




**ANNUAL REPORT**

**2017**

**TREES AND CROPS  
FOR THE FUTURE / TC4F**



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# Trees and crops for the future, TC4F

## Annual report 2017

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## Chairman of board / Göran Ståhl

In 2008 the Swedish Government launched a large and long-term program on Strategic Research Areas that would fund research of highest international quality, contributing to solving important problems in society in areas connected to the Swedish business sector. Higher education institutions were invited to apply.

The Trees and Crops for the Future program (TC4F) was proposed by SLU together with Umeå University and the Swedish Forest Research Institute. The application was successful and the program started in 2010. An evaluation in 2015 concluded that TC4F had carried out research of highest international standard and that the strategic importance of the subject area remained high. Since then, we know that the importance of knowledge supporting the transition to a bio-based economy has continued to increase. In Sweden, this is manifested by recent national food and forest strategies adopted by the Swedish Government.

TC4F aims to develop vital research-based knowledge for the development of a sustainable bio-based economy. It also aims to contribute to supplying core competences for this development, through research education and post-doctoral positions. The ambition is to actively disseminate



results to stakeholders in society, to students, and to research colleagues. This extended annual report, issued in a new format compared to previous annual reports, is part of this ambition.

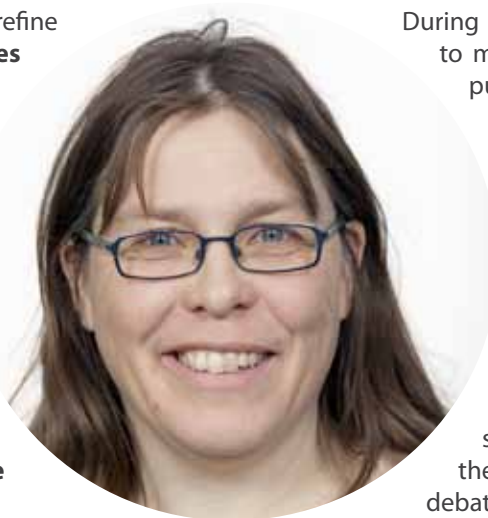
The program combines cutting-edge research within individual disciplines with multi-disciplinary work exploring novel fields of research at the boundaries between the individual subjects. Many of the most prominent researchers of forest and agricultural science in Sweden participate. One example is the previous theme leader within TC4F, Professor Torgny Näsholm, who has received the 2018 Marcus Wallenberg Prize, often recognized as the “Nobel Prize of Forest Sciences”. Another example is Associate Professor Chuanxin Sun, who in 2017 was awarded the prestigious *Physiologia Plantarum* Award.

The annual report for 2017 highlights a small selection of ongoing projects within TC4F and summarizes the achievement within each of our four themes. In short – we can look back at another year of excellent contributions by the researchers in the program.

*Chairman of board - Göran Ståhl*

## Program director / Eva Johansson

During 2017, several steps were taken to refine the strategic orientations of the **TC4F – Trees and Crops for the Future** – research program. The whole program was able to complete research and budgetary activities scheduled for phase 1 of TC4F. In addition, important efforts were made to envision orientations and objectives for phase 2 of the program and beyond. Through these efforts, strategies for the remaining part of phase 2 and beyond have been developed, highlighting important specific orientations for both the tree (**Trees for the Future – T4F**) and crop (**Crops for the Future – C4F**) parts of the program.



A primary goal of the whole program is to create bridges between high level basic research activities and practical applications of acquired knowledge, thereby contributing to solutions for the recognized need to create a circular bioeconomy in a changing climate. To help meet these challenges, interdisciplinary research efforts through targeted analyses of tree to landscape level processes, have been identified as the most important strategic foci for T4F, while various opportunities to tailor novel products from crops have been identified as the most innovative and groundbreaking foci for C4F. Thus, the visionary strategy for TC4F encompasses development of knowledge about sustainable plant production (T4F) and plant-based product development (C4F), with the joint main objective to support the development of a new circular bioeconomy in Sweden.

The most important outputs from T4F projects in 2017 included a reference genome sequence of aspen and genome-wide associations of some of its major traits, proof that the abundance and diversity of fungal and bacterial communities increase with improvements in soil nutrient status, and methods to establish poplars. A major contribution from C4F initiatives in 2018 was the detection of a single gene in barley that is controlled by two alternative promoters generating two functionally opposing transcription factors involved in sucrose sensing.

During the year, the program contributed to more than 80 high quality scientific publications, including 10 with an impact factor >5. In total, four PhD students and three MSc students engaged in the program defended their theses during 2017. Most of the senior researchers and many of the PhD students have also played active roles in basic education.

In addition, many of the senior researchers have raised the profile of the program, and contributed to public debate, through various media channels and contacted for interviews or comments regarding relevant policies. The most important topics for these outreach activities have been food and circular bioeconomy policies and plant breeding, genetic modification of plants (both trees and crops), sustainability and use of forest resources for various applications (including production and recreation), the revolutionary gene scissor (CRISPR/Cas9) technique for use in both trees and crops, and novel and emerging bio-based products from crops.

Existing collaborations with external actors have continued and enhanced during the year. These include various collaborative activities with Skogforsk, SweTree Technologies, Holmen Skog, Arevo, Future silviculture in Southern Sweden (50% financed by the forest sector in Southern Sweden), Lantmännen, Lyckeby Starch, Syngenta, ISCA Technologies, SCA, Essity, and the Syngenta flower division in the Netherlands. The development of a Plant Protein Factory was started in 2017.

The overall budget for program activities during 2018 was 28 219 000 SEK, and expenses by December 31st totalled a very similar amount: 26 846 000 SEK. However, small proportions of the budgets for Themes 1 and 2 were not used, while the budget was exceeded for Theme 3. The deficit for Theme 3 will be covered by funds remaining from Phase 1.

*Program director - **Eva Johansson***



Photo: J Lokrantz/Azote

A wide-angle photograph of a lush green wheat field stretching to a distant horizon under a sky filled with soft, white and grey clouds. The foreground shows individual wheat stalks with developing grain heads in detail.

# RESEARCH PORTRAIT

## Are boreal forests reaching their temperature limit?

*Will Nordic forests benefit from a warmer climate? Not necessarily, according to an ongoing project addressing TC4F's Theme 2, "Growth and interaction with the environment - current and future". This is because we may be approaching a threshold where the positive effects of warming are reversed. With increasing temperatures and water stress, forest growth is at risk of slowing, at least in southern Sweden.*

Average temperatures in boreal regions have increased by 0.3-1°C since the early 1970s. An associated positive effect on boreal forest growth detected in satellite vegetation records has been called a "greening trend". But recently an adverse effect has been indicated. Productivity seems to have levelled off in some parts of Alaska and western Canada, and in some locations it is even declining. Some scientists now talk of a "browning trend".

### Net photosynthesis may go down

Giulia Vico is an eco-hydrology expert who develops and uses models of responses to climate change. She and her

colleagues in the TC4F (Trees and Crops for the Future) program have recently submitted two papers that address effects of rising temperatures on the forest.

Modelling plant responses is a complex task, as numerous factors (*inter alia* temperature fluctuations, average temperatures, water availability and leaves' capacities to acclimatise to new conditions) must all be considered.

– Conflicting signs that productivity may also be declining in Scandinavia have been reported, says Giulia Vico. However, our large-scale study using satellite-derived vegetation





greenness combined with climate data, found some evidence of negative trends in the southern and drier part of Sweden.

Each species has an optimum temperature, above which increases in respiration and photorespiration may have stronger negative effects than the positive effects of increases in photosynthesis, thus leading to reductions in net photosynthesis rates. The losses will be even higher if we add dry spells in the summer. And this turning point, the threshold, may be reached in the near future, according to Giulia Vico.

## From leaf level to global models

Large-scale ecosystem modelling also requires knowledge of small-scale responses. So, the TC4F research team are also modelling leaf-scale responses to temperature fluctuations.

– Average temperature increase is one component, but for the trees and leaves temperature fluctuation is just as important, she says.

Her team has demonstrated that net carbon assimilation is strongly linked to short-term temperature changes, in scales of minutes or hours. Leaves have a certain capacity to acclimate to the thermal environment, which could compensate for adverse effects. The new results on short-term fluctuations are valuable contributions to long-term and global models.

The TC4F team will continue the work on climate change responses by considering other factors, such as late frost damage in the spring. This type of damage may be more common when the growing period is extended to the colder seasons in the spring and autumn.

## Multidisciplinary team

Giulia Vico finds working in a team like TC4F, where scientists from different disciplines have synergistic competences, highly advantageous. She is also involved in other projects at SLU, focussing on grain crops such as wheat, barley and rice.

– My experience from modelling the short rotation seed crops is very beneficial for the models we are running on long-lived trees. And vice versa, she says.

*/ Text and photo Mats Hannerz. Portrait photo Jenny Svernås-Gillner.*

## About Giulia Vico

Giulia Vico is an Associate Professor at SLU's Department of Crop Production Ecology in Uppsala, focusing on eco-hydrology modelling. She joined SLU in 2012, after working as research scientist and Postdoctoral fellow at Duke University in North Carolina, where she also received her PhD in Civil and Environmental Engineering. Giulia Vico is a native Italian and obtained a Master's in Environmental Engineering from Politecnico of Torino.



# Award-winning research improves crop quality and reduces climate impact

*If SUSIBA2 rice was globally cultivated, 200 million more people could potentially be fed, and there would be climatic benefits equivalent to stopping emissions from 120 million cars. These extraordinary claims are backed by evidence gathered by Chuanxin Sun, a leading researcher addressing TC4F's Theme 4, "Other renewable plant resources, non-food crops".*

The research group led by Chuanxin Sun has generated a rice variety with extraordinary traits. This has been done by manipulations of *SUSIBA2*, a regulatory gene controlling sugar synthesis and allocation, that greatly increase rice yields while cutting its climatic impacts.

## Rice – a major emitter of methane

Rice, growing in waterlogged paddy fields, emits large amounts of methane from its roots. In fact, rice production is responsible for up to 17% of the world's emission of methane, the second most important greenhouse gas after carbon dioxide. *SUSIBA2* rice produces 90% less methane than other ("wild type") varieties and still provides 10% higher crop yields.

What Chuanxin Sun and his team have done is to transfer the *SUSIBA2* gene from barley to rice. This changes the way

rice plants allocate carbon fluxes from photosynthesis to different tissues, causing them to send more photosynthetically generated carbon to stems and grains, and less to the roots.

– By reducing amounts of carbon sent to the roots, we reduce amounts of root exudates that are converted to methane, in field conditions as well as the lab. We have grown the rice outdoors in China for three years now, with successful results. The rice variety is not patented, so it is now open for use by anyone. Currently, it can't be used in China or Europe, since it is classified as a GMO product, but other are countries interested in using it in rice agriculture, he says.

## Top world innovation prize

The development of *SUSIBA2* rice was featured in *Nature* and earned both Popular Science magazine's Grand Prize for an Innovation in Engineering in 2015 and a prestigious *Physiologia Plantarum Award* in 2017.

Recently, Chuanxin Sun and his colleagues have extended the scope of possible developments by more fully elucidating the system that controls carbon fluxes in barley. A single gene with two promoters (*SUSIBA1* and *SUSIBA2*) determines not only the allocation patterns mentioned above, but also how much of the photosynthetic products

Guest researcher Mingliang Fei analysing *SUSIBA2* gene expression levels by qPCR.  
Photo: Mats Hannerz.





Dr. Yunkai Jin with *SUSIBA2* rice. Photo: Mats Hannerz.

## About Chuanxin Sun

Associate Professor Chuanxin Sun is leading a group of two Post-doc researchers, a PhD student and a guest researcher at SLU in Uppsala. He is also coordinating international work with *SUSIBA2* rice together with researchers based in the USA and China. He started off with a Master's from the Chinese Academy of Agricultural Sciences in Beijing, where he also spent two years as a researcher. In 1988, he moved to Sweden and Stockholm University, then 10 years later he joined SLU in Uppsala as a senior scientist, and subsequently Associate Professor. He is currently affiliated to SLU's Department of Plant Biology.

are channelled into starch and dietary fibres (fructan and beta-glucan). Thus, crops with tailor-made starch and dietary fibre contents can be produced. These findings were highlighted on a front cover of the journal *Molecular Plant*. Lantmännen, a Swedish agricultural company, supports the research and plans to use a variety produced by the team commercially.

Chuanxin Sun explains *SUSIBA1/2* regulation as a Yin-Yang system, with an activator and repressor balancing each other in the control of C-fluxes.

The research group is also screening other varieties for variations in *SUSIBA2* activity and have found some interesting lines for further research. Moreover, knowledge of the Yin-Yang system may help efforts to improve crops' lipid contents.

– We also use rice as a model plant in our lipid research. There is great potential to increase cereal's oil contents by exploiting understanding of the lipid controlling genes and *SUSIBA2*, says Chuanxin Sun.

*/ Text and photo Mats Hannerz.*



# More efficient site index estimates and new guidelines for mixed-forest management

*“A site index based on climate variables instead of latitude and altitude will allow us to improve our predictions of forests’ productivity” says Emma Holmström. Besides developing new site index models, she is studying mixed forest management. Her research contributes to efforts addressing TC4F’s Theme 3 “Adaptive and sustainable forestry”.*

Information about site conditions is essential for good forest management planning. The production potential of a site is a major determinant of the appropriate species to choose, numbers of seedlings to plant and optimal thinning procedures. A long-used indicator of productivity is the site index (SI), developed from empirical studies of existing stands and data gathered from production trials and national forest inventories.

## Better predictions with process-based models

The SI-method was developed in the 1970s, but it has limitations. One of Emma Holmström’s research objectives is to develop more precise and accurate methods.

– Instead of relying on measured heights of trees in existing stands or site property data combined with latitude and altitude, we are moving to the processes that drive forest productivity. We use climate data from SMHI (the Swedish Meteorological and Hydrological Institute), information about geology and soil from SGU (the Swedish Geological Survey), and topographic variables from height-data models available from Lantmäteriet (the Swedish mapping, cadastral and land registration authority). With this data, we develop models for the most important growth processes, she says.

## Possible to forecast mixed and heterogeneous forests

A site index based on climatic variables instead of latitude and altitude also enables better predictions of growth following climate changes. Pilot studies have indicated that process-based site index models are more efficient and accurate than previous models. An important advantage



Height measurement. Photo: Emma Holmström.

is independence from existing stands. Moreover, it is now possible to estimate productivity in untraditional forests, such as mixed or heterogeneous stands, and the potential productivity of bare land.

– Thanks to method development, we see potential to improve cost efficiency in forest planning, practical forest management and silvicultural research, says Emma Holmström.

