



# TC4F ANNUAL REPORT 2016

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

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# Reading instruction

This report is divided into three parts. In the first part, the progress of the research during 2016 is summarized by the programme director followed by researcher portraits that intend to give insights to the background and current work of four of the researchers involved in the programme.

The programme is divided into four different themes; “Forest genetics and next generation of forest trees” led by professor Stefan Jansson Umeå University, “Growth and interaction with the environment – current and future” led by professor Vaughan Hurry SLU, “Sustainable and adaptive management” led by professor Urban Nilsson SLU and “Other renewable plant resources, non-food crops” led by professor Li-Hua Zhu SLU. In part two, the theme leaders summarize the progress of the respective themes and highlights some of the main findings during 2016.

Part three contains lists of deliverables from the respective themes during 2016 and lists of personnel engaged in the programme.



# Part 1



# Looking back and ahead

**Program Director: Eva Johansson**

**Photo: Mats Hannerz**

TC4F – Trees and Crops for the Future – entered its second phase in 2016. This progression allowed projects initiated during the first phase to be brought towards a conclusion, and further investigations of research topics still relevant after the first phase. Importantly, it also enabled research questions to be steered in new directions.

Since the start, the focus of the programme has been to apply high-level basic research and acquired knowledge in teaching, in industrial applications, and for societal needs. One clear aim has been to connect the prioritised research areas of the programme with external actors. This enables innovations and novelty and strengthens important research and innovation within sustainable plant production and plant-based product development in both agricultural and boreal systems.

Important research findings from the programme can be categorised into two major areas: *forest production in a changing climate* and *development of sustainable and plant-based products*.

Research findings in *forest production in a changing climate* concerned: impacts of increased temperatures on plant respiration; effects of photosynthesis, nitrogen source and nitrogen fluxes on nutrient uptake, tree development and growth; impact of pre-commercial thinning and mixed-species stands on forest production; and use of population genetics and genomics in trees to understand genetic diversity and regulations of important traits in a changing climate.



Research findings in *development of sustainable and plant-based products* concerned: methods for fine-tuning protein materials through the modulation of genotype, environmental interactions, and glycerol to form hierarchical structures; and transgenic lines capable of producing large amounts of wax esters or ultra-high amounts of oleic acid.

The programme contributed to more than 80 high-quality scientific publications of which approximately 25 had an IF>5. Four PhD students and four MSc students defended their theses within the programme during 2016. Most of the senior researchers and many of the PhD students have been active in undergraduate education.

Many of the senior researchers have also been visible in the media, both in terms of press releases and interviews but also as experts in public debates. The most visible topics relate to debates concerning benefits and drawbacks of genetic modification of plants (in both trees and crops), sustainability, and use of forest resources

for various applications (including production and recreation), the novel and emerging technique of the gene scissor (CRISPR/Cas-9) for use in both trees and crops, and novel and emerging biobased products from crops.

Existing collaborations with external actors have continued and developed during the year, including collaborations with Skogforsk, SweTree Technologies, Holmen Skog, SweTree Nutrition, Future Silviculture in Southern Sweden (50% financed by the forest sector in Southern Sweden), Lantmännen, Lyckeby Starch, Syngenta, and ISCA Technologies. New collaborations with industry included the Syngenta Flower division in the Netherlands, SCA Personal Care division, and other partners in projects where

participation arose through activities in TC4F.

The overall budget for programme activities during 2016 was SEK 25,826,000 and expenses at 31 December were SEK 25,869,000, a result very close to the budget. However, Themes 1 and 2 did not use all budgeted funds while Themes 3 and 4 exceeded their budgets slightly. The slight deficit will be covered by funds remaining from phase 1.

The programme board of TC4F has initiated strategy development. The aims are to define strategic goals of the programme, develop interactions among strategic participants inside and outside the programme in order to strengthen TC4F, and increase visibility as a strategic pillar for SLU and its partners, Umeå University and Skogforsk.





**By combining proteins from wheat and starch from a special potato type, innovative biplastic materials can be produced. In the future, the new green-plastics can potentially be used for packaging, house insulation, car parts, medical textiles and many other products.**

# Future Materials

**Text & photo: Pär Fornling**

Ramune Kuktaite is a researcher at SLU in Alnarp. When we meet her, Ramune pulls out a rectangular sheet of beige material made of plant proteins from wheat. It is approximately half a centimetre thick, strong, and flexible, which she demonstrates by bending the biplastic material into an arch. Another rectangular sheet is thin and hard and is made of other types of proteins deriving from potatoes. In the laboratory, there is a selection of plastics in different shapes and colours.

“A major problem for the world is that we use so many petroleum-based plastic products. Our research shows that there are bio-based alternatives,” says Ramune.

She is driven by the quest for new knowledge and the vision to contribute to a better world by finding environmentally sound alternatives.

A related research theme in which Ramune is involved is to develop protein-rich foods that could be used as healthy alternatives to meat. The idea is to use locally produced proteins from, for example, beans, lupines and peas to make new protein-rich foods.

At Kaunas University of Technology in Lithuania, Ramune’s master’s degree focused on wheat gluten proteins and bread quality aspects. She did her practical work



at the Department of Plant Breeding at SLU and, after her master’s project, she returned to Sweden and SLU in Alnarp as a doctoral student.

After a couple of years in Italy, working for a company that develops gluten-free products, Ramune returned to SLU in 2008 to carry out research on how proteins can be used in developing bio-based plastic materials. This was in line with the vision of TC4F.

Making biplastic using starch from potatoes and maize is nothing new. The production method is well known, but its

suitability is unknown when novel starch materials are used or when starch is used together with proteins. The use of the newly produced potato starch in combination with wheat proteins to make a composite is an innovation. The result is materials with many different properties and varying colours.

The researchers use starch that originates from a genetically modified potato, developed by Mariette Andersson and her colleagues, using the CRISPR genome editing technology, the ‘gene scissors’. The result is a potato that differs from the ordinary, both in appearance and in the structure of the components. The protein – gluten – used for the plastic composite is taken from ordinary wheat flour.

“Proteins from wheat form very exciting building blocks, with different properties depending on which protein we use – the whole gluten, or its components gliadin and glutenin. By mixing these proteins with potato starch, we have produced three types of composites with different properties in terms of hardness, strength and stretchability.



“In another project, we’ve succeeded in developing fibres from plant proteins and starch that are so thin they can only be seen in a microscope, while others are as thick as spaghetti. We’re now working on improving methods to ‘weave’ even thinner fibres for textiles. With optimal composition and processing, we can make

very interesting materials,” explains Ramune.

