecting the gene regulatory networks behind carbon allocation in plants. Dissertation: 13 December, 2019.

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

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

**Hofvander P**. Teaching at the course "Växtbiokemi (Plant Biochemistry) (BI1146), 7.5 ECTS, Alnarp.

**Kanagarajan S**. Co-supervisor for PhD candidate Magnus Carlsson. Tentative title: Production and characterization of heme-binding protein in plants. Expected date for dissertation: June 2020.

**Kanagarajan S**. Co-supervisor for PhD candidate Sjur Sandgrind. Tentative title: Genome editing of oil crops. Expected date for dissertation: 2022.

**Kuktaite R**. Main supervisor for PhD-candidate Sbatie, Lama. Tentative title: Wheat quality in a varying climate. Expected date for dissertation: June, 2023.

**Kuktaite R**. Co-supervisor for Master student Belsing, Axel. Title: Swedish Wheat in a changing climate. Screening for stable quality of protein "markers" in spring wheat genotypes from 2017 and 2018. 30 ECTS. Expected date for defense of Master Thesis, April, 2020.

**Kuktaite R**. Supervisor for Master student Zaka, Samreen. Title: Development of new bread-baking quality evaluation methods in spring wheat. 30 ECTS. Expected date for defense of Master Thesis, September, 2020.

**Olsson M**. Main supervisor for PhD-candidate Emilia Berndtsson and Joakim Sjöstrand.

**Minina E** and **Bozhkov P**. Main supervisor and co-supervisor, respectively, for PhD-candidate Holla, Sanjana. Tentative title: Monitoring of autophagic flux in planta using luminous reporters. Expected date for dissertation: April, 2023.

Morriana R, **Nilsson K**, **Langton M**, supervisors for Alicia Vernay inermentship, Impact of PEF on silage to increase its digestibility for animal feed. AgroSup, Dijon, France.

**Nilsson K** and **Herneke A**. Teaching "Food Technology" (LV0112), 15ECTS, Ultuna.

**Nilsson K** Course Co-ordinator", Grundkurs Livsmedels-agronom" (LV0100), 15 ECTS, Ultuna.

Alsraydeh L and Kacper Jan Moracevic, Ehrensvärdska Gymnasiet, Karlskrona. Supervision of their project "Överproduktion av vaxestrar i transgen tobak"; gymnasiearbete 100p.

**Nilsson K** supervisor for Büşranur Harmancı experimental report on the clarity, whiteness and absorbance of different starche, Gaziosmanpasa University, Tokat, Turkey.

**Nilsson K**, Morriana R, **Langton M**, Supervisors for Post Doc Daniel García García Universitat Politècia de València, Alicante, Spain.

**Sun C**. Main supervisor for PhD-candidate Mingliang Fei. Date for the finished dissertation: June, 2019.

**Sun C**. Main supervisor for PhD-candidate Silvana Moreno. Tentative Title: Cereal breeding using the yin-yang genes as markers. Expected date for dissertation: Dec, 2022.

**Newson W**. Co-supervisor for PhD candidate Anja Herneke. Tentative title: Functionalization of nanofibers from plant based proteins. Expected date for dissertation: February 2022.

**Newson W**. Co-supervisor for PhD candidate Antonio Capezza. Tentative title: Novel absorbent Materials obtained from different plant proteins. Expected date for dissertation: October 2020.

**Newson W**. Co-supervisor for PhD candidate Anna-Lovisa Nynäs. Tentative title: Proteins from green biomass for food applications. Expected date for dissertation: November 2021.

**Zhu L-H**. Supervisor for PhD candidate Margnus Carlsson. Tentative title: Production and characterization of heme-binding protein in plants. Expected date for dissertation: June 2020.

**Zhu L-H**. Supervisor for PhD candidate Sjur Sandgren. Tentative title: Genome editing of oil crops. Expected date for dissertation: 2022.

**Åsman A.** Supervisor for Erasmus student Ali Burak Yildiz. Traineeship Title: Using CRISPR technology to study transcription factors in Arabidopsis.