## Stand development in mixed forests

Emma Holmström is also involved in research on mixed forests. She considers the research to be established and that it will undoubtedly be a major component of future silvicultural research.

– The main goal is not to compare monocultures with mixed forests, but to develop practical guidelines for forest owners who want to manage their mixed forests. We need, *inter alia*, more relevant descriptions of stand development when we use mixtures of broadleaves and conifers, and different tree species.

Considering mixed forests, she highlights the following questions:

- Do we need other methods or planning tools when managing mixed forests rather than monocultures?
- How should a mixed forest stand with two main species be treated, i.e. a stand where both species should grow well and be promoted throughout the rotation?
- What pre-commercial thinning and other silvicultural regimes should be applied to achieve different goals, at reasonable cost while maintaining reasonable operational efficiency?

/ Text Åsa Eckerrot, portrait photo Mats Hannerz.

## About Emma Holmström

Doctor Emma Holmström is working at SLU's Southern Swedish Research Centre in Alnarp. After obtaining a MSc in Forestry, she worked as a technician at the centre, studied for a PhD, and defended a thesis in 2015 focusing on establishment and silviculture in mixed birch and spruce forests. She is responsible for the Master's course "Sustainable forestry in southern Sweden", which is part of the Euroforester programme.



## Nitrogen studies at micro level – in the scale of a plant root

*What nitrogen is available to plants, and what forms of nitrogen are taken up from the soil? These are key questions the ecophysiologicalist Sandra Jämtgård is striving to answer, and help reduce nitrogen leakage into the environment. The research is contributing to efforts addressing TC4F's Theme 2, "Growth and interaction with the environment - current and future".*

According to many textbooks, plants take up the inorganic nitrogen forms nitrate and ammonium through their roots and use it in their growth processes, but recent research has shown that nitrogen absorption patterns are far more complex than that. For example, plants also commonly take up amino acids and other forms of organic nitrogen, as shown by Torgny Näsholm's research group, which includes Sandra Jämtgård.

### **Microdialysis, a method from medical science**

– Apart from amino acids, various forms of organic nitrogen in the soil have not been studied much previously, simply

because of a lack of suitable methods, until my research provided them, she says.

As a Post-doc in Brisbane in Australia in 2012, Sandra Jämtgård evaluated a method to analyse organic nitrogen compounds - peptides - in soil. That study led her to the microdialysis method she uses in her research today. Microdialysis is a method involving small dialysis membranes that was initially developed in medical research.

In soil research, it is used primarily to study nitrogen dynamics. The soil sampling technique she developed, with



Microdialysis, a method with minimal soil disturbance. Photo: Sandra Jämtgård.



Photo: Sandra Jämtgård.

colleagues, enables studies of root-scale soil solutions with minimal disturbance of the soil.

### Roots release organic compounds

– In the TC4F project, I mainly investigate the importance of roots' exudation of carbon compounds for the carbon-nitrogen dynamics of forest soils. It has long been known that roots and mycorrhizas exude carbon, says Sandra Jämtgård.

The compounds released can vary with tree species and soil type, but it is assumed that various organic acids, such as citric, oxalic and malic acids, dominate the exudates. However, the biological role of the exudates is largely unknown and debated.

By using microdialysis, it is possible to characterize the carbon compounds that are released by roots into the soil in forests with differing productivities. By combining microscale laboratory studies with field work, researchers can investigate links (and associated effects on nitrogen availability) between specific exudates, the regulation of important metabolic reactions and the soil microbiome (microbes present in the soil). Within the TC4F program this is being done in collaboration with Nathaniel Street, Vaughan Hurry and Torgny Näsholm.

### More efficient nitrogen uptake

– I hope the results of our research can be used to improve nitrogen use efficiency of plants used in forestry and agriculture and reduce nitrogen leakage to surrounding environments. Leakage of nitrogen is one of today's major environmental problems.

*/ Text Åsa Eckerrot, portrait photo Sandra Jämtgård.*

## About Sandra Jämtgård

The ecophysicologist Sandra Jämtgård started her studies in biology at the University of Gothenburg. Then, after a semester of soil science studies in Uppsala and Borneo, she moved to Umeå where she completed a Master's and started PhD studies on soil-plant interactions. In 2010 she defended her thesis. Since then, she has held Post-doc positions at SLU and the University of Queensland, Brisbane. Since 2015, she has been a researcher at SLU's Department of Forest Ecology and Management in Umeå. Soil-plant interactions are still the main foci of her research.





Photo: L Nilsson/Azote





# THEME LEADERS

# Theme 1

## - Forest genetics and next generation of forest trees

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

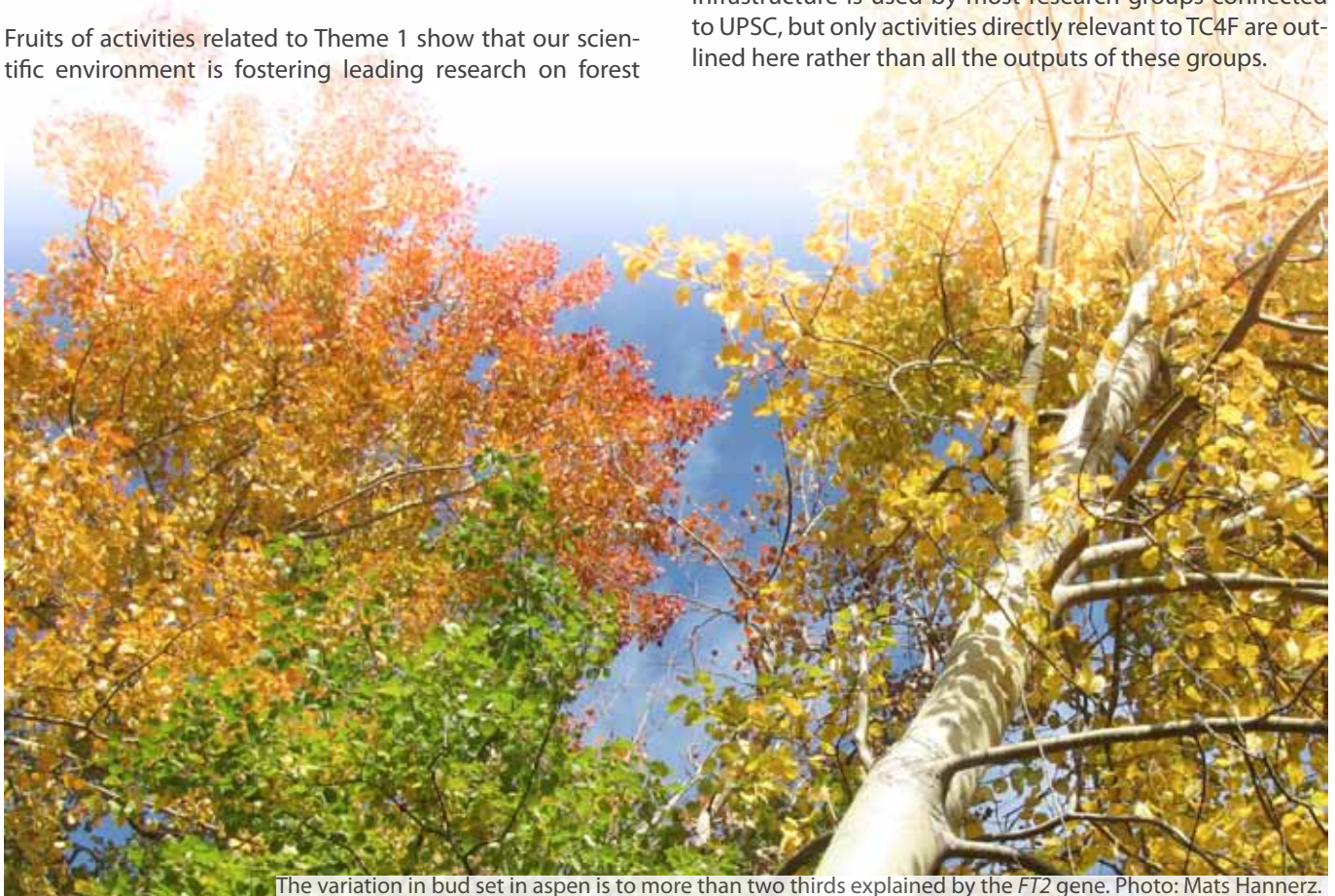
### Overall progress of the research in 2017

A key objective of work linked to Theme 1, on novel forest trees, is to create bridges between operational breeding at Skogforsk and basic research at Umeå University and SLU. Many basic scientific findings of the project result from analyses of trees included in breeding programmes and/or have interesting traits for forestry.

Fruits of activities related to Theme 1 show that our scientific environment is fostering leading research on forest

genetics and genomics that is highly relevant in practical forest tree breeding.

A very significant proportion of the Theme 1 funding is used to support research infrastructure (e.g. tree transformation, bioinformatics, field experiments and cell wall analysis facilities), supplementing other project funding. This infrastructure is used by most research groups connected to UPSC, but only activities directly relevant to TC4F are outlined here rather than all the outputs of these groups.



The variation in bud set in aspen is to more than two thirds explained by the *FT2* gene. Photo: Mats Hannerz.

## Main findings in 2017

The basic science parts of this program mainly involve use of aspen as a model system. They include two very fundamental long-term efforts that have finally been completed and described in two papers submitted for publication.

The first and foremost is the project to generate a reference genome sequence for aspen, which has taken more than 10 years (Lin *et al.*, submitted). However, during this time it has been considerably expanded and the manuscript reports not only the reference aspen genome but also the resequencing of other individuals of both Eurasian (*Populus tremula*) and American (*P. tremuloides*) aspen. It also includes a comparison with *P. trichocarpa*. This landmark study has provided foundations for all our other work on aspen.

The other, strongly related effort is reported in a manuscript presenting the first genome-wide association study (GWAS) of aspen, using phenotyping and resequencing data from the Swedish aspen (SwAsp) population (Wang *et al.* in press). This manuscript also includes data generated in another of the TC4F core activities. The *FT2* gene was found to be responsible for more than two thirds of the genetic variation in bud set timing in the SwAsp population and happened to be one of the modified genes in transgenic trees included in field experiments funded in Phase 1. This may be the best example presented in the literature to date on the characterization of a gene controlling an economically and ecologically important trait in a tree, all the way from identification and mapping in an undomesticated tree population to the molecular details.

Other related publications include papers describing the AspWood project (Sundell *et al.* 2017); extending understanding of secondary growth (Kucukoglu *et al.* 2017) and autumn phenology in aspen (Edlund *et al.* 2017, Michelson *et al.* 2017); elucidating interactions between nitrogen availability, soil properties and gene expression (Bandau *et al.* 2017, Decker *et al.* 2017); and dissecting gene expression networks (Mähler *et al.* 2017). Findings from basic science-oriented projects on other tree species have also been published, including *Eucalyptus* (Tan *et al.* 2017) and conifers (De La Torre *et al.* 2017, Sullivan *et al.* 2017). In addition, Skogforsk researchers have studied growth of poplar and aspen in field tests (Stener and Westin 2017).

More applied aspects of TC4F are mainly connected to Skogforsk's Norway spruce and Scots pine breeding pro-

gram. Three papers emanating from collaborative studies by Skogforsk and Umeå University researchers have been published, for example on genetic variation in pine weevil resistance (Zas *et al.* 2017), a major pest in Swedish forestry. The main conclusion is that this trait is probably not a good breeding target in Norway spruce because genetic variation in it is too weak. Genotype-by-environment interactions affecting growth of Norway spruce (Chen *et al.* 2017) and ways to analyse results of field tests (Wu *et al.* 2017) have also been studied.

## Contributions to social benefit

In addition to creating societal benefit through the development of tools and resources for tree breeders, the visibility of TC4F activities has been raised by participation in public debate. For example, TC4F has contributed to debate regarding European regulation of new plant varieties generated using genome editing by CRISPR/Cas9 technology, through funding "demonstration examples" that are about to be described in a paper by Fleig *et al.* (in preparation).



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 2017

The overall goal of the forest component of TC4F is to develop new forest management tools to meet challenges posed by societal change and the emerging bioeconomy in response to climate warming. The goal of efforts linked to **Theme 2** is to increase sustainable biomass yields from the existing forest estate.

Future climates will be characterized by warmer and more variable air temperatures, higher atmospheric CO<sub>2</sub> concentrations, and more frequent water stress. Theme 2 projects

explore how these changing conditions will affect boreal forests at scales ranging from single leaves to regions. Key goals are to understand the responses of trees to various biotic and abiotic factors related to plant-climate and plant-soil interactions, and to mathematically quantify the impacts of these factors on tree growth and ecosystem biodiversity, resilience and robustness.

### Main findings in 2017

During 2017 we published two significant contributions to the overall goals of providing new insights into, and



TC4F field experiment at the Kulbäcksliden experimental site with in-field whole tree photosynthesis measurements to assess the impact of improved nitrogen status on tree growth and carbon allocation to belowground plant structures and microbial communities. Photo: Vaughan Hurry.

mathematically quantifying, responses of trees to plant-climate and plant-soil interactions. One presents a comprehensive analysis of microbiomes in samples of soil, root and needle obtained from a mature spruce forest. It shows that the below-ground diversity of fungal (particularly ectomycorrhizal fungi, EMF) and bacterial communities increased with increases in soil nutrient levels. The relative abundance of nitrophilic EMF and bacterial taxa also increased. While not surprising, such changes in community structure may have significant effects on carbon storage and nitrogen cycling in boreal forests, and our current studies are addressing these possibilities.

Secondly, although Scots pine and Norway spruce co-occur and belong to the same plant functional group – and are thus treated as species that will behave identically in vegetation climate models – we showed that Norway spruce will be far more sensitive than Scots pine to future seasonal warming events. Even mild increases in seasonal temperatures will induce chronic heat-stress in this species, possibly providing an important driver for species change in our forests in the coming century. We are taking this further now to quantify effects of short- and long-term temperature changes on plant C uptake. At regional, Scandinavian scale we have identified the interaction between increases in temperature and water stress as one of the key climatic drivers of inter-annual variation in forest productivity.

## Contributions to social benefit

Research related to this theme is directly connected to the development of new fertilizers by the company Arevo, and their application by forest companies such as Holmen Skog. During 2017, we collaborated with these companies to establish extensive seedling and fertilizer trials to develop new ways to optimize forest regeneration while minimizing the impacts on soil microbial communities and soil functions. We know very little about the ecosystem- and host-level services provided by the microbial communities of Swedish forests or how changes in community composition may impact future forest productivity. However, the tools we have developed for meta-transcriptomics analysis provide previously unavailable insights into their functioning, response and diversity. In addition, our research adds to international efforts to develop process-based models that can provide better predictions of the effects of climate change on vegetation. Our modelling is also improving understanding of the potential effects of shifts in climatic conditions on forest productivity and health, not only in Sweden but globally.