At the MAX IV synchrotron laboratory in Lund, plant proteins and starch in bio-based materials and composites have been studied down to nanometre level.

“We found many interesting links between nanostructures and functional properties, which makes it easier to control and design different materials with desired properties,” says Ramune.

Lyckeby is interested in collaborating on production of the potato starch for the raw material, and the gluten that is used is a by-product from the starch industry. These proteins and other plant proteins, deriving from by-products from various industrial processes, are attractive sources for bio-plastic materials.

The researchers have also started collaborating with Lund University on developing a method to shape the bio-based plastics in a 3D printer. In principle, the material can be designed in any shape.

The raw materials are not very expensive, but are more expensive than petroleum counterparts.

“We’re showing what is technically possible, so in the next stage we’ll see how it can be made cheaper and how the environmental advantages are to be evaluated. It’s hard to compete with petroleum plastics in terms of price. To start with, I think it’s a matter of finding a specific niche for smart bio-based materials, such as smart textiles monitoring people’s health.

“There are many different possibilities. We’ve developed a foam-like material from plant proteins that can be used for building insulation, plastics that are suitable for packaging, and protein-fibre composites that can be of great interest to the car industry. Many companies have shown interest in such materials, including Volvo Cars,” explains Ramune Kuktaite.



**A fast-growing deciduous tree could be an alternative to the spruce in forestry. The poplar has great potential, but more research is needed to identify reliable growing methods. Henrik Böhlenius is well on the way to generating this knowledge with his research within TC4F.**

# Poplar for the Future

**Text & photo: Pär Fornling**

Henrik's work focuses on poplar and hybrid aspen, both of which have the potential to produce 3-4 times as much wood as spruce under ideal conditions. Deciduous trees also contribute to diversity and increase variation in the forest landscape.

"We know quite a lot about cultivating the fast-growing trees on arable land, but forest land is completely different," says Henrik Böhlenius.

Previously he worked with forest genetics at UPSC (Umeå Plant Science Centre). This background is useful now that Henrik has switched from plant cells to practical, applied research at the Southern Swedish Forest Research Centre in Alnarp.

His work involves evaluating trials all over Sweden to identify good cultivation systems. The objective is to find and demonstrate successful methods so that the forestry sector can be confident about choosing one of the fast-growing deciduous trees as an alternative when new forest is planted.

"Our trials show that browsing is much greater on hybrid aspen than poplar. On 23 different sites, we planted groups of poplar and hybrid aspen, side by side. The trials showed that the poplar was less prone to browsing, and that there may be differences between different poplar clones. The analysis is not yet complete but, if it's successful, we'll have identified genotypes that are relatively resistant to browsing,"



says Henrik. Both tree species are browsed during the spring and summer, but for aspen, browsing is more extensive. However, in the winter, there is no difference between the species in terms of browsing of the top shoot. At that time of year, the young trees can be treated with wildlife repellent, which is not possible in the summer because the plants grow so quickly (2-4 centimetres per day).

Even if the poplar plants are browsed, they usually continue to grow, and have a good ability to repair the damage. Once the poplar has reached a browsing-proof height, the tree, with its thick bark, is not so attractive for deer and moose.

However, hybrid aspen, with its fine, smooth stems, still attracts browsing.

There are some 400,000 hectares of abandoned arable land throughout the country, affording great opportunities for both poplar and hybrid aspen.

“But realistically, we’re perhaps talking about a potential of 50,000-100,000 hectares of fast-growing deciduous trees on abandoned arable land. In the forest, it’s perhaps a couple of million hectares, and planting on even part of this can generate large areas,” speculates Henrik.

On abandoned arable land, poplar can reach a browsing-proof height already in the first or second year. One option, tested successfully in the trials, is to plant extremely long cuttings (up to two metres). However, on stony forest land, planting these cuttings is a problem, and is a relatively expensive procedure.



“On abandoned arable land, all plant types work well – long and short cuttings, bare roots, and container grown plants – but forest land presents more of a problem. Our research shows that cuttings do not grow at all on forest land, the plant must have a developed root system and containerised plants outperform bare-rooted plants. We’re now trying to identify how the “best” containerised plant should be produced,” explains Henrik.

When planting new stands, one challenge is competing vegetation.

Researchers estimate that the forest owner has approximately two years in which to establish plants in the forest before competing vegetation becomes a problem. Consequently, it is important to quickly create the optimal conditions in which the poplar plants can establish.

Unlike hybrid aspen, poplar struggles in acidic soils, which are the most common soil type on forest land. In greenhouse experiments, pH values around 3.5-4 result in plant death, and growth rate decreases if the pH is below 5. However, hybrid aspen is less sensitive to acidity. At Tönnersjöheden, trials are taking place where scarification is combined with liming. First results indicate that, after two growth seasons, the plants are 1.4 metres high.

“How lime should be applied is not fully understood and therefore needs to be investigated in more detail before this can be used in practice,” says Henrik.

One method being tested to further improve establishment and boost growth is to combine lime, ash and fertiliser. Like lime, ash increases the pH value in the soil. Another alternative is to identify clones that can survive the acidic conditions. So far, the trials seem promising.

Once the trees are established, one of the subsequent questions is how to perform pre-commercial thinning in the second generation and how to plan for the second generation. One of Henrik’s experiments has demonstrated that, in time, one or a small number of stems become the dominant trees, with straight stems forming trees with a fine appearance. Alternatively, competing stems can be removed and used for bioenergy.

The trials have so far produced a growth of 25 cubic metres per hectare and year for poplar on abandoned arable land, which is somewhat better than the results for hybrid aspen. Results on forest land remain to be seen. New clones will be tested throughout Sweden. However, before they can be used on a large scale, reliable cultivation systems must be developed.



**Successful planting of new forest involves scarification, plant selection, management and technology. Marie-Charlotte Nilsson Hegethorn, professor in forest regeneration, is taking regeneration a step further. Within TC4F she is studying basic functions in the ecosystem to improve understanding of ecosystem relationships ahead of current challenges and tomorrow's climate change.**

# Future Regeneration

**Text & photo: Pär Fornling**

Marie-Charlotte's research has shown how moss attracts bacteria to produce nitrogen, and how crowberry uses chemical warfare to inhibit the establishment of pine.