# Personnel in T4F 2019

## 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 | 50% |
| Natuschka Lee | F, researcher/associate professor | 0 |
| Ove Nilsson | M, Professor | 0 |
| Olivier Keech | M, Associate-Professor | 8% |
| 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 | 50% |
| 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 |
|---|---|---|
| Annika Nordin | F, Professor | 25% |
| Vaughan Hurry | M, Professor | 0 |
| Nathaniel Street | M, Associate Professor | 12,5% |
| Benjamin Forsmark | M, PhD student | 80% |
| Camilla Canovi | F, PhD student | 100% |
| Elena van Zalen | F, PhD student | 100% |
| Andreas Schneider | M, PhD student | 0% |
| David Castro | M, PhD student | 10% |
| Tuuli Aro | F, PhD student | 10% |
| Mark Swaine | M, Postdoc | 100% (Jan-Oct 2019) |
| Sandra Jämtgård | F, Researcher | 0 |
| Giulia Vico | F, Docent | 15% |
| Guiomar Ruiz-Pérez | F, PostDoc | 100% (Jan-Mar 2019) |
| Simon Law | M, Postdoc | 100% (Mar-Dec 2019) |
| Alexander Vergara | M, Postdoc | 100% |
| Qi Yang | F, Postdoc | 100% (Jan-Aug 2019) |
| Lucia Tamburino | F, postdoc | 100% (Sept-mid Oct 2019) |
| Alonso Serrano | M, Computer engineer | 100% |

## 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% |

# C4F- Crops for the Future, Personnel

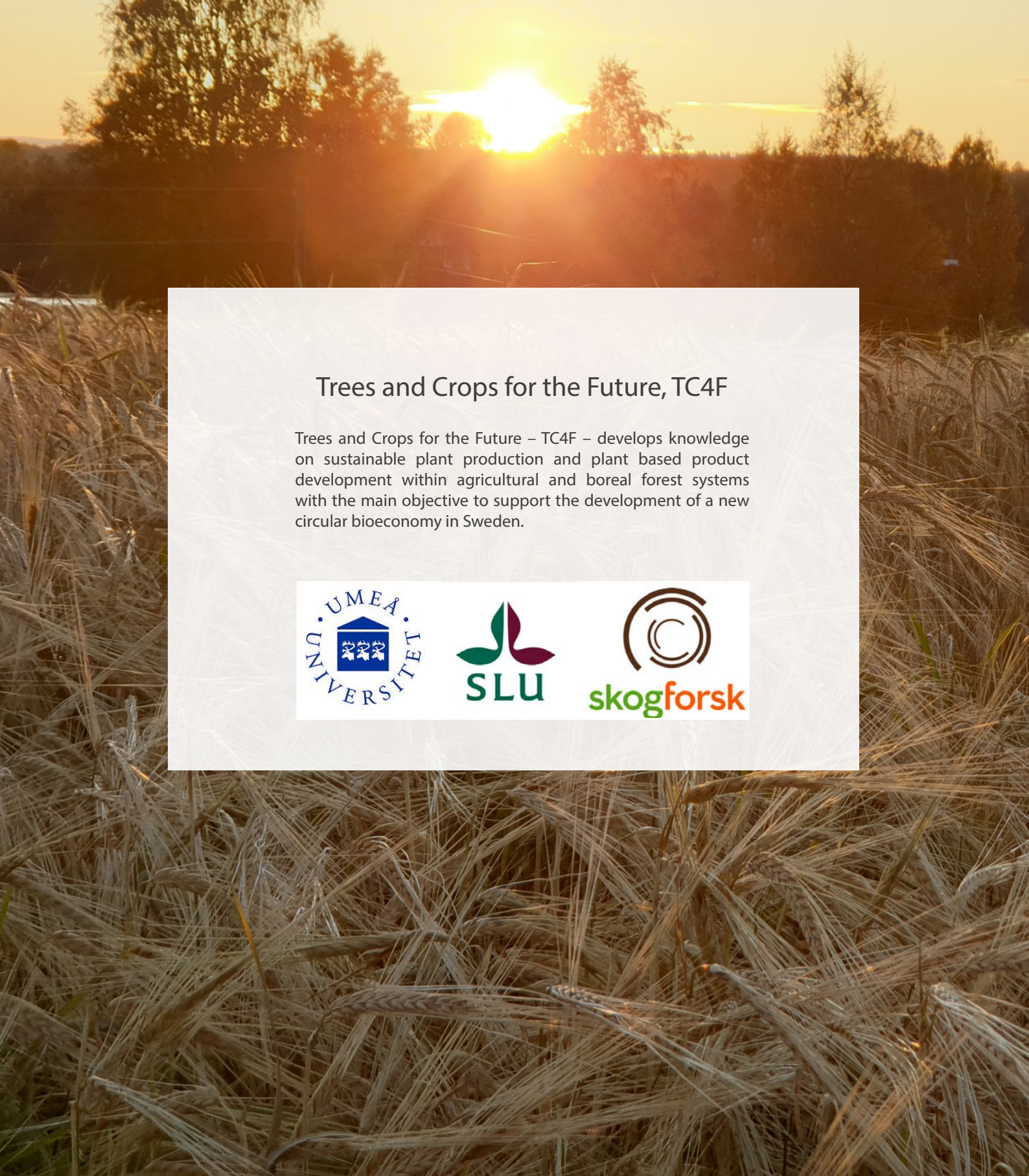
| Name | Gender & Position | Part of full time financed by TC4F |
|---|---|---|
| Eva Johansson | F, Professor, C4F leader | 15% |
| Li-Hua Zhu | F, Professor, C4F vice leader | 10% |
| Sven-Erik Svensson | M, PhD student | 35% |
| Ramune Kuktaite | F, Researcher | 0 |
| William (Bill) Newson | M, Postdoc | 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 | 0% |
| Sjur Sandgrind | F, Postdoc | 0 |
| Sungyong Kim | M, PhD student | 17% |
| Xueyuan Li | M, Research assistant | 45% |
| Magnus Carlsson | M, PhD student | 50% |
| Sungyong Kimi | M, Postdoc | 0 |
| Rui Guan | F, Postdoc | 0 |
| Chuanxin Sun | M, Docent | 15% |
| Yunkai Jin | M, Postdoc | 20% |
| Salim Hossain Reza | M, Postdoc | 20% |
| Folke Sitbon | M, Professor | 0 |
| Maud Langton | F, Professor | 0 |
| Anja Herneke | F, PhD student | 30% |
| Klara Nilsson | F, PhD student | 20% |
| Solja Pietaiänen | F, PhD student | 0 |
| Rosanna Moriana | F, Researcher | 20% until Aug, 2019 |
| Daniel Johansson | M, Researcher | 15% from Nov, 2019 |
| Daniel García García | M, Postdoc | 0 |
| Xinran Liu, (Sherry) | F, Internship | 0 |
| Alicia Vernay | F, Exchange student | 0 |
| Büşranur Harmancı | F, Exchange student | 0 |
| Saeid Karkehabadi | M, Researcher | 0 |
| 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 | 25% |
| Per Snell | M, PhD student | 0 |
| Peter Bozhkov | M, Professor | 0 |
| Kerstin Dalman | F, Research engineer | 0 |
| Adrian Dauphinee | M, Postdoc | 0 |
| Pernilla Elander | F, PhD student | 0 |
| Elena Minina | F, Researcher | 0 |
| Anna Åsman | F, Postdoc | 50% |
| Sanjana Holla | F, PhD student | 0 |