By using microdialysis, it is possible to characterize the carbon compounds that are released by root into the soil in forests with differing productivities. Photo: Sandra Jämtgård.



## 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 2017

During 2017, most of the activity related to **Theme 3** was concentrated on starting new research that will result in publications towards the end of the program period. Two new PhD students started at the beginning of the year and one researcher at the end of the year.

One of the PhD students is constructing hybrid models for growth of Scots pine and birch. A hybrid model combines empirical data with a mechanistic model, enabling more flexible forecasts of growth under new climate conditions. The other student is investigating interactions between fire parameters (intensity and severity), logging and climate change (e.g. warmer air temperatures), and their effects on seedling growth, nutrition and survival.

Projects initiated during 2017 are focused on issues including (*inter alia*) regeneration in burnt areas, pre-commercial thinning regimes for promoting more diverse forest structures, hybrid models for growth of Scots pine and Norway spruce in southern Sweden, and microbial effects on growth of lodgepole pine.

However, in addition to the initiation of new research projects, intermediate reports from projects started during the previous year or during Phase 1 were published.

### Main findings in 2017

There have been major breakthroughs in both management methods for establishing poplar in practice and understanding reasons for differences in establishment between poplars and hybrid aspen. Published contributions during this period included a pilot model for estimating site indices from climatic and other data, available in the form of map-layers (Mason *et al.* 2017). This preliminary model has less bias and at least as good precision as the currently avail-

able model based on field measurements. We also presented various other simulations. One, obtained using Heureka and data from long-term pre-commercial thinning experiments, shows that a possible way to reduce the economic impact of browsing by roe deer and moose in dense Scots pine regeneration is to postpone pre-commercial thinning (Fahlvik *et al.* 2017).

Modelling the growth of genetically improved seedling material showed that modifications of existing models were needed for Scots pine, but not Norway spruce (Egbäck *et al.* 2017).

In addition, genetic variants of *Populus tremula* that are well suited for high N environments due to strong resistance to pests were identified (Bandau *et al.* 2017), effects of forest stand types on the success of non-native species were studied (Fajardo and Gundale 2018), and mechanisms through which forest nitrogen fertilization affect C accumulation were identified (Maaroufi *et al.* 2017).

### Contributions to social benefit

Some research addressing Theme 3 is practically oriented and is being done in close collaboration with forest-sector actors and other stakeholders. Partly for these reasons, some of the studies are frequently reported in popular forest magazines. For example, our research on management of mixed-forest stands was the main topic in an issue of SkogsEko in 2017.

We have continued to arrange field excursions and other educational activities for people engaged in practical forestry. The major excursion during 2017 was organised in collaboration with the Southern Swedish Forest Research Centre at SLU, but we also participated in numerous other excursions and meetings. A course in regeneration and



forest production was provided for forest managers in the company Skogssällskapet.

Mixed forest. Photo: Mats Hannerz.

There has been quite a lot of media attention regarding the recovery of the Sala fire site, and the principal investigator (M-C Nilsson-Hegethorn) has contributed to public information through several interviews. Land owners' interest in the project has also been evident during 2017.

During the autumn of 2017, the FRAS research project was started. Participants include six PhD-students, and researchers engaged in Theme 3 projects will act as supervisors for many of them. A workshop was arranged by FRAS and TC4F team members, and similar workshops will be held during the coming years.

Major Theme 3 activities have included research on ways to cultivate fast-growing broadleaves on forest land. The research has resulted in practical recommendations for regeneration of poplar, which have been disseminated to forest managers in southern Sweden. This extension-activity will continue during the coming years and we anticipate that results from projects linked to Theme 3 will substantially facilitate effective use of poplar in southern Swedish regenerations.



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

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

### Overall progress in 2017

Some of the many projects addressing **Theme 4** have achieved major advances. Notably, in the study on carbon allocation in barley a molecular “Yin-Yang system” was found that regulates carbon fluxes, and thus determines the end products. The finding was highlighted on the front cover of the journal *Molecular Plant* (Impact Factor 8.8). One publication in *JoVE* showed our results in video format, and a substantial number of publications in applied journals have clearly demonstrated the applicability of the findings. Efforts associated with Theme 4 have resulted in a number of peer-reviewed publications, several PhD or Master’s theses, and new PhD students have joined associated project teams. We have also obtained a number of research grants linked to the TC4F program.

### Main findings in 2017

We have found a system in barley involving a single gene with two alternative promoters that can generate two transcription factors with opposing functions in sucrose sensing. The system can be exploited in barley breeding to produce healthy food ingredients with tailored amounts of fructan and dietary fibre. The findings were a cover story of an issue of *Molecular Plant* (Jin *et al.* 2017).

We found that thermally processed films from isoelectrically precipitated protein may have stronger mechanical properties than those from supernatants. Alkaline extraction and isoelectric precipitation were the most promising methods to produce preparations with high protein content, strong protein-protein interaction and mechanical behaviour.



Successful field trapping experiment in China of Diamond moth with plant derived pheromone formulation. Photo: Jianqing Day.



We have shown that water welding could scale up the production of freeze-dried foams from plant protein, yielding larger and stronger pieces of foam. Furthermore, we have used flax-fibre-weaves to considerably improve the strength of biocomposites and audio-visually recorded the production of *Crambe*/wheat gluten blends. Additionally, transglutaminase from a novel strain of *Streptomyces* showed promising effects in wheat dough and protein-based systems.

Results of nano-fibril production from proteins extracted from faba beans, mung beans and lupins have been inconsistent and require verification, but our collaborative studies with KTH on nano-fibrils from whey protein have been presented in a paper published in 2018.

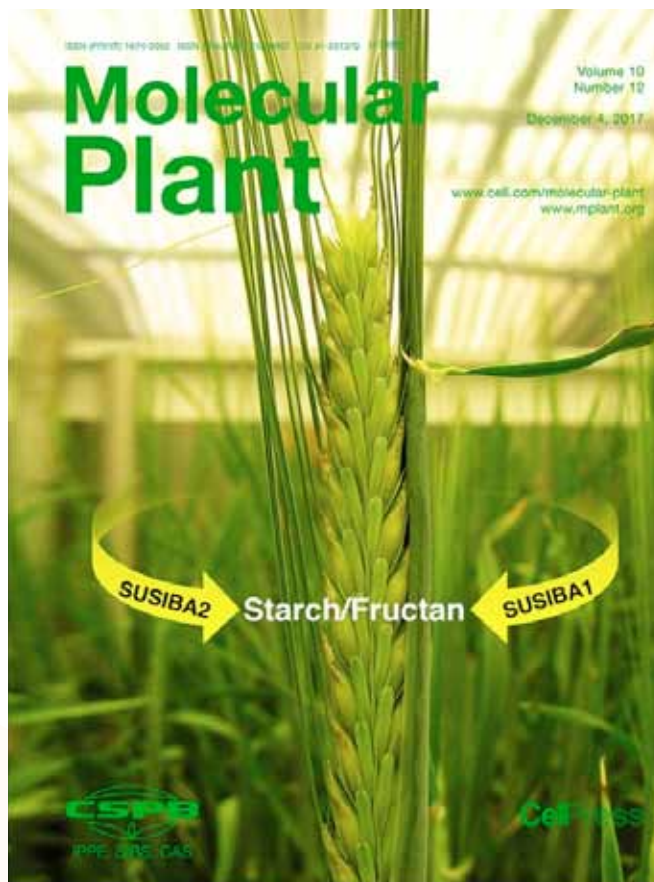
Use of horticultural wastes was introduced as a strategic project in 2017. Side-streams of *Brassica* vegetables, kale and broccoli have been collected for chemical analyses. In these efforts we are collaborating with SLU's Department of Molecular Sciences for fibre analysis. Analytical protocols are being established for analysis of phenolic compounds.

In a field trial we found that a hybrid *Crambe* line with higher quality wax esters than the parental line also had 30% higher wax ester contents under normal field conditions. We have also studied the roles of diacylglycerol acyltransferases in regulation of oil quantities and quality in *Crambe*.

We have stacked improved traits into single breeding lines in field cress (*Lepidium campestre*), which will be used in further breeding of the species. We have also initiated a protoplast regeneration system for this species to be used for genome editing.

We have found some interesting indications of autoregulation between the *WRI1* protein and cis-controlling elements of the *WRI1* gene. We have made some interesting observations on transcription factors (TFs) involved in embryo development and oil accumulation, which provide foundations for further studies of TFs that participate in oil induction and accumulation. New candidate TFs involved in oil production in nutsedge tubers have been identified. We have likely identified all critical Solanaceous factors for oil induction.

In efforts to produce insect pheromones in *Camelina sativa*, we have converted purified Z11-16:Acid into alcohol and the corresponding acetate and aldehyde, in batches with



On the cover: A single gene generates two transcription factors *SUSIBA1* and *SUSIBA2* via two alternative promoters, and orchestrates the sucrose-coordinated synthesis of starch and fructan in barley. Image: Chuanxin Sun.



high purity. A Diamondback moth field trapping experiment in China showed that an appropriate mixture of these compounds was as effective as a synthetic mixture even at 38% purity. We have also produced pheromone molecules and precursors as parts of wax esters in *Camelina*.

Genetic abrogation of autophagy in *Arabidopsis* facilitates degradation of lipid droplets in cotyledons upon seed germination. Analyses of *Arabidopsis* lines with altered levels of autophagy grown in a large trial, in collaboration with Dirk Inze's group, have revealed that overexpressing autophagy-related (ATG) genes has strong conditional effects on the plants' behaviour.

We have found that overexpression of *ATG5* and *ATG7* may have beneficial effects on a range of fitness traits. In collaboration with groups headed by Daniel Hofius and Richard Vierstra, we have also found that increased susceptibility to virulent bacterial pathogen was the first fitness cost of constitutively enhanced autophagy.

"Haemoglobin Production in Plants" is another strategic project initiated in 2017. The ultimate goal is to produce a blood substitute for oxygen transport for medical purposes. We have already successfully produced, for the first time, milligram quantities of human haemoglobin in tobacco, through transient expression of a customised construct.

## Contributions to social benefit

Some of our results will have long-term social impacts, while others will have short-term benefits. The finding of the Yin-Yang system has helped to generate five new barley lines with higher fibre contents, thereby adding value to barley for health purposes. These lines have been tested in the field and will be used by Lantmännen for commercial production. The major production of vegetable oil is limited to a few crop species and demands for vegetable oil are expected to rise in the future for food, biofuels and industrial purposes. We are exploring novel tissues and species for oil production, particularly crop species for which extraction infrastructure is already in place and oil biosynthesis could provide an additional valuable processing side stream.

New knowledge has been obtained on novel potential uses of proteins produced from plant residues. Oilseeds can be used not only for extracting oils, but also for producing plastic from the seedcakes. We have tried to use *Crambe*

seedcakes to produce various products, which would increase the value of the crop and replace fossil-based plastics. Today more than half of the plants are not harvested or discarded after harvest, so efficient utilization of such wastes would substantially reduce environmental impacts.

Using pheromones in integrated pest management is environmentally benign in comparison to using insecticides. Pheromones are typically used in traps or dispensed for mating disruption and the blends used can be very species specific. Moreover, plant-based fatty acid derivatives used for insect pheromone production are renewable and more environmentally friendly than synthetic alternatives.

The demand for donated blood and blood products is increasing, especially in rapidly developing countries. The number of blood donors is not matching the demands and blood has short storage ability. A blood substitute can provide clinical benefits in terms of availability, safety and convenience. Development of plant-based blood substitutes would contribute to saving lives and human health.

A Vinnova-funded project entitled "the Plant Protein Factory" was initiated in 2017. Industrialists and academics will cooperatively build a pilot factory in Stage 2 of the project, which will commence in 2018, following major further outreach activities in 2017. Personnel and resources affiliated with Theme 4 have also contributed to the formation of initiative "Grogrund", together with a 90 million SEK grant from the government for 2018-2020 to seed the collaborative venture.



Barley with higher fibre content. Photo: Mats Hannerz.



Photo: Mats Hannerz.

# TC4F in 2017

## 4 December

The *SUSIBA1* and *SUSIBA2* transcription factors covers the issue of *Molecular Plant*.



## 20 November

Nils Henriksson defends the thesis "Tree carbon partitioning, respiratory efficiency, and nitrogen acquisition."



## 27 October

Ove Nilsson and Stefan Jansson give lectures at the symposium "Treenomics - from genomic information to business opportunities" to the honour of Marcus Wallenberg Prize winner.



## 25 August

Qiong Wu defends the thesis "Biofoams and biocomposites based on wheat gluten proteins".



## 6 July

A CRISPR/Cas9 meal is served at a Michelin-star restaurant during the symposium "New breeding technologies in the plant sciences - applications and implications in genome editing".





**24 February**

Signe Lett defends the thesis "Mosses as mediators of climate change: Implications for tree seedling establishment in the tundra."



**29 March**

Chuanxin Sun receives the Physiologia Plantarum award for the *SUSIBA2* low-methane rice.



**19 May**

Docent lecture of Ramone Kuktaite: "A new approach to capture the secrets of plant protein structure and function".



**2-5 July**

Li-Hua Zhu and Per Hofvander organizes the 8<sup>th</sup> European Symposium on Plant Lipids in Malmö.

# TC4F publications and activities 2017

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 2017 Theme 1 has published 22 peer reviewed scientific articles in international journals.

Bandau, F., **Albrechtsen, B.R.**, Julkunen-Tiitto, R., **Gundale, M.J.** 2017. Genotypic variability in *Populus tremula* L. affects how anthropogenic nitrogen enrichment influences litter decomposition. *Plant and Soil* 410, 467-481.

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Chen, Z.Q., Karlsson, B., Wu, H.X. 2017. Patterns of additive genotype-by-environment interaction in tree height of Norway spruce in southern and central Sweden. *Tree genetics and genomes* 13:25.

Decker, V.H.G., Bandau, F., **Gundale, M.J.**, Cole, C.T., **Albrechtsen, B.R.** 2017. Aspen phenylpropanoid genes' expression levels correlate with genets' tannin richness and vary both in responses to soil nitrogen and associations with phenolic profiles. *Tree Physiology* 37, 270-279.

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Edlund, E., Novak, O., Karady, M., Ljung, K., **Jansson, S.** 2017. Contrasting patterns of cytokinins between years in senescing aspen leaves. *Plant, Cell & Environment*, 40, 622-634.

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Kucukoglu, M., Nilsson, J., Zheng, B., Chaabouni, S., **Nilsson, O.**, 2017. WUSCHEL-RELATED HOMEBOX4 (WOX4)-like genes regulate cambial cell division activity and secondary growth in *Populus* trees. *New Phytologist* 215, 642-657.