Marie-Charlotte's forest trail began while she was studying biology at Umeå University. After a summer job at the nearby SLU, Olle Zackrisson, professor in forest vegetation ecology, suggested she take up a post at the university as a doctoral student. In 1992, she was awarded a PhD, with a thesis examining the effects of crowberry shrubs on natural regeneration.

The crowberry may lie behind many unsuccessful regeneration attempts in northern Sweden. The shrub produces a toxin that is released and spread during rain and snow melt, and competes for nutrients and space. Marie-Charlotte showed that the toxin accounted for nearly half of the negative effect.

It has long been known that clearcut burning is a successful way to generate new forest in stands containing a lot of crowberry. This led to more detailed studies on the effect of forest fires, which in various ways has been a common theme throughout Marie-Charlotte's research.

"Fire helps to regenerate the entire ecosystem, and new pines quickly become established after a fire. Perhaps fire could be used more in regeneration, but it is a complicated method that requires



knowledge and planning. Another question is the effects on climate, because a lot of carbon is released during burning. On the other hand, fire speeds up regrowth and the trees then absorb carbon. Here, we need to know more about the balances," says Marie-Charlotte.

Another area where Marie-Charlotte and her research colleagues have been successful is within nitrogen fixation in mosses covering the forest floor of boreal forests.

“The source of nitrogen in old forests has been a mystery. Most is recycled when needles and other litter are broken down, but nitrogen is also supplied externally. Common red-stemmed feathermoss and glittering woodmoss play an important role. This is a refined system that we discovered in 2000, since when the research has generated more and more information.”

The mosses send out chemical signals that attract cyanobacteria, which can trap nitrogen from the air, while also producing oxygen by photosynthesis. This means that cyanobacteria have been vital for life on Earth.

In a normal Swedish coniferous forest, there are around three tonnes of moss per hectare. The symbiosis with bacteria supplies approximately 2 kg of nitrogen per hectare and year to the forest. The natural quantities are not massive, but nevertheless significant. Fertilisation in forests is unusual, and the nitrogen from the mosses accumulates.

“Over a hundred-year rotation period, more than 20 percent of the nitrogen comes from the symbiosis between the mosses and bacteria,” explains Marie-Charlotte, who describes a fascinating interaction.

The process is not continuous, and only takes place during certain periods. When it is time, the moss sends out signals that make the cyanobacteria form thread-shaped structures that they use in movement. The moss then sends out another signal to attract the bacteria. On the moss leaf, these filaments develop further into cyanobacteria, which can trap nitrogen.

The whole process starts when the moss requires nitrogen for its own uses. Consequently, the process stops when the forest is fertilised, because the moss no longer needs to produce its own nitrogen.

The researchers are now trying to identify exactly what types of chemical signals the moss sends out.

“The mosses are very exciting. If you go out in a very old forest and measure the growth of stemwood and shoots, and compare the dry weight with the mosses and

berry shrubs that are stimulated by the mosses, the productivity is approximately the same in the tree layer as it is in the field layer. The moss contains a microfauna with hundreds of species, ranging from nematodes to springtails and tardigrades. The extent to which the mosses’ nitrogen fixation can be increased remains to be seen, but it’s an exciting thought,” says Marie-Charlotte.



Marie-Charlotte is once again working with forest fires in another context, together with doctoral student Theresa Ibáñez, who has recently been employed via TC4F. In the area of the large forest fire in Västmanland, they are carrying out regeneration trials in greenhouses with open roofs. This simulates a temperature increase of a couple of degrees. In the greenhouses, three different provenances of spruce and pine are being tested. In addition to the trials on the fire area, the same provenance experiments are carried out in the adjacent forest, which survived the flames. The project involves both simulating climate change and managing regeneration after forest fires, as the risk of fires will increase as the climate warms.

“We need to carry out more practical trials to understand how the European forest reacts ahead of a warmer climate. There are many assumptions, but to build good models, we must use realistic trials and experiments. This is difficult research with many components, where temperature increase affects growth, insects, ground vegetation, parasites, fires and precipitation,” says Marie-Charlotte.



**Using the new tools of genetic engineering, Nathaniel Street is mapping a hidden world in the soil, around the roots of trees. By understanding the interactions involving fungi and bacteria, it may be possible to utilise all the good forces and increase the growing power of trees. Trials are also taking place to give pine seeds a good start using helpful fungi.**

# Genetic Tools for the Future

**Text & photo: Pär Fornling**

Nathaniel likes to investigate complicated associations and to find patterns in what, at first glance, appear to be an incomprehensible mishmash. In other words, he has found his perfect niche as a researcher at UPSC (Umeå Plant Science Centre), one of the world's leading research institutes in forest biotechnology.

His research can broadly be divided into two areas:

- Surveying and understanding the interaction between fungi and bacteria, and how these interact with forest trees.
- Surveying and improving understanding of the spruce genome, above all the complex association between different genes that gives the tree its characteristics.

He completed his PhD in 2006 at the University of Southampton. In the work for his thesis, he identified the genetic differences between two different types of poplar clones. One was extremely sensitive to drought, while the other was quite resistant. The interesting idea, was to use genetic engineering to develop drought-resistant individuals, but the research was not taken that far.

He came to Umeå in 2007 at a time of breakthrough. DNA sequencing had given researchers a tool for identifying



microscopic fungi and bacteria in a completely new way. Comparisons of gene sequences showed a species flora in the soil that was infinitely more varied than researchers assumed a few decades ago.

“Twenty years ago, there were a few tens of known species, and ten years ago around a hundred. But thanks to rapid gene sequencing, we now know we’re talking about thousands. What remains is to understand what they do and, not least, how they interact with one another,” says Nathaniel.

It has been known for a long time that tree roots live in symbiosis with certain fungi via mycorrhiza, which mutually benefits the trees and the fungi. But now it is clear that the interaction is very complex.

In addition to differences in the microbial composition in the symbiosis between spruce, pine and other tree species,

there are also geographical differences. The microbial composition in a spruce forest in northern Sweden is expected to be different to that in a spruce forest further south, something that Nathaniel will be examining more closely next year.

He is currently collecting material from spruce and pine stands in large field experiments in Vindeln outside Umeå. DNA is extracted from soil and root samples for sequencing in an external laboratory. This will be followed by laborious work in front of a computer.

“In Sweden, we’re at the forefront in work with coniferous forest, but naturally we’re not the only researchers in this field. The same fungi are undoubtedly being investigated at several research centres around the world. We’re currently in something of a pioneer phase. In the next step, I can see we’ll be working together more, comparing results and drawing conclusions,” says Nathaniel.