*Researchers listed with 0% have received financing from TC4F earlier which resulted in projects with independent financing.

# TC4F Economy 2019

In 2019, TC4F received 27.5 mio SEK of funding which were distributed according to the budget. 107% were used. The deficit was compensated by remaining funds from 2018.

| | SLU | UmU | Skogforsk | Total |
|---|---|---|---|---|
| Distributed Funds (tkr) | | | | |
| Coordination | 1 356 | | | 1356 |
| Tema 1 (Stefan Jansson, UmU) | 1 985 | 3 092 | 1 100 | 6 177 |
| Tema 2 (Vaughan Hurry) | 4 787 | 2 008 | | 6 795 |
| Tema 3 (Urban Nilsson) | 7 094 | | | 7 094 |
| | | | | |
| C4F (Eva Johansson /Li-Hua Zhu) | 6 148 | | | 6 148 |
| TOTAL | 21 370 | 5 100 | 1 100 | 27 570 |
| | | | | |
| Costs, spent funds (tkr) | | | | |
| Coordination T4F | 852 | | | 852 |
| Coordination C4F | 397 | | | 397 |
| Tema 1 (Stefan Jansson, UmU) | 2 192 | 3 092 | 1100 | 6 384 |
| Tema 2 (Vaughan Hurry) | 4 406 | 2 008 | | 6 414 |
| Tema 3 (Urban Nilsson) | 8 134 | | | 8 134 |
| | | | | |
| C4F (Eva Johansson /Li-Hua Zhu) | 7 404 | | | 7 404 |
| | | | | |
| TOTAL | 23 385 | 5 100 | 1 100 | 29 585 |
| | | | | |
| RESULT | | | | -2 015 |



# 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.

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skogforsk