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Li, Z., De La Torre, A.R., Sterck, L., Canovas, F.M., Avila, C., Merino, I., Cabezas, J.A., Cervera, M.T, **Ingvarsson, P.K.**, Van de Peer, Y. 2017. Single-copy genes as molecular markers for phylogenomic studies in seed plants. *Genome Biology and Evolution*, 9, 1130-1147.

Michelson, I.H., **Ingvarsson, P.K.**, **Robinson, K.M.**, Edlund, E., Eriksson, M.E., **Nilsson, O.**, **Jansson, S.** 2018. Autumn senescence in aspen is not triggered by day length. *Physiologia Plantarum* 162: 123-134.

Myking, T., Tvedt, M.W., Karlsson, B. 2017. Protection of forest genetic resources by intellectual property rights (IPR) – exploring

possibilities and conceivable conflicts. *Scandinavian Journal of Forest Research* 32, 598-606.

Ponzio, C., Papazian, S., **Albrechtsen, B.R.**, Dicke, M., Gols, R. 2017. Dual herbivore attack and herbivore density affect metabolic profiles of *Brassica nigra* leaves. *Plant, Cell & Environment* 40,1356-1367.

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Sundell, D., **Street, N.R.**, Kumar, M., Mellerowicz, E.J., Kucukoglu, M., Johnsson, C., Kumar, V., Mannapperuma, C., Delhomme, N., Nilsson, O., Tuominen, H., Pesquet, E., Fischer, U., Niittylä, T., Sundberg, B., Hvidsten, T.R. 2017. AspWood: High-spatial-resolution transcriptome profiles reveal uncharacterized modularity of wood formation in *Populus tremula*. *Plant Cell* 29,1585

**Tan, B.**, Grattapaglia, D., Salgado Martins, G., Zamprogno Ferreira, K., Sundberg, B., **Ingvarsson, P.K.** 2017. Evaluating the accuracy of genomic prediction of growth and wood traits in two *Eucalyptus* species and their F1 hybrids. *BMC Plant Biology*, 17, 110.

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Zhang, B., Holmlund, M., Lorrain, S., Norberg, M., Bakó, L., Fankhauser, C., **Nilsson, O.** 2017. BLADE-ON-PETIOLE proteins act in an E3 ubiquitin ligase complex to regulate PHYTOCHROME INTERACTING FACTOR4 abundance. *eLife* 6:e26759.

## Popular scientific publications

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**Lee, N.** 2017. Short announcement: Första spadtaget... Nytt forskningsnätverk kring nordbiets hälsa. Nordbi aktuellt ([www.nordbi.se](http://www.nordbi.se)). Nr 2, page 5.

## Interviews and presence in media

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**Jansson, S.** 2017. Kunder rädda för GMO. Intervju i *Umeå Tidning* 4/2017 s 6. <http://www.umeatidning.se/index.php/tidningsarkiv/tidningsarkiv-2017>.

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**Jansson, S.** 2017. Die gute Seite der Gentechnik. Intervju i Süddeutsche Zeitung 24/3 2017. [www.sueddeutsche.de/wirtschaft/samstagsessay-an-die-gruene-substanz-1.3434739?amp](http://www.sueddeutsche.de/wirtschaft/samstagsessay-an-die-gruene-substanz-1.3434739?amp). Översättning i <http://ajstein.tumblr.com/post/158941310410/the-positive-side-of-genetic-engineering-sz>.

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**Lee, N., Nilsson, I.** 2017. Interview in Västerbottenskuriren, 13 March 2017, page 38.

**Lee, N., Stål, O.** 2017. News report: Stor rymdkonferens om astrobiologi i Umeå. Folkbladet, 17:e oktober 2017, page 8.

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**Lee, N., Wynne, A.** 2017. News report: Astrobiologi för livet på jorden. Västerbottens kuriren. 14 oktober 2017, page 13.

**Lee, N.** 2017. TV interview about the Astrobiology workshop in Umeå, in svt1's morgonstudie, with André Pops and Caroline Neurath, 17 oktober 2017.

## Scientific presentations

Almqvist, C., Högberg, K.-A. 2017. Scots pine in south and central Sweden. Konferensbidrag HealGenCar, Riga 19-20 April.

**Andersson Gull, B., Almqvist, C., Rosenberg, O., Wennström, U.** 2017. Consequences and mitigation of pest damage in Swedish



Norway spruce seed orchards. IUFRO Seed Orchard Conference, Bålsta, Sweden, 4–6 Sep.

**Andersson Gull, B.,** Almqvist, C., Rosenberg, O., **Wennström, U.** 2017. Betydelsen av skadegörare i fröplantager. Föredrag KSLA, 9 March.

Berlin, M. 2017. Trans-national collaboration in tree breeding and use of forest reproductive material (FRM). Konferensbidrag HealGenCar, Riga 19-20 April.

Funda, T., **Wang, X-R., Wennström, U.,** Almqvist, C., **Andersson Gull,, B.** 2017. Evaluation of large isolation tents for high-quality seed production in a Scots pine seed orchard. Poster presentation at IUFRO Seed Orchard conference, Bålsta. Sweden, 4 - 6 Sep.

**Hall, D.** 2017, Using next generation sequencing to distinguish genotypes and establish marker set for pollen contamination and adaptive differences between uncontaminated, outcrossed and natural stand seedlings; procedures, problems and prospects. Invited talk, IUFRO Seed Orchard conference, Bålsta. Sweden, 4 - 6 Sep.

HealGenCAR Workshop Application of SNP data in forest genetics, 14-17 November 2017 in Umeå, Sweden. Skogforsk arrangör och deltagare.

Helmersson, A. 2017. Trans-national collaboration in southern Sweden. Konferensbidrag HealGenCar, Riga 19-20 April.

**Jansson, S.** 2017. Forestry in Nordic bioeconomy: natural variation and genome editing. Invited talk, 60th anniversary of the Department of Biochemistry, Turku university, Turku Finland 11-12 May.

**Jansson, S.** 2017. Natural variation in aspen. Invited seminar, Helsinki University, Finland, 18 Jan.

**Jansson, S.** 2017. How can spruce needles be green in the winter? Invited talk, SE2B meeting, Frankfurt, Germany, 15-16 March.

**Jansson, S.** 2017. The Scandinavian Plant Physiology Society: Challenges in the North. Invited talk NorPlantBio-möte, Hamar, Norge 21 June 2017.

**Jansson, S.** 2017. How can spruce needles be green in the winter? Invited talk, SEB conference, Gothenburg, Sweden July.

**Jansson, S.** 2017. The first(?) CRISPR gene edited meal, Invited talk, SEB workshop on NBT, July, Gothenburg, Sweden.

**Jansson, S.** 2017. Genome editing using CRISPR/Cas9 in plants and the EU GMO legislation. Invited talk, Korean Society for Molecular and Cellular Biology annual meeting, Seoul, South Korea 11 Sep.

**Jansson, S.** 2017. Natural variation in aspen. Invited seminar, Seoul National University, South Korea, 13 Sep.

**Jansson, S.** 2017. Natural Variation, Genomics and Biotechnology. Invited talk, Marcus Wallenberg Prize-symposium, Grand Hotel, Stockholm. 27 Oct .

**Jansson, S.** 2017. Natural variation in aspen, Invited talk, CEPLAS meeting, Cologne, Germany, 19-20 Oct.

**Jansson, G.** 2017. What is needed to perform joint testing across countries? Konferensbidrag HealGenCar, Riga 19-20 April.

Lehto, K., Kauko, A., Nurmi, P., Lee, N., Chatzitheodoridis, E., Lehto, H. 2017. eTimeTrek: digital deep history of the Universe. Proceedings article from the International Symposium on Education in Astronomy and Astrobiology, Utrecht, The Netherlands, 3-7 July 2017, <http://astrobiology-campus.eu/3-7-july-2017-utrecht-the-netherlands-the-international-symposium-on-education-in-astronomy-and-astrobiology/>

**Lee, N.** (and the international BIOMEX team with Jean Pierre de Vera et al). 2017. Lecture: Bacteria, phototrophs and plants in space. Årsmöte för SWAN 2017: Konferens i astrobiologi – om liv på jorden och ute i universum, Umeå Universitet, 16-17 Oktober 2017.

**Lee, N.** 2017. Lecture: Science & Fiction – Are we ready to meet life in the universe? Årsmöte för SWAN 2018: Konferens i astrobiologi – om liv på jorden och ute i universum, Umeå Universitet, 16-17 Oct.

**Lee, N.** 2017. Visions on new projects for regional development and education. Joint Arctic Agenda workshop in Luleå 13-14 Sep.

Organiser of the Annual meeting of the Swedish Astrobiology Network (SWAN): 17-18 October 2017, in Umeå.

**Nilsson, O.** 2017. FT paralogs control the annual growth cycle and latitudinal adaptation in Aspen trees. Invited talk. Geneva University, Switzerland. 3 May.

**Nilsson, O.** 2017. FT paralogs control the annual growth cycle and latitudinal adaptation in Aspen trees. Invited talk. University of Lausanne, Switzerland. 4 May.

**Nilsson, O.** 2017. Building a strong research and innovation environment. The example of UPSC. Invited talk at the Scandinavian Plant Physiology Society. Nådendal, Finland. Geneva University, Switzerland. August 16-17.

**Nilsson, O.** 2017. Photoperiodic regulation of tree growth and development and presentation of Umeå Plant Science Centre. Invited talk. Beijing Forestry University, China. 4-5 Sep.

**Nilsson, O.** 2017. FT paralogs control the annual growth cycle and latitudinal adaptation in Aspen trees. Invited talk. INRA Versailles, France. 23-24 Oct.

**Nilsson, O.** 2017. Forest biotechnology. Invited talk. Markus Walenberg Prize Symposium, Stockholm. 27 Oct. **Wang, X-R.** 2017, Seed orchard – linking basic research and forest production. Invited talk, IUFRO Seed Orchard conference, Bålsta. Sweden, 4 - 6 Sep.

**Nilsson, O.** 2017. Bridging the valley of death - building a strong research and innovation environment at UPSC. Invited talk. Foundation for Strategic Research symposium, Sigtuna. 28 Nov.

**Persson, T.** 2017. The use of Finnish material in northern Swedish *Pinus sylvestris* trials. Konferensbidrag HealGenCar, Riga 19-20/4.

Sheldrake, M, **Lee, N.** 2017. Poster: Basic challenges in life sciences. Årsmöte för SWAN 2017: Konferens i astrobiologi – om liv på jorden och ute i universum, Umeå Universitet, 16-17 Oktober 2017.

**Wang, X-R.** 2017, Seed orchard – linking basic research and forest production. Invited talk, IUFRO Seed Orchard conference, Bålsta. Sweden, 4 - 6 Sept. 2017.

## Popular scientific presentations at meetings or excursions

**Albrechtsen, B.** 2017. "Om växter och deras försvar". UR samtiden. <https://urskola.se/Produkter/200795-UR-Samtiden-Fascinerande-vaxter-Om-vaxter-och-deras-forsvar>.

Christensen, B., Emtenäs, M., **Jansson, S.**, Klaminder, J., Lejon, K., Norqvist, P., Rudälv, C., Telifatides, S. 2017. Levande frågelåda för sjätteklassare Umeå universitet 17 May.

**Jansson, S.** 2017. Miljöbalkens påverkan på forskning och utveckling. Föredrag på Gentekniknämnden 25 Jan.

**Jansson, S.** 2017. How can modern biotechnology contribute to a sustainable agriculture? Föredrag på IVAs konferens Hållbart jordbruk – vad innebär det idag och i framtiden? 29 Jan.

**Jansson, S.** 2017. GMO – Går det att förbjuda något som inte går att definiera? Föredrag på Vetenskapslunch, Kafe Station Umeå 22 Feb.

**Jansson, S.** 2017. Hur vet egentligen trädet att det är host? UR Samtiden 9 March. <https://www.upsc.se/about-upsc/downloads/videos/5200-media-a-downloads-3.html>.

**Jansson, S.** 2017. First CRISPR meal served, did it taste good? Föredrag på ChemBio, Helsinki, Finland 30 March.

**Jansson, S.** 2017. The first(?) CRISPR meal served. Föredrag för Umu Alumner i Shanghai, Kina 8 April.

**Jansson, S.**, Manzoor, A., Sturmark, C., Wedell, A. 2017. PI-samtal om genomitering. Fri Tanke förlag 15 May.

**Jansson, S.** 2015. Lokal koordinatör för Fascinerande växters dag 20 May.

**Jansson, S.** 2017. The Brave New World of Plants. Föredrag på FoodTech Stockholm konferens 2 June.

**Jansson, S.** 2017. Vad är GMO? - Teknik, lagstiftning, forskning, debatt- Föredrag för Måltidsekologistudenter, Örebro Universitet 7 Sep.

**Jansson, S.** 2017. Vad kan man åstadkomma med genkniven CRISPR/Cas9 – och kommer man att få tillstånd till det? Föredrag på Senioruniversitetet Stockholm 16 Sep.

**Jansson, S.** 2017. CRISPR/Cas9-tekniken och framtidens grödor. Föredrag på Senioruniversitetet Uppsala 23 Nov.

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

**Bildmuseet** (for arranging an art exhibition on insect hotels) - N. Lee.

**Nordbi-föreningen** (an organisation with the mission to save the threatened honeybee species "the Nordic honeybee, *Apis mellifera mellifera*) - N. Lee.

**Skogforsk**, directly involved in the theme, is partially financed by the forestry industry. Through the channels of the UPSC Berzelii Centre for Forest Biotechnology, we collaborate with most of the big forestry companies in Sweden.

**SCA Obbola** regarding course development of courses within the bio resource engineer program: Bio-resource-Design (5BI224), Build (5BI226), Test (5BI227), Umeå University.

**Studieförbundet Vuxenskolan**, Umeå (on teaching about plant-insect activities to the public). - N. Lee.

**Umeå kommun** (for the nature trail "Tidsresan" and pollinating insects) - N. Lee.

**Uminova holding** (for the nature trail "Tidsresan" and pollinating insects) - N. Lee.

## Other funding

**Ingvarsson, P.**, "Climate-adapted poplar through more efficient breeding and better tools for matching genotype and site - developing the poplar bio-economy market in Sweden".

**Lee, N.** 300 k SEK were obtained from the KBC board at UmU for a 3 year period in order to establish the "FISH" method development, research collaborations and courses (the first courses will run in 2018).

**Lee, N.** 50 kSEK from Uminova holding for the nature trail "Tidsresan" and pollinating insects).

**Lee, N.** 20 kSEK from the Arctic research center (Arcum) for the nature trail "Tidsresan" and pollinating insects).

**Lee, N.** Travel grant and sequencing support for plant-microbial analyses on stressed phototrophic model organisms from the Horizon 2020 program "Europlanet".