Many bacteria and fungi supply nitrogen to the tree and thereby promote growth, but there are also species that have a negative effect. In a neighbouring project with links to SLU, a rather revolutionary seed pad has been developed by the company SweeTree Nutrition. This is a small tray that contains genetically improved pine seeds with a special long-acting fertiliser. The tray can attract water and provides good conditions for seed establishment in the field. Nathaniel’s research group is now studying which fungi establish contact with the seed plant.

One other tangible result of the research can be to use soil analyses to monitor environmental change. Rich fungi and bacteria in the soil are directly linked to the vegetation and diversity of trees and plants.

“So far, we’re only in the learning phase of surveying and understanding the associations between trees, bacteria and fungi. In the next ten years, we’ll learn a tremendous amount. What happens in the soil will be a factor to consider in regeneration of forest,” predicts Nathaniel.



Researchers at UPSC were the first to map the vast genome of the spruce (seven times greater than the human genome).

“Even if everything is mapped, a gigantic puzzle is to link together all DNA sequences to long continuous strands. The aim is to produce complete DNA sequences for each of the spruce’s 12 chromosomes. It’s a laborious job, but we’re well on the way,” explains Nathaniel.

When the complete picture starts to fall into place, the next challenge will be to understand how the genes interact. Nathaniel has studied which genes steer leaf shape in aspens. When researchers understand how it is all connected, this will form a springboard to other functions. Not least, the genetic interaction that steers growth.

“Leaf shape is determined by hundreds of different genes, and some genes seem to be more important than others. We’re now finding differences and associations, which is very exciting. With that knowledge, we can move on to genetically modified trees, but it can also be a tool in conventional plant breeding. Because trees grow relatively slowly, it can take a long time to breed new generations. When we use genetic markers to find out about desirable propensity, we can then select future trees at a much earlier stage,” says Nathaniel Street, researcher in TC4F.





# Part 2



# TC4F theme leaders about the research in 2016

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

**Team leader: Stefan Jansson**

**Photo: Johan Gunséus**

### Overall progress of research in Theme 1 during 2016

The work in Theme 1 on novel forest trees has continued to bridge basic research at Umeå University with operational breeding at Skogforsk. Most of the basic scientific findings of the project have been the result of the analysis of forest trees that are in breeding programmes and/or are interesting for forestry.

Activities within Theme 1 confirm that our scientific environment is producing leading research on forest genetics and genomics, with relevance for forest tree breeding.

A very significant proportion of the funding of Theme 1 is used for research infrastructure (e.g. tree transformation, bioinformatics, field experiments, and cell wall analysis), supplementing other project funding. This infrastructure is used by most research groups connected to UPSC, but not all the research output of these groups is listed here, only those that are directly involved in TC4F.



### Main findings in 2016

Some of the work deals with very fundamental aspects of tree – indeed all plant – biology.

We have studied DNA methylation, which influences gene expression and possibly all other traits in trees (*Ausin et al. 2016*).

We have published a comprehensive review summarising how the tree keeps track of the calendar, i.e. tree phenology (*Ding and Nilsson, 2016*), and studied how trees control flowering time (*Hoenicka et al. 2016, Klocko et al. 2016*). These traits are

not only very important for tree ecology but also for breeders that develop trees for the future.

Another key trait for both the tree and for humans using the tree is wood formation. We have provided more insight into how the interplay between the two plant hormones, auxin and cytokinin, influences cambial activity, i.e. wood formation (*Immanen et al. 2016*).

We have been able to suggest a reason why whole-genome duplications are rare in conifers (*Scott et al. 2016*), and also studied speciation in aspens (*Wang et al. 2016*). This information about basic processes in trees is important for tree breeders, as is data on how genetic variation is created in trees (e.g. *Wang et al. 2016a* and *Wang et al. 2016b*, *Jin et al. 2016*).

Most of the studies concern tree species found in Sweden, but we have also studied gene expression in species from other parts of the world (*Hu et al. 2016a*, *Hu et al. 2016b*). In one review (*Ingvarsson et al. 2016*) we have summarised data concerning the analysis of tree genomes.

Several sub-projects have been direct collaborations between academia and Skogforsk. For example, *Funda et al. (2016)* studied pollination in Scots pine

while other studies have been more directly connected to operational tree breeding at Skogforsk (*Berlin et al. 2016*, *Barring et al. 2016*).

## In what ways is research in Theme 1 contributing to social benefit?

All issues concerning forest tree breeding have an immense impact, both directly and indirectly, on societal benefits. One scientific publication (*Custers et al. 2016*) directly addresses the relationship between tree breeding and society.

The most significant work in relation to society involves activities addressing the uncertain relationship between gene editing using CRISPR/Cas9 (which we specifically develop in the programme) and the legal status of these plants in Europe and the world. A “CRISPR cabbage meal” was reported worldwide, and the groundwork underlying the study (mentioned in the annual report for 2015) was funded by TC4F.

Theme 1 researchers have been very active in the societal debate and in outreach to the public.

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

**Team leader: Vaughan Hurry**

**Photo: Mattias Pettersson**

### Overall progress of research in Theme 2 during 2016

During 2016, we successfully concluded a number of projects begun during Phase 1 and the output from these projects can be seen in the publication list, with a number of additional manuscripts in preparation to complete these first phase projects.

Our research published in 2016 significantly contributed to international



efforts to understand the impacts of climate change on forest growth, health and nutrient cycling in the boreal forest.

To develop these research ideas further, during 2016 we initiated a number of new projects, in line with our overall plan for phase 2 of TC4F. We began support for a new Associate Professor recruited into the program to build on phase 1 modelling efforts and we also recruited a new postdoc to the same project. They have developed a stochastic model to quantification of the effects of leaf level acclimation to fluctuating temperatures on net CO<sub>2</sub> assimilation and have commenced their studies to identify the key climatic drivers for tree health across Sweden.

We also employed two additional postdocs in theme 2 during the year. Expanding on the nutrient cycling research, these postdocs have established the methodologies for amplicon metagenomics and generated data from Norway spruce and aspen. We are currently integrating this with our novel metatranscriptomics data to more broadly apply our novel metatranscriptomics analysis pipeline to our ongoing field studies in order to further our understanding of carbon and nitrogen interactions in boreal forests, laying the foundation for new forest management systems.