**Wang, X-R.**, "Long-term sustainable forest production: knowledge-based strategies in seed orchard and reforestation operations" – Formas funded project in collaboration with Skogforsk.

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

## Other funding

**Street, N.** SciLifeLab National Projects 2017 "Diversity impacts on the belowground metacommunity associated with contrasting nitrogen fertilization sources". 500 kSEK. Project ID NP0081.

**Wang, X-R.** VR 2018-2021. Dynamics of hybrid speciation and adaptation to extreme habitats. 3 250 kSEK

## Investments in research infrastructure

Funds have been used to maintain field sites for studies on natural variation in aspen (the SwAsp gardens in Ekebo and Sävar) and transgenic aspens (In Våxtorp).

## Education

### - PhD theses, MSc theses, Bachelor theses

Diez Rodriguez, B. 2017. MSc thesis: Genotypic variability of *P. tremula* resistance traits against aphid herbivory. Supervisor: **Benedicte Riber Albrechtsen.**

Fagnäs, Z. 2017. MSc thesis: Biogeography of Norway spruce (*Picea abies* (L.) Karst.). Department of Ecology and Environmental Sciences, Umeå University, oai:DiVA.org:umu-132875. Supervisor: **Xiao-Ru Wang.**

**Sundell, D.** 2017. Doctoral thesis: Novel tools enabling future bio-energy research in forest tree species: Umeå University. ISBN: 978-91-7601-707-4.

Papazian, S. 2017. Doctoral thesis: Black mustard and the butterfly effect. Metabolomics of plant-insect interactions under multiple stress conditions. Supervisor: **Benedicte Riber Albrechtsen**, Co-supervisor Thomas Moritz.

## - Supervision and teaching

**Albrechtsen, B.** Main supervisor for MSc-candidate Sara Westman. Chemical priming of seeds for enhanced crop resistance. Expected dissertation: June 2018

**Albrechtsen, B.** Main supervisor for MSc-candidate Cecilia Ström. Imaging aphid feeding to detail resistance traits in the phloem. Co-supervisor: Karen Kloth. Expected dissertation: June 2018

**Albrechtsen, B.** Course planning and development within the bio resource engineer program: Bio-resource-Design (5BI224), Build (5BI226), Test (5BI227) 15+7.5+15= 37.5 HP or ECT, Umeå University.

**Albrechtsen, B.** Lab development: Biological stress on course Plant Growth and Development

**Albrechtsen, B.** Course organizer and teach Plant Production systems (5BI205) 7.5hp, Bio-resource-Design (5BI224) 15hp, Umeå University.

**Albrechtsen, B.** Teaching single lectures at the courses Växter som råvaruproducenter (5BI189) and Plant Growth and development (5BI210) 15hp.

**Ingvarsson, P.** Main supervisor for PhD-candidate Biyue Tan Tentative title: Genomic selection in *Eucalyptus*. Expected date for dissertation: April, 2018

**Ingvarsson, P.** Main supervisor for PhD-candidate Xi Wang. Tentative title: Whole-genome re-sequencing in Norway spruce. Expected date for dissertation: March, 2020

**Ingvarsson, P.** Main supervisor for PhD-candidate Rami-Petteri Apuli. Tentative title: Climate-adaptation in aspen. Expected date for dissertation: April, 2021

**Ingvarsson, P.** Main supervisor for PhD-candidate Helena Dahlberg Tentative title: Effects of forestry practice and breeding in genetic variation in natural stands of Norway spruce. Expected date for dissertation: March, 2021

**Ingvarsson, P.** Teaching at the course "Genetik, Cellbiologi och Mikrobiologi" (BI1278), 15 ECTS, Uppsala.

**Ingvarsson, P.** Teaching at the course "Genetic diversity and plant breeding" (BI1103), 15 ECTS, Uppsala.

**Jansson, S.** Main supervisor for PhD-candidate Pushan Bag. Tentative title: Winter adaptation of photosynthesis in conifers. Expected date for dissertation: Feb. 2022.

**Jansson, S.** Teaching at the course "Plant biotechnology and molecular breeding" 15 ECTS, Umeå.

**Jansson, S.** Teaching at the course “Plant growth and development” 15 ETCS, Umeå.

**Jansson S.** Teaching at the course “Livsmedelssystemets roll i en hållbar utveckling” 15 ETCS, Örebro University,

**Jansson S.** Teaching at the course “Inledande ingenjörskurs i Bioteknik” (5MO072), 7.5 ECTS, Umeå Universitet.

**Jansson, S.** Teaching at the course “Inledande ingenjörskurs i Bioresursteknik” 7.5 ECTS, Umeå University.

**Jansson, S.** Teaching at the course “Plant Biology and biotechnology” 15 ECTS, Umeå University.

**Jansson, S.** Teaching at the course Plant biology – for future forestry, 7.5 ECTS, SLU, Umeå.

**Lee, N.** Ingvild Loubet, 3 months (June-September 2017) undergraduate internship on the project on plant-microbial-insect relations.

**Nilsson, O.** Main supervisor for PhD-candidate Shashank Sane. Tentative title: Regulation of the juvenility-to-maturity transition in trees. Expected date for dissertation: December, 2018.

**Nilsson, O.** Main supervisor for PhD-candidate Dominique André. Tentative title: The role of FT-like genes in the control of tree phenology. Expected date for dissertation: December, 2019.

**Street, N.** Main supervisor for PhD-candidate Andreas Schneider. Tentative title: The effects of nitrogen on the metacommunity associated with Norway spruce and Scots pine. Expected date for dissertation: August, 2021.

**Street, N.** Main supervisor for PhD-candidate Barbara Terebeinic. Tentative title: The control of leaf development in *Populus tremula*. Expected date for dissertation: August, 2018.

**Street, N.** Co-supervisor for PhD-candidate Julia Haas. Expected date for dissertation: Oct, 2018.

**Street, N.** Main supervisor for Master student Janis Szeremeta. Title: Developing a pipeline for processing metagenomics amplicon data. 15 ECTS.

**Street, N.** Main supervisor for Master student Wei Meng. Title: The potential role of the phyllospheric microbiota of Norway spruce (*Picea abies* (L.) H. Karst) in biological nitrogen fixation. 15 ECTS

**Street, N.** Course organizer and teaching at the course “Functional genomics theory”, (5BI211), 7.5 ECTS, Umeå University.

**Street, N.** Course organizer and teaching at the course “Applied Functional genomics”, (5BI212), 7.5 ECTS, Umeå University.

**Wang, X-R.** Main supervisor for PhD-candidate Alex Sullivan. Tentative title: Biogeography and evolutionary history of Norway spruce. Expected date for dissertation: Dec. 2018.

**Wang, X-R.** Main supervisor for PhD-candidate Hanhan Xia. Tentative title: Landscape genetics of *Pinus tabuliformis*. Expected date for dissertation: Nov. 2018.

**Wang, X-R.** Teaching at the course “Evolutionary Biology” 15 ETCS, Umeå University .

**Wang, X-R.** Teaching at the course “Theoretical Ecology” 15 ETCS, Umeå University.

**Wang, X-R.** Teaching at the course “Genetics and Evolution” 30 ETCS, Umeå University.

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

## Scientific publications

During 2017 Theme 2 has published 29 peer-reviewed scientific articles in international journals.

Blackburn, M., Laudon, H., **Näsholm, T.**, Sponseller, R.. 2017. Evaluating hillslope and riparian contributions to dissolved nitrogen (N) export from a boreal forest catchment. *Journal of Geophysical Research – Biogeosciences* 122, 324-339.

Breinl, K., Di Baldassarre, G., Girons Lopez, M., Hagenlocher, M., **Vico, G.**, Rutgeresson, A. 2017. Can weather generation capture precipitation patterns across climates, spatial scales and under data scarcity? *Scientific Reports* 7, 5449.

Buckley, S., Brackin, R., **Näsholm, T.**, Schmidt, S., **Jämtgård, S.** 2017. Improving in situ recovery of soil nitrogen using the microdialysis technique. *Soil Biology and Biochemistry* 114, 93-103.

Del Campo, A., González-Sanchis, M., Lidón, A., Bautista, I., Lull, C., García-Prats, A., **Ruiz-Pérez, G.**, Francés, F. Ecohydrological-based forest management in semiarid forests: the only way forward to address current challenges. *Ecological Studies. Analysis and Synthesis*, Springer.

Dralle, D., Karst, N., Müller, M., **Vico, G.**, Thompson, S. 2017. Stochastic modelling of inter-annual variation of hydrologic variables. *Geophysical Research Letters* 44,7285-7249.

**Franklin, O.**, Cambui, C., **Palmroth, S.**, **Oren, R.**, **Näsholm, T.** 2017. The carbon bonus of organic nitrogen enhances nitrogen use efficiency of plants. *Plant Cell & Environment* 40, 25-35.

Ganeteg, U., Ahmad, I., **Jämtgård, S.**, Cambui, C., Inselsbacher, E., Svennerstam, H., Schmidt, S., **Näsholm, T.** 2017. Amino acid transporter mutants of Arabidopsis provides evidence that a non-mycorrhizal plant acquires organic nitrogen from agricultural soil. *Plant Cell & Environment* 40, 413-423.

Hedwall, P-O., Gruffman, L., Ishida, T., From, F., Lundmark, T., **Näsholm, T.**, **Nordin, A.** 2017. Can the performance of forest fertilization be enhanced by the use of an organic fertilizer? *Plant and Soil*, accepted.

**Högberg, P.**, **Näsholm, T.**, **Franklin, O.**, Högberg, M. 2017. On the nature of the nitrogen limitation to plant growth in Fennoscandian boreal forests. Tamm review. *Forest Ecology and Management*. doi: org/10.1016/j.foreco.2017.04.045.

**Hurry, V.** 2017. Metabolic reprogramming in response to cold stress is like real estate, it's all about the location. *Plant, Cell and Environment* 40, 599. 601.

**Jocher, G.**, Marshall, J., Nilsson, M., Linder, S., De Simon, G., Hörnlund, T., Lundmark, T., **Näsholm, T.**, Ottosson Löfvenius, M., **Tarvainen, L.**, Wallin, G., Peichl, M. 2018. Impact of canopy decoupling and subcanopy advection on the annual carbon balance of a boreal Scots pine forest as derived from eddy covariance. *Journal of Geophysical Research– Biogeosciences* 123, 303-325.

**Jocher, G.**, Ottosson Löfvenius, M., De Simon, G., Hörnlund, T., **Linder, S.**, Lundmark, T., Marshall, J., Nilsson, M., **Näsholm, T.**, **Tarvainen, L.**, Öquist, M., Peichl, M. 2017. Apparent winter CO2 uptake by a boreal forest due to decoupling. *Agricultural and Forest Meteorology* 232, 23-34.

**Kurepin, L.V.**, Ivanov, A.G., Zaman, M., Pharis, R.P., **Hurry, V.**, Hüner, N.P.A. 2017. Interaction of glycine betaine and plant hormones: Protection of the photosynthetic apparatus during abiotic stress. In: Hou, H.J.M., Najafpour, M.M., Moore, G.F., Allakhverdiev, S.I. (eds) *Photosynthesis: Structures, mechanisms, and applications*. Springer. pp.185-202.

Laitinen, T., Morreel, K., Delhomme, N., Gauthier, A., Schiffthaler, B., Nickolov, K., Brader, G., Lim, K-J., Teeri, T.H., **Street, N.R.**, *et al.* 2017. A key role for apoplastic H2O2 in Norway spruce phenolic metabolism. *Plant Physiology* 174, 1449–1475.

**Lim, H.**, **Oren, R.**, **Linder, S.**, From, F., **Nordin, A.**, Fahlvik, N., Lundmark, T., **Näsholm, T.** 2017. Annual climate variation modifies nitrogen induced carbon accumulation of *Pinus sylvestris* forests. *Ecological Applications* 27, 1836-1851.

**McMurtrie, R.E.**, **Näsholm, T.** 2018. Quantifying the contribution of mass flow to nitrogen acquisition by an individual plant root. *New Phytologist* 218, 119–130.

Metcalfe, D.B., Ricciuto, D., **Palmroth, S.**, Campbell, C., **Hurry, V.**, Mao, J., Keel, S.G., **Linder, S.**, Shi, X., **Näsholm, T.**, Ohlsson, K.E.A., Blackburn, M., Thoirnton, P.E., Orem, R. 2017. Informing climate models with rapid chamber measurements of forest carbon uptake. *Global Change Biology* 23, 2130-2139. (DOI: 10.1111/gcb.13451).

**Palmqvist, K.**, **Franklin, O.**, **Näsholm, T.** 2017. Symbiosis constraints: Strong mycobiont control limits nutrient response in lichens. *Ecology and Evolution* 7, 7420-7433.

O'Sullivan, O.S., Heskell, M.A., Reich, P.B., Tjoelker, M.G., Weerasinghe, K.W.L.K., Penillard, A., Zhu, L., Egerton, J.J.G., Bloomfield, K.J., Creek, D., Bahar, N.H.A., Griffin, K.L., **Hurry, V.**, Meir, P., Turnbull, M.H., Atkin, O.K. 2017. Thermal limits of leaf metabolism across biomes. *Global Change Biology* 23, 2098-223, (DOI: 10.1111/gcb.13477).

**Oyewole, O.**, Inselsbacher, E., **Näsholm, T.**, **Jämtgård, S.** 2017. Incorporating mass flow strongly promotes N flux rates in boreal forest soils *Soil Biology and Biochemistry* 114, 263-269.

**Ruiz-Pérez, G.**, Koch, J., Manfreda, S., Caylor, K., Francés, F. 2017. Calibration of a parsimonious distributed ecohydrological daily model in a data scarce basin using exclusively the spatio-temporal variation of NDVI. *Hydrology and Earth System Science* 21,12: 6235.

Schiffthaler, B., Bernhardsson, C., Ingvarsson, P.K., **Street, N.R.** 2017. BatchMap: A parallel implementation of the OneMap R package for fast computation of F1 linkage maps in outcrossing species. *PLOS ONE* 12, e0189256.

St-Martin, A., **Vico, G.**, Bergkvist, G., Bommarco, R. 2017. Diverse cropping systems enhanced yield but did not improve yield stability in a 52-year-long experiment, *Agriculture, Ecosystems and Environment* 247, 337-342.

Sundell, D., **Street, N.R.**, Kumar, M., Mellerowicz, E.J., Kucukoglu, M., Johnsson, C., Kumar, V., Mannapperuma, C., Delhomme, N., **Nilsson, O.**, Tuominen, H., Pesquet, E., Fischer, U., Niittylä, T., Sundberg, B., Hvidsten, T.R. 2017. AspWood: High-spatial-resolution transcriptome profiles reveal uncharacterized modularity of wood formation in *Populus tremula*. *Plant Cell* 29,1585.

**Tarvainen, L.**, **Näsholm, T.** 2017. Can adjustments in foliar nitrogen use efficiency reduce drought stress impacts on boreal trees? *Tree Physiology (commentary)* 37, 415-417.

**Tarvainen, L.**, Lutz, M., Rantfors, M., **Näsholm, T.**, Wallin, G. 2017. Temperature responses of photosynthetic capacity parameters were not affected by foliar nitrogen content in mature *Pinus sylvestris*. *Physiologia Plantarum* 162, 370-378.

**Tarvainen, L.**, Rantfors, M., Wallin, G. 2015. Seasonal and within-canopy variation in shoot-scale resource-use efficiency trade-offs in a Norway spruce stand. *Plant, Cell & Environment* 38, 2487-2496.

Torngern, P., **Oren, R.**, Oishi, A.C., Uebelherr, J.M., **Palmroth, S.**, **Tarvainen, L.**, Ottosson-Löfvenius, M., **Linder, S.**, Domec, J-C., **Näsholm, T.** 2017. Ecophysiological variation of transpiration of pine forests: synthesis of new and published results. *Ecological Applications* 27, 118-133.

**Vico, G.**, Dralle, D., Feng, X., Thompson, S.E., Manzoni, S. 2017. How

competitive is drought deciduousness in tropical forests? A combined eco-hydrological and eco-evolutionary approach, *Environmental Research Letters* 12, 065006.

## 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.

**Ruiz-Pérez, G.**, Besós, C. 2017. ¿Se puede calibrar un modelo de vegetación a través de la información proporcionada por satélites?, popular scientific blog iAgua, © iAgua 2017, iAgua Conocimiento CIF: B86645348. <https://www.iagua.es/noticias/espana-estados-unidos-kenia/iiama/16/05/12/iiama-calibra-modelo-vegetacion-traves>.

## Interviews and presence in media

Del Campo, A., González-Sanchis, M., Lidón, A., Bautista, I., Lull, C., García-Prats, A., **Ruiz-Pérez, G.**, Francés, F. 2017. La silvicultura ecohidrológica, idónea para la gestión forestal mediterránea. *La Vanguardia*, December 30. <http://www.lavanguardia.com/vida/20171230/433965991659/la-silvicultura-ecohidrologica-idonea-para-la-gestion-forestal-mediterranea.html>

**Vico G** was interviewed by the Uppsala Nya Tidningen in Jan 2017. An article describing her research was published on the same newspaper on 23 Jan. 2017, under the title Extremväder en utmaning för odlarna (part of the series 'Hej forskare!')

## Scientific presentations

de Oliveira, G., Brunsell, N.A., Sutherlin, C.E., Crews, T., **Vico, G.**, 2017. Assessing Water-use Relationships in a Perennial Kernza Field, 2017 Fall Meeting, AGU, New Orleans, LA, USA, 11-15 Dec.

Feng, X., Ackerly, D., Dawson, T.E., Manzoni, S., Skelton, R.P., **Vico, G.**, Thompson, S.E. 2017. The Ecohydrological Context of Drought and Classification of Plant Responses, 2017 Fall Meeting, AGU, New Orleans, LA, USA, 11-15 Dec.

García-Arias, A., **Ruiz-Pérez, G.**, Francés, F. 2017. Can a riparian model be spatially validated? Oral presentation at the 6th International Multidisciplinary Conference on Hydrology and Ecology, Birmingham, UK. 18-23 June.

García-Arias, A., **Ruiz-Pérez, G.**, Francés, F. 2017. Importance of ecohydrological modelling approaches in the prediction of plant behaviour and water balance at different scales. Poster presentation at the EGU General Assembly. Vienna, Austria, 23-28 April.

Manzoni, S., Porada, P., Winterdahl, M., Beer, C., Brüchert, V., Capek,

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

Manzoni, S., Čapek, P., Mooshammer, M., Thurner, M., Winterdahl, M., Beer, C., Brüchert, V., Caballero, R., Lindahl, B., Lyon, S., Richter, A., Šantrůčková, H., **Vico, G.** 2017. Way DA (2017), Nutrient constraints on metabolism from microbial communities to ecosystems, BIOGEOCONOMY, Litomyšl, Czech Republic, 20-24 August (Invited).

Manzoni, S., Berg, H., Lindborg, R., Lyon, S., Chau, T.D., Tumbo, M.A., **Vico, G.** 2017. Quantifying the trade-offs between ecosystem service provision and water management in rice systems, Sustainability and Resilience Workshop, Lund, Sweden, 6-7 March (Invited).

Muneepeerakul, C., **Vico, G.** 2017. Leave it more to aquifer? Characterizing potential benefits and unintended consequences of weather index insurance on irrigated cropland, Abstract C004831, JpGU-AGU Joint Meeting 2017, Makuhari Messe, Chiba, Japan, 20-25 May.

**Näsholm, T.** 2017. Keynote presentation. The root nitrogen perspective of soils. 8th International Symposium on Root Development Umeå, 29 May - 1 June.

**Ruiz-Pérez, G.**, Medici, C., Latron, J., Llorens, P., Gallart, F., Francés, F. On the use of three hydrological models as hypotheses to investigate the behaviour of a small Mediterranean catchment. Poster presentation at the EGU General Assembly. Vienna, Austria, 23-28 April.

**Ruiz-Pérez, G.**, **Vico, G.** 2017. The role of temperature and temperature-induced drought on forest productivity in the Northern Countries. Poster presentation at the EGU General Assembly. Vienna, Austria, 23-28 April.

Sutherlin, C.E., Brunsell, N.A., de Oliveira, G., Crews, T., **Vico, G.** 2017. Investigating the Sustainability of Perennial Agriculture, 2017 Fall Meeting, AGU, New Orleans, LA, USA, 11-15 Dec.

**Vico, G.**, Way, D.A., **Hurry, V.**, Manzoni, S. 2017. Can leaf net carbon gain acclimate to keep up with global warming? New Phytologist 39th Symposium "Trait covariation: Structural and functional relationships in plant ecology", Exeter, UK, 27-29 June.

**Vico, G.**, Brunsell, N. 2017. Implications for water use of a shift from annual to perennial crops – A stochastic modelling approach based on a trait meta-analysis, Abstract EGU2017-7828, EGU General Assembly 2017, Vienna, Austria, 24-28 April.

**Vico, G.** 2017. Can leaf net carbon gain acclimate to keep up with

global warming? invited presentation at the University of Gothenburg, Sweden, 11 April.

**Vico, G.** 2017. Proposal writing – A writer's perspective, invited presentation at Formas presentation of annual open calls KTH, Stockholm, Sweden, 9 March.

**Vico, G.** 2017. Acclimation of leaf net carbon gain under fluctuating and increasing temperatures, invited presentation at Forest Ecology and Management (FEM) Seminar Series, Department of Forest Ecology & Management, SLU, Umeå, Sweden, 23 Jan.

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

Collaboration with **Swe Tree technologies**, **Arevo AB** and **Holmen Skog AB**.

## Other funding

SciLifeLab National Projects 2017 "Diversity impacts on the belowground metacommunity associated with contrasting nitrogen fertilization sources". 500 KSEK. Project ID NP0081.

## Education

### - PhD theses, MSc theses, Bachelor theses

Zsofia Stangl (female.) 2017. Doctoral thesis: Acclimation of plants to combinations of stress factors: connecting the lab to the field. Main supervisor: **Hurry Vaughan**. ISBN 978-91-7601-700-5

Nils Henriksson (male). 2017. Doctoral thesis: Tree carbon partitioning, respiratory efficiency, and nitrogen acquisition. Thesis No. 2017:95. Supervisor: **Torgny Näsholm**, John Marshall and **Lasse Tarvainen**.

Hyungwoo Lim (male). 2017. Doctoral thesis: Interactive effects on biomass production between nitrogen and water availabilities in boreal forests. Thesis No. 2017:107. Supervisors: **Torgny Näsholm** and **Ram Oren**.

### - Supervision and teaching

**Ruiz-Pérez, G.** Teaching at the master-level course "Ecohydrology: a Mediterranean perspective", (GE7049), 7.5 ECTS, Stockholm University.

**Vico, G.** Course leader of and lecturer in the master-level course "Biology and production of agricultural plants" (B1258), 10 ECTS SLU.

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

**Vico, G.** Lecturer on 'Proposal writing' at the workshop 'How to become a postdoc?', co-organized by the Research Schools in the

Faculty of Natural Resources and Agriculture, SLU,

**Vico, G.** Teaching at the course “Ecohydrology: a Mediterranean perspective”, (GE7049), 7.5 ECTS, Stockholm University.

**Vico, G.** Main supervisor of Lucia Tamburino, postdoc at the Department of Crop Production Ecology, Swedish University of Agricultural Sciences, modelling the interactions and co-evolution of societies and managed ecosystems.

**Vico, G.** Main supervisor of G. Ruiz-Pérez, postdoc at the Department of Crop Production Ecology, Swedish University of Agricultural Sciences, modelling boreal forest response to summer climatic extremes.

**Vico, G.** Co-supervisor of A. Menegat, postdoc at the Department of Crop Production Ecology, Swedish University of Agricultural Sciences, modelling weed-crop interaction. Co-supervisor with L.

Andersson, U. Boström, A. Lundkvist, A.T.S. Nilsson, D. Hanson

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

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

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

**Vico, G.** Main supervisor of Marie Lalou, intern from University of Picardie ‘Jules Verne’, Amiens, France; research project on spring phenology and leaf gas exchange in poplar clones.



# Theme 3

## - Sustainable and adaptive forest management

### Scientific publications

During 2017 Theme 3 has published 22 peer-reviewed scientific articles in international journals.

Bandau, F., Albrechtsen, B.R., Julkunen-Tiitto, R., **Gundale, M.J.** 2017. Genotypic variability in *Populus tremula* L. affects how anthropogenic nitrogen enrichment influences litter decomposition. *Plant and Soil*, 410, 467-481.

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

Cintas, O., Berndes, G., Hansson, J., Poudel, B. C., Bergh, J., Börjesson, P., **Lundmark, T.** ... , **Nordin, A.** 2017. The potential role of forest management in Swedish scenarios towards climate neutrality by mid century. *Forest Ecology and Management* 383, 73-84.

Decker, V.H., Bandau, F., **Gundale, M.J.**, Cole, C.T., Albrechtsen, B.R. 2017. Aspen phenylpropanoid genes' expression levels correlate with genes' tannin richness and vary both in responses to soil nitrogen and associations with phenolic profiles. *Tree Physiology* 37, 270-279.

Egbäck, S., **Nilsson, U.**, Nyström K., Högberg K-A., Fahlvik, N. 2017. Modeling early height growth in trials of genetically improved Norway spruce and Scots pine in southern Sweden. *Silva Fennica* 51, article id 5662.

Fajardo, A., **Gundale, M.J.** 2018. Canopy cover type, and not fine-scale resource availability, explains native and exotic species richness in a landscape affected by anthropogenic fires and posterior land-use change. *Biological Invasions* 20, 385-398.

Fahlvik, N., Berglund, M., Hampus, H., **Nilsson U.** 2018. Simulation of the long-term effects of different strategies for precommercial thinning in *Pinus sylvestris*. *Scandinavian Journal of Forest Research* 33, 347-356.

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

Felton, A., Sonesson, J., **Nilsson, U.**, Lämås, T., **Lundmark, T.**, **Nordin, A.**, ... Roberge, J.M. 2017. Varying rotation lengths in northern production forests: Implications for habitats provided by retention and production trees. *Ambio* 46(3), 324-334.

Felton, A., Ranius, T., Roberge, J. M., Öhman, K., Lämås, T., Hynynen, J., **Lundmark, T.**, ... **Nordin, A.** 2017. Projecting biodiversity and wood production in future forest landscapes: 15 key modeling considerations. *Journal of Environmental Management* 197, 404-414.

Hedwall, P. O., Gruffman, L., Ishida, T., From, F., **Lundmark, T.**, Näsholm, T., **Nordin, A.** 2018. Interplay between N-form and N-dose influences ecosystem effects of N addition to boreal forest. *Plant and Soil* 423, 385-395.

**Holmström, E.**, Karlsson, M., **Nilsson, U.** 2017. Modeling birch seed supply and seedling establishment during forest regeneration. *Ecological Modelling*, 352, 31-39.

Jocher, G., De Simon, G., Hörnlund, T., Linder, S., **Lundmark, T.**, Marshall, J., ... Peichl, M. 2017. Apparent winter CO<sub>2</sub> uptake by a boreal forest due to decoupling. *Agricultural and Forest Meteorology* 232, 23-34.

Kwaaitaal, M., Nielsen, M., **Böhlenius, H.**, Thordal-Christensen, H. 2017. The plant membrane surrounding powdery mildew haustoria shares properties with the endoplasmic reticulum membrane. *Journal of experimental botany* 68, 5731-5743.

Lidberg, W., Nilsson, M., **Lundmark, T.**, Ågren, A. M. 2017. Evaluating preprocessing methods of digital elevation models for hydrological modelling. *Hydrological Processes*, 31, 4660-4668.

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

Lett, S., Wardle, D.A., **Nilsson, M-C.**, Teuber, L., Dorrepaal, E. 2017. The role of bryophytes for tree seedling responses to winter climate change: implications for the stress gradient hypothesis. *Journal of Ecology* 105, 496-506.

Lim, H., Oren, R., Linder, S., From, F., **Nordin, A.**, Fahlvik, N., **Lundmark, T.**, ... Näsholm, T. 2017. Annual climate variation modifies nitrogen induced carbon accumulation of *Pinus sylvestris* forests. *Ecological Applications* 227, 1838-1851.

Maaroufi, N., **Nordin, A.**, Palmqvist, K., **Gundale, M.J.** 2017. Nitrogen enrichment impacts on boreal litter decomposition are driven by changes in soil microbiota rather than litter quality. *Scientific Reports* 7, 4083.

**Mason, E.G., Holmström, E., Nilsson, U.** 2017. Using hybrid physiological/mensurational modelling to predict site index of *Pinus sylvestris* L. in Sweden: a pilot study. *Scandinavian Journal of Forest Research* 33, 147-154.

Prescott, C.E., Reid, A., Wu, S.Y., **Nilsson, M-C.** 2017. Decomposition rates of surface and buried forest floor material. *Canadian Journal of Forest Research* 47, 1140-1144.

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

## Interviews and presence in media

Agestam, E., **Nilsson, U.** Satsa på tall och gran ihop. *Skogseko* 2017-03.