## Main findings in 2016

As part of a multi-site multi-nation effort, with collaborators, we have developed a new algorithm for accounting for thermal acclimation of plant respiration in Earth System Models (*Heskel et al. 2016. PNAS. 113:3832-3837*). This work was widely acknowledged by the scientific community and covered in media in many countries.

The role of mycorrhizal fungi in tree nitrogen nutrition was investigated in an earlier phase of the program and in this later phase we have developed this research further studying the role of current photosynthesis on tree nitrogen nutrition (*Hasselquist et al. 2016*).

A new model was developed to test and predict the importance of nitrogen source on growth and development of plants (*Franklin et al. 2016*) and relationships between soil nitrogen fluxes and root nitrogen uptake studied in the field (*Oyewole et al. 2016*).

We have also developed a novel model that suggests that CO<sub>2</sub> assimilation can acclimate partially to climate change-induced higher temperatures but that acclimation cannot buffer against an increase in the variability in future temperatures, which will most likely result in a decrease in average carbon uptake by our forests, and an increase in its inter-season variability (*Ruiz-Pérez, in prep*).

We have developed tools to use RNA Sequencing data to assemble expressed transcripts from both the host tree and the associated fungal and bacterial species present in the metacommunity (called metatranscriptomics analysis). The tools (named Ananas) have been made freely available at: <https://github.com/AnanasAssembler/AnanasAssembler>

We have shown that sequencing RNA from field-collected samples profiles the fungal and bacterial metacommunity. The data obtained provides information on the active biological process within the community. We have utilized our new metatranscriptomics tools to identify expression differences in the metacommunity among plant tissue types and across an annual growth cycle. The method is now established for wider use (*Sundström et al. in prep*).

## In what ways is research in Theme 2 contributing to social benefit?

Our research adds to international efforts to develop process based models to better predict the impacts of climate change on vegetation.

Research within this theme has direct connections to the development of new

fertilizers by the company SweTree Nutrition. During 2016, four patent applications were filed, protecting the use of specific forms of slow release fertilizers.

Our modelling findings are a step forward in our understanding of the potential effects of shifts in the climatic conditions on forest productivity and health, not only in Sweden but globally.

The tools developed for meta-transcriptomics analysis provide previously unavailable insight into the functioning,

response and diversity of the microbial community of Swedish forests. Importantly, we know little about the ecosystem and host-level services provided by these communities and how changes in community composition may impact future forest productivity.

The methods we are developing provide novel tools that will be available to other researchers to explore these essential questions under natural conditions.

## Theme 3 – Sustainable and adaptive forest management

**Team leader: Urban Nilsson**

**Photo: Per Melander**

### Overall progress of research in Theme 3 during 2016

During 2016, researchers from Theme 3 brought research started in the first phase towards a conclusion, but also started new projects that will continue during phase two of TC4F. Two PhD students defended their theses, and most of the research projects started during phase one are now reported in scientific publications.

Research in silviculture is long-term and we rely heavily on field experiments set up by our predecessors. We established several new field experiments and research projects that will be important for the coming years. Examples are a large survey study in mixed forest stands, field experiments on establishment of fast-growing broadleaves, new models for estimating site productivity, and re-measurement of old experiments in Scots pine and Norway spruce.

We also recruited a PhD-student and a postdoc during the year.

### Main findings in 2016

During 2016, Theme 3 has been involved in improving recommendations for pre-



commercial thinning and establishment of mixed-species stands (*Holmström et al. 2016*). We are also developing recommendations for fast-growing broadleaves based on more recent field trials, but more research is still needed in this area (*Böhlenius et al. 2016*). Several articles have been published on these subjects, and the findings have been disseminated in excursions and seminars.

New models have been developed for estimating the effect of climate change on forest production (*Subramanian et al. 2016*), for estimating growth of genetically improved seedling material (*Egbäck et al. 2016*), and for analysing the economic loss

due to damage by browsing (*Nilsson et al. 2016*).

We have found that the fungal community varies in species (e.g. *Pinus contorta*) when introduced to a new environment, which provides an important step forward in understanding how soil biota may impact growth and invasion (*Gundale et al. 2016*).

We have provided evidence that trophic cascades can regulate N<sub>2</sub>-fixation rates in the bryosphere and that elevated rates of N deposition may shift the control of cyanobacterial N<sub>2</sub>-fixation, which may have consequences for the functioning of boreal forest ecosystems (*Kardol et al. 2016*).

We have also found that biochar management affects soil and plant community properties (*Gundale et al. 2016*).

### In what ways is research in Theme 3 contributing to social benefit?

From the start, the research in Theme 3 has been carried out in close collaboration with the forest sector. Researchers have been

involved in numerous presentations aimed at disseminating new results for practitioners and forest owners. However, equally important to knowledge dissemination is the opportunity to listen to representatives from the forest sector to find new relevant research questions.

We have participated in several workshops where the aim has been to improve current methods for forest management, and these workshops often result in new ideas for future research.

A new form of interaction was tested when we were asked by one of the major forest companies to participate in a web-seminar. The experiences from this experiment were very positive and we will continue to develop this form of communication.

Another area where we have been active during 2016 is management of Scots pine in southern Sweden. The area of forests dominated by Scots pine is constantly decreasing in the region and it is important to stop this development. We have been active in communicating this message and we will publish papers describing the negative effects of this ongoing transition of the forest landscape.

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

**Theme leader: Li-Hua Zhu**

**Photo: Viktor Wrange**

### Overall progress of research in Theme 4 during 2016

Overall progress has been satisfactory during the year, which is reflected in the number and quality of scientific articles and the wide range of outreach activities.

The theme involves several subprojects, and research activities concern improvement of oil and starch qualities and quantities, studies on molecular mechanisms of oil accumulation in different



plant tissues, production of insect pheromones in plants, production of biobased materials, evaluation of starch and protein properties in relation to the qualities of biobased products, and studies on molecular mechanisms of autophagy on plant health.

During the year, one researcher was promoted to associate professor, one PhD candidate completed her thesis, two master's students conducted their thesis work on some of the subprojects within the theme, and most of the researchers were actively involved in teaching at various levels. Many senior researchers are either main or co-supervisors for PhD students, and some junior researchers are also involved in co-supervision of PhD students. A couple of new PhD students and postdocs were recruited into the research environments within the theme.

We introduced a new research project on autophagy into the theme, a relatively new research area in plant science. In this subproject we are mainly focusing on understanding the influence of autophagy on plant lipid biosynthesis and the underlying molecular mechanisms, which are largely unknown. Development of methodology and a model system has started in relation to *Arabidopsis*, by combining molecular genetics and cell biology. Such knowledge will later be transferred to other crops.

## Main findings in 2016

For the first time, we showed that wheat plants, through the modulation of the genotype (G) and environmental (E) interactions, can be used as a 'green factory' to fine-tune structure and increase the strength of gluten protein materials. By monitoring GxE interactions (with no use of chemicals) in the plants, films can be produced that are both stiff and strong (*Rasheed et al. 2016*).

We have also produced an innovative composite material from wheat proteins and modified potato starch by extrusion processing, and we showed that the

composition of the blend, selection of plasticizers and processing temperature can improve the strength, stiffness and extensibility of gliadin/glutenin and glycerol films. This suggests the structural-functional relationship of the gliadin/glutenin-potato starch composites, which can be useful in designing various green materials (*Muneer et al. 2016*).

We have shown how different amounts of glycerol impact the nano-structure dynamics and functional properties of gliadin and glutenin protein films. For greatest stiffness and strength material, 10% glycerol protein films were the best choice (*Kuktaite et al. 2016*).

We have developed stable transgenic lines of *Crambe* that can produce large amounts of wax esters through overexpressing the jojoba wax biosynthesis genes (*Zhu et al. 2016*), and lines that can produce ultra-high oleic acid by down-regulating two key oil synthesis genes (*Li X. et al. 2016*). Both wax esters and oleic acid are industrial feedstock of high value.

By using the same approaches as described in *Crambe*, we have successfully developed transgenic lines of the wild species *Lepidium*, which can be used either for food oil or industrial feedstock of high quality (*Ivarson et al. 2016*).

We have shown that potato tuber expression of the *Arabidopsis WRII* gene increased triacylglycerol and membrane lipids while affecting central carbohydrate metabolism (*Hofvander et al. 2016*).

We have produced insect pheromone precursors in tobacco and camelina and converted them into insect pheromones; preliminary tests in the field show promising results.

We have also studied the function of the transcription factor *WRII* originated from different plant species, with the aim of finding new genes involved in oil biosynthesis in different tissues. We have developed a method for live imaging of lipid droplets (LDs) and autophagosomes in *Arabidopsis*.

We have found ten strong enhancers of autophagy and established homozygous *Arabidopsis* lines expressing individual *ATG* genes under seed-specific promoters, and lines co-expressing two or three *ATG* genes under seed-specific and constitutive promoters.. Transcriptomic analysis of wild type, *ATG* knockout and overexpressing plants has revealed several important expression trends supporting observed phenotypes.

### In what ways is research in Theme 4 contributing to social benefit?

The research in Theme 4 is aimed at delivering strong social benefits, directly or indirectly. Plant oil is used as food, fuel and industrial feedstock and it is both renewable and environmentally sound compared with fossil oils.

Increasing plant oil production by improving existing oil crops, where an

infrastructure for extraction is already in place, and developing new oil crops are strategically important as it is expected that more plant oil will be needed in the future due to the growing population and depletion of fossil oils.

Another focus is production of biobased materials with a variety of industrial uses, which are very important in the transition to a biobased society.

Plants could be used as a ‘green factory’ to fine-tune the tensile properties of the materials to avoid or reduce the use of chemicals, by monitoring the interaction of genotype and environment. This will significantly reduce the negative effects of agriculture on the environment and bring social benefits to both farmers and consumers by reducing the use of chemicals and reducing chemical residues in the end products.

Using pheromones in integrated pest management represents environmentally benign means to combat pests compared with the use of insecticides.





# Part 3



# TC4F Activities 2016

## Board Meetings

February 4  
April 14  
October 14  
December 1

## Management Group Meetings

March 16  
November 15

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

### Scientific publications

During 2016 Theme 1 has published 20 peer reviewed scientific articles in international journals. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.

Ausin, I., Feng, S., Yu, C., Liu, W., Kuo, H.Y., Jacobsen, E.L., Zhai, J., Gallego-Bartolome, J., Wang, L., Egertsdotter, U., **Street, N.R.**, Jacobsen, S.E., Wang, H. 2016. DNA methylome of the 20-gigabase Norway spruce genome. *Proceedings of the National Academy USA* doi:10.1073/pnas.1618019113

Berlin, M., Persson, T., **Jansson, G.**, Haapanen, M., Ruotsalainen, S., Barring, L., **Andersson Gull, B.** 2016. Scots pine transfer effect models for growth and survival in Sweden and Finland. *Silva Fennica* 50(3). doi: 10.14214/sf.1562

Barring, L., Berlin, M., **Andersson Gull, B.** 2016. Tailored climate indices for climate-proofing operational forestry applications in Sweden and Finland. *International Journal of Climatology*. doi: 10.1002/joc.4691

Custers, R., Bartsch, D., Fladung, M., **Nilsson, O.**, Pilate, G., Sweet, J., Boerjan, W. 2016. EU regulations impede market introduction of GM forest trees. *Trends Plant Sci.* 21:283-285

**Ding, J.** and **Nilsson, O.** 2016. Molecular regulation of phenology in trees – because the seasons they are a-changin'. *Curr. Opin. Plant Biol.* 29: 73-79