**Böhlenius, H.** Öppnar väg för poppel. *Nyhetsbrev ISSV* April 2017.

Felton, A., **Holmström, E.** Älgarnas foder och hälsa. *SSV Nyhetsbrev* February 2017.

**Goude, M.** Bättre metoder för att beräkna trädens tillväxt. *Nyhetsbrev ISSV* November 2017.

**Holmström, E.** Bonitering vid skrivbord ger bättre bedömning, *ATL*, 2017. Ulf Aronsson.

**Holmström, E.** Björk och gran goda grannar, *Skogen*, 5, 2017. Teresia Borgman.

**Holmström, E.** Tema gallring. *Tidningen Skogen*, 2, 2017. Teresia Borgman.

**Holmström, E.** Ta vara på den självföryngrade björken. *Skogseko* 2017-03.

**Holmström, E.** Storsatsning på Sydsvensk skog. *Nyhetsbrev ISSV* April 2017.

**Holmström, E.** Storsatsning på forskning om variation i skogsbruket. *Skogseko* 2017-02.

**Holmström, E.** Fras började i gallringsskogen. *Nyhetsbrev ISSV* December 2017.

**Holmström, E., Karlsson, M., Nilsson, U.** Räkna med självföryngrad björk. *ISSV Nyhetsbrev* March 2017.

**Nilsson, M-C.** 2017. Stora Enso Skogs medlemsmagasin *Excellens*. Skogsföryngring.

**Nilsson, M-C.** 2017. Interview for *ATL*.

**Nilsson, M-C.** 2017. SLU's utbildning inom ämnet skogsföryngring. *Inbjuden*. Skogsstyrelsen, Stockholm.

**Nilsson, U.** Hjälpplantering hjälper dåligt. *LandSkogsbruk* 2018-02-04. .

**Nilsson, U.** Dags för en förändrad föryngring. *Skogsvärden* 1 2017.

**Nilsson, U.** Skogen kan ge mer men också bli mer variationsrik. *Skog och framtid* 1 2017.

**Nilsson, U.** Bra med tidig röjning visar forskning. *LandSkogsbruk* 2017-11-07.

**Nilsson, O.** Tall och gran sida vid sida. *ISSV Nyhetsbrev* March 2017.

## Scientific presentations

**Holmström, E.** Modeling birch seed supply and seedling establishment during forest regeneration. *Forest regeneration in Changing Environments*, Corvallis, Oregon, USA, Jyly 11-13 2017.

**Nilsson, U.** Pre-commercial thinning to create fodder for browsing animals. *Forest regeneration in Changing Environments*, Corvallis, Oregon, USA, Jyly 11-13 2017.

**Nilsson, O.** Establishment and initial growth of planted Scots pine and Norway spruce on low and high fertility sites in northern and southern Sweden. *Forest regeneration in Changing Environments*, Corvallis, Oregon, USA, Jyly 11-13 2017.

## Popular scientific presentations

**Nilsson, M-C.** 2017. Interaktion mellan mossor och cyanobakterier i skog. Inbjuden föreläsare vid Svenska Botaniska Föreningens årssammankomst, Uppsala, 12 March.

**Nilsson, U.** Course in regeneration and forest production, Skogs-sällskapet, four occassions during autumn 2017.

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

FRAS research program,

Skogsstyrelsens Centrala Plant och Fröråd (**M-C Nilsson-Hegethorn**, board member and commission to review SLU's education in regeneration)

Sveaskog, establishment of research trials in ekopark Öjesjöbrännan. (**M-C Nilsson-Hegethorn**)

Erik Rönnbergs Fond. Information and establishment of demonstration trials on the property Fagerdal, Jämtland. (**M-C Nilsson-Hegethorn**, chairman).

Brattåsstiftelsen. (**M-C Nilsson-Hegethorn**, expert adviser).

Marknadskonsult Doublecheck. (**M-C Nilsson-Hegethorn**, expert adviser).

## Education

### - PhD theses, MSc theses, Bachelor theses

Signe Lett. 2017. Doctoral thesis: Mosses as mediators of climate change: Implications for tree seedling establishment in the tundra. Supervisors: E. Dorrepaal, D. Wardle, and **M-C. Nilsson**.

### Supervision and teaching

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

Susan Nuske. Post-doc. Started 2017. Supervisors: **M. Gundale**, **M-C. Nilsson** and D. Wardle.

Erik Sundström (2017-). MSc thesis. Supervisors: **M-C. Nilsson** and J. Stenlid.

Weiqiu Liu, Guest researcher 12 months. Started 2017. Supervisors: **M-C. Nilsson** and U. Rasmussen.

Martin Ahlström. PhD-student. Effect of silvicultural treatment on the risk for storm damage in managed forest stands in southern Sweden. Dissertation planned to spring 2018. Supervisor: **U. Nilsson**.

**Oscar Nilsson**. PhD-student. Production of Scots pine and Norway spruce in Sweden. Dissertation planned to spring 2020. Supervisors: **U. Nilsson** and K. Hjelm.

**Martin Goude**. PhD-student. Hybrid growth models for Scots pine and Norway spruce in Sweden. Dissertation planned to winter 2021. Supervisors: **U. Nilsson**, **I. Barbieto** and E. Mason.

Mikolaj Lula. PhD-student. Regeneration of Scots pine in southern Sweden. Dissertation planned to autumn 2021. Supervisors: **U. Nilsson**, A. Jensen, K. Wallertz, M. Wallgren and G. Örlander.

Mostarin Ara. PhD-student. Pre-commercial thinning in planted Norway spruce stands in southern Sweden. Dissertation planned to winter 2022. Supervisors: **U. Nilsson**, M. Berglund, N. Fahlvik, **I. Barbieto** and E. Olofsson.

Ellen Nordström. Naturvårdshänsyn på hyggen 1960- till 2010-tal. SLU, SSFRC No. 202. Master thesis, supervisor **Emma Holmström**.

Aigars Loks. Soil watermap usage in planning of thinnings. SLU, SSFRC No. 284. Master thesis, supervisor **Emma Holmström**.

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

# Theme 4

## - Other renewable plant resources, non-food crops

### Scientific publications

During 2017 Theme 4 has published 13 peer-reviewed scientific articles in international journals.

**Andersson, M., Turesson, H.,** Nicolia, A., Ann-Sofie Fält, A.-S., Samuelsson, M., **Hofvander, P.** 2017. Efficient targeted multiallelic mutagenesis in tetraploid potato (*Solanum tuberosum*) by transient CRISPR-Cas9 expression in protoplasts. *Plant Cell Rep* 36, 117–128.

**Ceresino, E.B.,** de Melo, R.R., Kuktaite, R., Hedenqvist, M.S., Zucchi, T.D., **Johansson, E.,** Sato, H.H. 2017. Transglutaminase from newly isolated *Streptomyces* sp. CBMAI 1617: production optimization, characterization and evaluation in wheat protein and dough systems. *Food Chemistry* 241, 403-410.

**Ivarson, E.,** Iven, T., Sturtevant, D., Ahlman, A., Cai, Y., Chapman, K., Feussner, I., **Zhu, L-H.** 2017. Production of wax esters in the wild oil species *Lepidium campestre*. *Industrial Crops & Products* 108, 535–542.

**Ivarson, E.,** Leiva-Eriksson, N., Ahlman A., **Kanagarajan S.,** Bülow L., **Zhu L-H.** 2017. Effects of overexpression of WRI1 and hemoglobin genes on the seed oil content of *Lepidium campestre*. *Frontiers in Plant Science* 7, 2032.

Gällstedt, M., Pettersson, H., Johansson, T., **Newson, W.R., Johansson, E.,** Hedenqvist, M.S. 2017. Film extrusion of *Crambe abyssinica*/wheat gluten blends. *JoVE* 119, e54770:2-6.

**Jin, Y.,** Hu, J., Liu, X., Ruan, Y., **Sun, C.,** Liu, C. 2017. T-6b allocates more assimilation product for oil synthesis and less for polysaccharide synthesis during the seed development of *Arabidopsis thaliana*. *Biotechnology for Biofuels* 10, 19.

**Jin, Y.,** Fei, M., Rosenquist, S., Lu Jin, L., Gohil, S., Sandström, C., Olsson, H., Persson, C., Höglund, A.S., Fransson, G., Ruan, Y., Åman, P., Jansson, C., Liu, C., **Andersson, R., Sun, C.** 2017. A dual-promoter gene orchestrates the sucrose-coordinated synthesis of starch and fructan. *Molecular Plant* 10, 1556-1570 and cover image (IF = 8.827).

Losvik, A., Beste, L., Glinwood, R., **Ivarson, E.,** Stephens, J., **Zhu, L-H.,** Jonsson, E. 2017. Overexpression and Down-Regulation of Barley Lipooxygenase LOX2.2 Affects Jasmonate-Regulated Genes and Aphid Fecundity. *Int. J. Mol. Sci.* 18, 2765; doi:10.3390/ijms18122765.

**Minina, E.A.,** Moschou, P.N., **Bozhkov, P.V.** 2017. Limited and digestive proteolysis: crosstalk between evolutionary conserved pathways. *New Phytologist* 215, 958–964.

**Minina, E.A.,** Coll, N.S., Tuominen, H. **Bozhkov, P.V.** 2017. Metacaspases versus caspases in development and cell fate regulation. *Cell Death and Differentiation* 24, 1314–1325.

**Newson, W.R.,** Prieto-Linde, M.L., **Kuktaite, R.,** Hedenqvist, M.S., Gällstedt, M., **Johansson, E.** 2017. Effect of extraction routes on protein content, solubility and molecular weight distribution of *Crambe abyssinica* protein concentrates and thermally processed films thereof. *Industrial Crops and Products* 97, 591-598.

Wu, Q., Rabu, J., Goulin, K., Sainlaud, C., Chen, F., **Johansson, E.,** Olsson, R.T., Hedenqvist, M.S. 2017. Flexible strength-improved and crack-resistant biocomposites based on plasticised wheat gluten reinforced with a flax-fibre-weave. *Composites Part A* 94, 61-69.

Wu, Q., Lindh, V., **Johansson, E.,** Olsson, R.T., Hedenqvist, M.S. 2017. Freeze-dried wheat gluten biofoams; scaling up with water welding. *Industrial Crops and Products* 97, 184-190.

### Popular scientific publications

**Johansson, E., Newson, W.R.,** Fredlund, K., Malik, A.H. 2017. Proteinbaserad utsädespelletering – för ökad avkastning hos sockerbeta? Fakta från SLU Partnerskap Alnarp, LTV-fakultetens faktablad 2017:8.

### Interviews and presence in media

**Kuktaite, R.** 2017. The use of MAX IV facility for structure investigating in bio-based materials. <https://www.maxiv.lu.se/news/experiment-at-max-iv-green-plastics/> [https://www.youtube.com/watch?v=80\\_j6TH9owE](https://www.youtube.com/watch?v=80_j6TH9owE) [https://www.youtube.com/watch?v=TsP\\_mXDE3GY](https://www.youtube.com/watch?v=TsP_mXDE3GY)

**Sun, C., Andersson, R.** 2017. The SLU news (<https://www.slu.se/ew-nyheter/2017/12/genetiken-bakom-inlagringen-av-starkelse-och-kostfiber-i-kornkarnan-ar-avslojad/>), 5 December.

**Zhu, L-H.** 2017. Hon hoppas att hennes tobaksplantor ska kunna rädda människors liv. *Sydsvenskan*. <https://www.sydsvenskan.se/2017-10-11/nyfikenheten-som-driver-mig>. 13 October.

**Zhu, L-H.** 2017. Hon hoppas att hennes tobaksplantor ska kunna rädda människors liv. *Hålla Lomma/Bjärred*, 11 October.

Protein2Food Newsletter- February, 2017. Protein-rich pasta from peas, a healthy innovation: <https://www.protein2food.eu/protein-rich-pasta-with-dietary-fibres-from-peas-a-healthy-innovation/>

Kraftfullt svenskt bioplastprojekt. PlastForum, 23 Jan 2017.

Växtprotein och biprodukter. Lantbruksnytt. 2 June 2017.

Näringämnen i grönsaker. Vetenskapsradions veckomagasinet. 22 Sept 2017.

## Scientific presentations

**Zhu, L-H.** and **Hofvander, P.** 2017. Chairpersons of 8<sup>th</sup> European Symposium on Plant Lipids, international symposium with over 100 participants from 19 countries in which our research in *Crambe*, *Lepidium*, pheromones and carbon allocation were presented.

**Andersson, M.** 2017. Multiallelic mutagenesis in tetraploid potato by CRISPR/Cas9 expression in protoplast. Oral presentation at CRISPR AgBio, Precision genome editing. London, UK. 25-26 September.

**Andersson, M.** 2017. Efficient targeted multiallelic mutagenesis in tetraploid potato. Oral presentation at New breeding technologies in the plant sciences - Applications and implications in genome editing SEB. Göteborg, Sweden. 7-8 July.

Berenguer, E., Solis, M-T., Pérez-Pérez, Y., **Minina, A.**, Risueno M.-C., **Bozhkov, P.**, Testillano, P.S. 2017. Metacaspases and autophagy are induced in microspore embryogenesis of *Brassica napus*. Poster. Transautophagy Annual Conference. March 2017, Madrid, Spain.

**Bozhkov, P.** 2017. Plants with Enhanced Autophagy: Methods and Phenotypes. Plenary lecture. Transautophagy Annual Conference. March 2017, Madrid, Spain.

**Bozhkov, P.** 2017. Invited seminar. Autophagy in plant fitness. May 2017, Dalhousie University, Canada.

**Cardoso, C.**, **Minina, E.**, Lindberg, S., Robert, S., Bozhkov, P. 2017. Talk. Chemical Genetics of Plant Autophagy. Transautophagy Annual Conference. March 2017, Madrid, Spain.

Carlsson, G., **Kuktaite, R.** 2017. Can diverse cropping systems and better use of plant bio-resources contribute to the bio-based economy? SLU 40 years anniversary, Invited talk, 19 September.

**Carlsson, M.**, **Kanagarajan, S.**, Chakane, S., Kettisen, K., Ratanasopa, K., Bülow, L. **Zhu, L.-H.** 2017. Human fetal hemoglobin expression, purification and characterization in *Nicotiana benthamiana*. XVI ISBS Int. Symposium Blood Substitutes & Oxygen Therapeutics. 13-15 Nov. Montreal, Quebec, Canada.

Ceresino, E.B., **Johansson, E.**, Sato, H.H., Plivelic, T.S., Hall, S.A., **Kuktaite, R.** 2017. Improving gliadin foam structure and polymeriza-

tion by the newly produced transglutaminase. 12<sup>th</sup> SLACA - Latin American Symposium of Food Science 4-7 November, 2017, Campinas, Brazil, <http://2017.slaca.com.br/en/node/201>.