- Funda, T., **Wennström, U.**, Almqvist, C., **Andersson Gull, B.**, **Wang, X-R.** 2016. Mating dynamics of Scots pine in isolation tents. *Tree Genetics & Genomes* DOI 10.1007/s11295-016-1074-z
- Hoenicke, H., Lehnhardt, D., Briones, D., **Nilsson, O.**, Fladung, M. 2016. Low temperatures are required to induce the development of fertile flowers in transgenic male and female early flowering poplar (*Populus tremula* L.). *Tree Physiol.* 36: 667-677
- Horneck, G., Walter, N., Westall, F., Grenfell, J.L., Martin, W.F., Gomez, F., Leuko, S., **Lee, N.**, Onofri, S., Tsiganis, K., Saladino, R., Pilat-Lohinger, E., Palomba, E., Harrison, J., Rull, F., Muller, C., Strazzulla, G., Brucato, J.R., Rettberg, P., Capria, M.T. 2016. AstRoMap European Astrobiology Roadmap. *Astrobiology*, 16(3): 201-243
- Hu, X-G., Liu, H., Zhang, J-Q., Sun, Y-Q., Jin, Y., Zhao, W., El-Kassaby, Y.A., **Wang, X-R.**, Mao, J-F. 2016. Global transcriptome analysis of *Sabina chinensis* (Cupressaceae), a valuable reforestation conifer. *Molecular Breeding* 36:1-15
- Hu, X-G., Liu, H., Jin, Y., Sun, Y-Q., Li, Y., Zhao, W., El-Kassaby, Y., **Wang, X-R.**, Mao, J-F. 2016. De novo transcriptome assembly and characterization for the widespread and stress-tolerant conifer *Platycladus orientalis*. *PLoS One* 11(2): e0148985
- Immanen, J., Nieminen, K., Smolander, O-P., Kojima, M., Alonso Serra, J., Koskinen, P., Zhang, J., Elo, A., Mähönen, A.P., **Street, N.R.**, et al. 2016. Cytokinin and Auxin Display Distinct but Interconnected Distribution and Signalling Profiles to Stimulate Cambial Activity Report Cytokinin and Auxin Display Distinct but Interconnected Distribution and Signaling Profiles to Stimulate Cambial Activity. *Current biology* 26: 1–8
- Ingvarsson, P.K.**, Hvidsten, T.R., **Street, N.R.** 2016. Genome assembly, comparative genomics and populations genetics of forest trees. *New Phytologist*, 212, 338-344, doi:10.1111/nph.14153
- Jin, Y., Wang, S., Hu, X-G., Huang, L-S., Li, Y., **Wang, X-R.**, Mao, J-F. 2016. Genetic evaluation of the breeding population of a valuable reforestation conifer *Platycladus orientalis* (Cupressaceae). *Scientific Reports* 6:34821
- Klocko, A., Ma, C., Robertson, S., Esfandiari, E., **Nilsson, O.** Strauss, S. 2016. FT overexpression induces precocious flowering and normal reproductive development in *Eucalyptus*. *Plant Biotech J.* 14: 808-819
- Norman, A.J., Stronen, A.V., Fuglstad, G., Ruiz-Gonzalez, A., Kindberg, J., **Street, N.R.**, Spong, G. 2016. Landscape relatedness: detecting contemporary fine-scale spatial structure in wild populations. *Landscape Ecology* 32:181
- Qian, C., Yin, H., Shi, Y., Zhao, J., Yin, C., Luo, W., Dong, Z., Chen, G., Yan, X., **Wang, X-R.**, Ma, X-F. 2016. Population dynamics of *Agriophyllum squarrosum*, a pioneer annual plant endemic to mobile sand dunes, in response to global climate change. *Scientific Reports* 6:26613
- Scott, A.D., Stenz, N., **Ingvarsson, P.K.**, Baum, D.A. Whole-genome duplication in coast redwood (*Sequoia sempervirens*) and its implications for explaining the rarity of polyploidy in conifers. *New Phytologist*, 211, 186-193. doi: 10.1111/nph.13930
- Wang, J., **Street, N.R.**, Scofield, D.G., **Ingvarsson, P.K.** 2016. Natural selection and recombination rate variation shape nucleotide polymorphism across the genomes of three related *Populus* species. *Genetics*, 202, 1185-1200. doi: 10.1534/genetics.115.183152
- Wang, J., **Street, N.R.**, Scofield, D.G., **Ingvarsson, P.K.** 2016. Variation in linked selection and recombination drive genomic divergence during allopatric speciation of European and American aspens. *Molecular Biology and Evolution*, 33, 1754-1767
- Zulfugarov, I.S., Tovuu, A., Kim, C-Y., Vo, K.T.X., Ko, S.Y., Hall, M., Seok, H-Y., Kim, Y-K., Skogstrom, O., Moon, Y-H., **Jansson, S.**, Jeon, J-S., Lee, C-H. 2016. Enhanced resistance of *PsbS*-deficient rice (*Oryza sativa* L.) to fungal and bacterial pathogens. *J. Plant Biol.* 59: 616

## Scientific presentations

- Andersson Gull, B.** 2016. *Breeding and breeding results in Sweden*. Invited presentation at LIECO Forum “Forschung für die Praxis – Trees4Future”, St. Martin, Innkreis, Austria, April 28.
- De Vera JP and the Biomex team, including **Lee, N.** 2016. *BIOMEX – past, present and future activities of an ISS-experiment*. Oral presentation at the Annual Astrobiology Conference, Athens, Greece, September 27-30.
- Jansson, S.** 2016. *Natural variation in aspen*. Invited seminar, Stockholm University, February 25.
- Jansson, S.** 2016. *Does EU need GM legislation?* Invited talk at the Mistra Biotech meeting, Falsterbo, March 10.
- Jansson, S.** 2016. *How can spruce keep their needles green in the winter (even in Umeå)?* Invited talk at the SE2B meeting, Frankfurt, April 7.
- Jansson, S.** 2016. *Natural variation in aspen*. Invited talk at Kick-off for the Department of medical chemistry, Umeå University, August, 18.
- Jansson, S.** 2016. *Regulation of autumn leaf senescence in aspen*. Talk at meeting for KAW project. September 18.
- Jansson, S.** 2016. *How can spruce needles be green in the winter?* Talk, Conifers in winter workshop, Umeå, October 24.
- Jansson, S.** 2016. *How can spruce needles be green in the winter?* Invited talk, Nordic photosynthesis congress, Copenhagen Denmark, October 25-27.
- Lee, N.** 2016. *Advanced microscopy techniques for in situ detection of photosynthetic microorganisms and other species relevant in wastewater treatment*. Poster presentation at the Umeå Renewable Energy Meeting (UREM). KBC Center, Umeå University, February 23-25.
- Lee, N.** 2016. *How well have we explored Life on Earth?* Oral presentation at the Annual meeting of the Swedish National Space Board. Umeå, March 16-17.
- Lee, N.** 2016. *How dead is dead? Detecting life, death, or at least biological activity on earth and elsewhere*. Oral presentation at the annual meeting of the Swedish Network of Astrobiology, Uppsala, April 21.
- Lee, N.** 2016. *Advanced approaches for detecting identity, activity, function and other changes in life sciences*. Oral presentation at the BIOlogy and Mars Experiment Meeting – postflight review of the BIOMEX experiment on board EXPOSE-R2, Rome, Italy, May 10-12.
- Lehto, K., **Lee, N.** and the eTimeTrek team 2016. *The educational time trek: a travel through the deep time, the universe and the earth*. Poster at the 1st meeting of Deutsche Astrobiologische Gesellschaft, Berlin; Annual Astrobiology Conference, Athens, Greece, September 27-30.
- Nilsson, O.** 2016. *Molecular regulation of tree phenology*. Invited presentation at the Annual meeting of the European Molecular Biology Organisation (EMBO), Heidelberg, October 27.
- Xiao-Ru, W.** 2016. *Widespread selection and adaptive introgression of parental alleles in the genome of Pinus densata*. Invited talk, IUFRO Genomics and forest tree genetics, Arcachon, France, May 30 - June 3.
- Xiao-Ru, W.** 2016. *Genotyping by sequencing (GBS) - optimization and applications*. Talk at meeting for Skogforsk, Sävar, June 15.