**Elander, P.H.**, **Dalman, K.**, **Cardoso, C.**, **Marmon, S.**, Stymne, S., **Minina, E.A.**, **Bozhkov, P.** 2017. Talk. Autophagy in plant oil deposition and catabolism. Transautophagy Annual Conference. March 2017, Madrid, Spain.

**Grimberg, Å.** 2017. Transcriptional induction of oil accumulation in wheat endosperm. Oral presentation at 8<sup>th</sup> European Symposium on Plant Lipids. Malmö, Sweden, 2-5 July.

**Ivarson, E.**, Ahlman, A., **Lager, I.**, **Zhu, L-H.** 2017. Reduction of pod shatter in *Lepidium campestre* through biotechnical approaches. Poster presentation at 8<sup>th</sup> European Symposium on Plant Lipids, 2-5 July, Malmö, Sweden.

**Ivarson, E.**, Ahlman, A., **Zhu, L-H.** 2017. Improvement of oil qualities and quantities in a wild oilseed species *Lepidium campestre*. Invited lecture at The 13<sup>th</sup> International Symposium on Biocatalysis and Agricultural Biotechnology, 17-20 Oct., National Chung Hsing University, Taichung, Taiwan.

**Jeppsson, S.**, Demski, K., **Carlsson, A.S.**, **Lager, I.**, **Zhu, L-H.**, Banaś, A., Stymne, S. 2017. Characterisation of DGAT Isoforms from *Crambe abyssinica* Expressed in Yeast. Poster presentation at 8<sup>th</sup> European Symposium on Plant Lipids, 2-5 July, Malmö, Sweden.

**Johansson, D.** 2017. Legume protein nano-fibrils: Functional food ingredient in future plant based foods? FSS-Food Science Sweden – Current research, strengths and priorities for the future, 8 December, Uppsala. Poster presentation.

**Kuktaite, R.** 2017. A new approach to capture the secrets of plant protein structure and function. Docent lecture, LTV faculty, SLU, Alnarp, 19 May.

**Kuktaite, R.**, Krupinski, P., Rasheed, F., Bozorg, B., Jönsson, H. 2017. Computer modelling of future bio-plastics. Poster presentation, SLU, Alnarp, PlantLink day, 29 September.

**Kuktaite, R.** 2017. Can the industrial side-products be used for bioplastics? MAX IV-SLU platform. TC4F meeting, Lund, 20 November.

**Langton, M.** 2017 Designing different type of structures of protein nano fibrils oral presentation at the SuMo conference – “Transport in nanostructured materials - design and characterization” on the 31 August - 1 September, Varberg, oral presentation.

**Lendel, C.**, **Langton, M.** et al. 2017. The Swedish Protein Materials Network, poster at the conference “Bringing New Materials to Market” organised by SSF in Stockholm, 25 April.

**Minina, E.A.**, Moschou, P.N., Vetukuri, R.R., Sanchez-Vera, V., **Cardoso, C.**, Liu, Q., **Elander, P.H.**, **Dalman, K.**, Beganovic, M., Yilmaz, J.L., Marmon, S., Shabala, L., Suarez, M.F., Ljung, K., Novák, O., Shabala, S., Stymne, S., Hofius, D., **Bozhkov, P.V.** 2017. Transcriptional stimulation of rate-limiting components of the autophagic pathway improves plant fitness. Poster. 1<sup>st</sup> Nordic Autophagy Society Conference. November 2017, Sigtuna, Sweden.

**Nynäs, A-L.**, **Newson, W.**, **Langton, M.**, **Johansson, E.** 2017. Leaf proteins in freeze-dried foams — Food structures from agricultural side streams, poster presentation at Biopolymers, Dec 2017, Nantes.

Solís, M-T., Bárány, I., Berenguer, E., **Minina, A.**, Santamaría, E., Crespo, J-L., Díaz, I., Risueno, M.C., **Bozhkov, P.**, Testillano, P.S. 2017. Induction of autophagy, metacaspase and cathepsin activities during developmental PCD of tapetum. Poster. Transautophagy Annual Conference. March 2017, Madrid, Spain.

**Stensgård, A-K.**, **Li, M.**, **Johansson, D.**, **Langton, M.** 2017. Participated at the 2<sup>nd</sup> Workshop on Protein Materials – Stockholm, KTH campus, 9-10 March, poster presentation

**Zhu, L-H.** 2017. Metabolic engineering of plant oils. Invited lecture at the 4th Academic conference of women scientists on plant biology, 10-17 June, Xinjiang, P.R. China.

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

Collaboration with **Grönsaksmästarna Nordic AB**, **Lantmännen**, **Nordic Green Food AB /Yi-Pin Soya**, Vallentuna, **SLU Holding**, **Lyckeby Starch AB**, Syngenta, **SCA Technologies**.

**SweeTree Technologies** on the manipulation of autophagy for improving plant productivity. This collaboration has led to the following patent: **Bozhkov, P.**, **Minina, E.**, Moschou, P., Hofius, D., Stymne, S. (2017) Transcriptional stimulation of autophagy improves plant fitness. International Patent WO2017095320

## Other funding

- Lantmännen grant, 1.653 MSEK for 3 years. Project title: Från korn till havre med fokus på betaglukan innehåll i kärna.
- FORMAS: Manipulating autophagy to increase plant productivity. 3 years, SEK 3,000,000
- Lantmännens Stiftelse, Legumes for novel texturized protein-rich foods, 1.37 MSEK
- Grogrund, 90 miljö SEK /3 år
- FORMAS, Gelation properties of protein from Swedish legumes, 3 MSEK

## Investments in research infrastructure

- Vice-coordinator at SLU for MAX IV -SLU platform - 15% of financing.
- Computer, conference system, etc
- Tensile stage possible to fit under the microscope, including temperature and humidity control chamber and control unit. (from other funding)

## Education

### - PhD theses, MSc theses, Bachelor theses

**Qiong Wu.** (Female) 2017. Doctoral thesis: Biofoams and biocomposites based on wheat gluten proteins. KTH Royal Institute of Technology School of Chemical science and Engineering, Stockholm, Sweden. ISSN 1654-1081, TRITA-CHE Report 2017:30, ISBN: 978-91-7729-453-5. **Eva Johansson** co-supervisor.

**Louise Selga** (Female). 2017. Master thesis: Optimization of pro-toplast methods suitable for transient CRISPR/Cas9 expression in *Lepidium campestre*. SLU, Second cycle, A2E. Alnarp: SLU, Department of Plant Breeding (from 130101). **Emelie Ivarson** Main supervisor, **Li-Hua Zhu** Examiner.

**Mengli Li** (Female) 2017. Exchange student report Investigation of faba bean protein extraction and fibrillation, in collaboration with Department of Food Science and Nutritional Engineering, China Agricultural University, Beijing, China

### - Supervision and teaching

**Li-Hua Zhu**, main supervisor and **S. Kanagarajan**, co-supervisor for PhD student Magnus Carlsson. Tentative title: Human hemoglobin production in plants. Expected date for dissertation: End of 2019.

**Anders Carlsson**, main supervisor, **Ida Lager** and **Li-Hua Zhu**, co-supervisors for PhD student Simon Jeppsson. Tentative title: Production of green technical plant oils through the biotechnological modification of oil biosynthesis in the oil crop *Crambe*. Expected date for dissertation: End of 2019.

**Ramune Kuktaite**, main supervisor for PhD-candidate Faraz Muneer. Tentative title: "Quality and relationship to protein structure in composite materials", Expected date for dissertation: October, 2018.

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

**Marie Olsson**, main supervisor for PhD (Licentiate)-candidate

Emilia Berndtsson. Tentative title: Characterisation of fibres and bioactive compounds in side streams of Brassica vegetables. Expected date for Licentiate dissertation: October 2019.

**Daniel Johansson**, supervisor for Master student Sohail Ehsanzamir. Title: Gelation of fava beans, 30 ECTS.

**Maud Langton** and **Daniel Johansson**, supervisors for Hanyu Bai "Studies on characterisation of mung bean protein extracts and the formation of nanofibers", China Agricultural University.

**Eva Johansson** and **Maud Langton**, main- and co-supervisor respectively for **Anna-Lovisa Nynäs's** Intropaper – White proteins from green leaves in food applications – a literature study.

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

**Faiza Rasheed** and **Ramune Kuktaite**. PhD course responsible and organizer, course "Aspects of quality", 4 ECTS Alnarp, Nov 2017.

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

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

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

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

**Li-Hua Zhu**. Responsible for undergraduate education at Department of Plant Breeding, SLU Alnarp and responsible for 2 courses: Plant Physiology (BI1189) 15 ECTS, Advanced Plant Breeding and Genetic Resources (BI1057), 15 ECTS. Teaching at these two courses and in Genetics and Plant Breeding, 15 ECTS.

**Marie Olsson**. Course organizer and teaching at the course "Post-harvest – biology and technology after harvest", (BI1235), 15 ECTS, SLU, Alnarp.

**Marie Olsson**. Course organizer and teaching at the course "Horticultural products and quality", (BI1285), 15 ECTS, SLU, Alnarp.

# Personnel in TC4F 2017

## 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
Nathaniel Street	M, Lektor	80%
Barbara Terebienec	F, PhD student	0
Bastian Schiffthaler	M, PhD student	0
Chanaka Mannapperuma	M, PhD student	0
Niklas Mähler	M, Postdoc	0
Kerstin Richau	F, Postdoc	100%
Andreas Schneider	M, PhD student	0
Xiao-Ru Wang	F, Professor	0
David Hall	M, Researcher	0
Alexis Sullivan	F, PhD student	0
Benedicte Albrechtsen	F, Researcher	20%
Pär Ingvarsson	M, Professor	0
Carolina Bernhardsson	F, Postdoc	0
Biyue Tan	F, PhD student	0
Xi Wang	F, PhD student	0
Helena Dahlberg	F, PhD student	0
Kathryn Robinson	F, Researcher	75%
Nicolas Delhomme	M, Research engineer	0
Iryna Shutova	M. Research engineer	100%
Verena Fleig	F, Research engineer	0
Ove Nilsson	M, Professor	0
Shasank Sane	M, PhD student	50%
Domenique André	F, PhD student	0
Hailiang Mao	M, Postdoc	0
Jihua Ding	F, Postdoc	0
José Alfredo Zambrano	M, Postdoc	0
Bengt Andersson Gull	M, Professor	10%
Johan Westin	M, Researcher	25%
Sara Abrahamsson	F, Researcher	10%
Gunnar Jansson	M, Researcher	5%
Johan Kroon	M, Researcher	10%
Torgny Persson	M, Researcher	5%
Ulfstand Wennström	M, Researcher	10%



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

Name	Gender & Position	Part of full time financed by TC4F
Giulia Vico	F, Docent	50
Guiomar Ruiz-Pérez	F, Postdoc	100%
Mark Swaine	M, Postdoc	100%
Sandra Jämtgård	F, Researcher	0%
Torgny Näsholm	M, Professor	0%
Vaughan Hurry	M, Professor	0%
Julia Haas	F, PhD student	10%
David Castro	M, PhD student	10%
Alexander Veraga	M, Postdoc	100%
Görel Sundström	F, Postdoc	100%
Andreas Schneider	M, PhD student	10%
Nathaniel Street	M, Docent	50%
Kathryn Robinson	F, Researcher	50%
Kerstin Richau	F, Postdoc	100%
Annika Nordin	F, Professor	25%
Tinkara Bizjak	F, PhD student	100%
Lasse Tarvainen	M, Postdoc	75%
George Jocher	M, Postdoc	33%

## Theme 3 - Sustainable and adaptive forest management


Name	Gender & Position	Part of full time financed by TC4F
Marie-Charlotte Nilsson-Hegethorn	F, Professor	0
Michael Gundale	M, Docent	50%
Urban Nilsson	M, Professor	0
Euan Mason	M, Professor	20%
Nils Fahlvik	M, Researcher	25%
Emma Holmström	F, Researcher	100%
Henrik Böhlenius	M, Researcher	40%
Oscar Nilsson	M, PhD student	100%
Martin Goude	M, PhD student	100%
Theresa Ibanez	F, PhD student	100%
Tomas Lundmark	M, Professor	0%
Ignacio Barbieto	M, Researcher	10%

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

Name	Gender & Position	Part of full time financed by TC4F
Li-Hua Zhu	F, Professor, theme leader	0
Eva Johansson	F, Professor, Program director	25%
Faiza Rasheed	F, Postdoc	25%
Sven-Erik Svensson	M, PhD student	35%
Ramune Kuktaite	F, Researcher	0
William (Bill) Newson	M, Postdoc	30%
Joel Marklund	M, PhD student	7%
Maria Luisa Prieto-Linde	F, Lab technician	0
Anders Ekholm	M, Lab technician	0
Faraz Muneer	M, PhD student	0
Elaine Ceresino	F, PhD student	0
Anna-Lovisa Nynäs	F, PhD student	100%
Annelie Ahlman	F, Lab technician	0
Antonio Capezza	M, PhD student	0
Emilia Berndtsson	F, PhD student	5%
Marie Olsson	F, Professor	0
Chuanxin Sun	M, Researcher	15%
Maud Langton	F, Professor	0
Anja Herneke	F, PhD-student	100%
Daniel Johansson	M, Postdoc	0
Jing Li	F, Postdoc	0
Mengli Li	F, Exchange student	83%
Anni-Kaisa Stensgård	F, Master student	0
Sohail Ehsanzamir	M, Master student	0
Per Hofvander	M, Researcher	30%
Åsa Grimberg	F, Researcher	50%
Mariette Andersson	F, Researcher	10%
Helle Turesson	F, Research engineer	0%
Anders Carlsson	M, Professor	5%
Ann-Sofie Fält	F, Technician	10%
Per Snell	M, PhD student	0%
Selvaraju Kanagarajan	M, Researcher	40%
Xueyuan Li	M, Research Assistant	45%
Emelie Ivarson	F, Postdoc	50%
Magnus Carlsson	M, PhD student	0
Ida Lager	F, Reseracher	0

## Theme 4 - cont.

Simon Jeppsson	M, PhD student	0
Yunkai Jin	M, Postdoc	20%
Folke Sitbon	M, Professor	
Roger Andersson	M, Professor	0
Xue Zhao	F, PhD student	0
Peter Bozhkov	M, Professor	0
Elena Minina	F, Senior Researcher	22%
Kerstin Dalman	F, Research eng.	24%
Catarina Cardoso	F, Postdoc	0
Pernilla Elander	F, PhD student	0



## 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.



[www.tc4f.se](http://www.tc4f.se)