## Popular scientific publications

- Beltran, J.P, **Jansson, S.** van der Meer, J. (contact persons) 2016. Open letter to the President of the European Parliament to encourage society to respect independent science advice and

to condemn physical attacks on scientists 1/7 2016. <http://www.epsoweb.org/respect-science-advice>

- Jansson, S.** 2016. Framtidens trädgårdsväxter är redan här. Blogg och pressrelease <https://www.blogg.umu.se/forskarbloggen/2016/09/framtidens-tradgardsvaxter-ar-redan-har-dagbok-fran-varldens-forsta-tradgardsodling-av-crispr-editerade-vaxter/>
- Jansson, S.** 2016. Future garden plants are here Blogg och pressrelease 5/9 2016. <https://www.blogg.umu.se/forskarbloggen/2016/09/future-garden-plants-are-here-a-diary-from-the-first-crispr-edited-plants-in-the-world/>.
- Jansson, S.** 2016. Greenpeace har gått vilse i GMO-debatten. Dagens ETC 21/8 2016. <http://www.etc.se/debatt/greenpeace-har-gatt-vilse-i-gmo-debatten>
- Jansson, S., Fossdal, C-G.** 2016. Norge et land av «GMO-talibanere» som undergraver vitenskapelig ervervet kunnskap og erkjennelse. Dagbladet 24/10 2016. <http://www.dagbladet.no/kultur/norge-et-land-av-gmo-talibanere-som-undergraver-vitenskapelig-ervervet-kunnskap-og-erkjennelse/64015658>
- Jansson, S., Fossdal, C-G.** 2016. Altfor streng tolkning av genteknologiloven. Dagbladet 22/11 2016. <http://www.dagbladet.no/kultur/altfor-streng-tolkning-av-genteknologiloven/65365661>

## Popular scientific presentations at meetings or excursions

- Christensen, B., Emtenäs, M., **Jansson, S.**, Klaminder, J., Lejon, K., Norqvist, P., Rudälv, C., Telifatides, S. 2016. Presentation at "Levande frågelåda" för sjätteklassare Umeå University, May 12.
- Jansson, S.** 2016. *Framtidens grödor och växter*. Presentation at Grand-dagarna, Stockholm, January 26. <https://soundcloud.com/ume-universitet/stefan-jansson>
- Jansson, S.** 2016. *Genmodifierade växter (GMO) för en hållbar framtid*. Presentation at "Teknik-åttan", Umeå, April 20.
- Jansson, S.** 2016. *To be or not to be a GMO, that is the question*. Talk at TEDx Umeå, May 11. <https://www.youtube.com/watch?v=kyrsNa1jLpo>
- Jansson, S.** 2016. *Genmodifierade växter (GMO) för en hållbar framtid*. Presentation at Midgårdsskolan, Umeå, June 1.
- Jansson, S.** 2016. *En bättre värld*. Podcast at Sommarforskarpodd, RadioScience, September 2. <http://www.radioscience.se/sommarforskare/38-en-battere-varld/>
- Jansson, S.** 2016. *Hur vet trädet att det är höst?* Presentation at Botaniska sällskapet i Stockholm, October 12.
- Jansson, S.** 2016. *How to write a good application?* Presentation on course for Research leaders, Umeå University, October 18.
- Jansson, S.** 2016. *Forskare i media - Varför är det viktigt att synas i debatten, och hur planerar man sin forskningskommunikation?* Presentation for information officers at Umeå University, October 20.
- Lee, N.** 2016. *Will we ever talk to aliens?: Life in extremes and the search for life elsewhere*. Organization of popular scientific meeting series regarding life on earth and in universe. KBC, Umeå University, February 14-15. Including talks by Professor Charles Cockell, UK. <http://www.teknat.umu.se/pressinformation/nyhetsvisning/kommer-vi-nagonsin-att-traffa-aliens.cid262929>
- Lee, N.** 2016. *Vad krävs för liv på andra planeter?* Presentation at Folkuniversitetet, Östersund, November 17.
- Nilsson, O.** 2016. *Umeå Plant Science Centre – ett excellencecenter för växtforskning*. Presentation for the Swedish parliamentary committee on agriculture. Umeå, March 30.
- Nilsson, O.** 2016. *Forest Genomics and Biotechnology*. Presentation for "Asia Business Council". Stockholm, May 27.

- Nilsson, O.** 2016. *How to build a strong research environment?* Presentation on course for research leaders, Umeå University, March 17.
- Robinson, K.M.** 2016. *Natural variation for biomass potential and architecture traits in aspen (Populus tremula).* Invited talk, Accelerated Breeding of Aspen project meeting, Arlanda, January 15.
- Robinson, K.M.** 2016. *Growth and biomass in the Swedish Aspen collection.* Invited talk, Accelerated Breeding of Aspen project meeting, Umeå, October 27.
- Xiao-Ru, W.** 2016. *Biodiversity and tree breeding.* Presentation at the graduate student summer camp, Beijing Forestry University, China. July 12.

## Interviews and presence in media

- Jansson, S.** *Vill bana mark för framtidens grödor.* Interview in local newspaper, Aktum 1/2016. <http://aktum.umu.se/vaxtforskaren-som-vill-bana-vag-for-framtidens-grodor/>
- Jansson, S.** *Vi kommer att äta genförändrade grödor.* Interview in National newspaper, Magasinet Hunger 1/2016
- Jansson, S.** *Nya GMO-aspar skall planteras i Våxtorp.* Interview in Local newspaper, Hallandsposten 16/4 2016. <http://www.hallandsposten.se/nyheter/laholm/nya-gmo-aspar-ska-planteras-i-v%C3%A5xtorp-1.312566>
- Jansson, S.** *Nu klipper vi till livets kod.* Interview in National newspaper, Ingenjören 3/2016. [www.ingenjoren.se/media/2016/07/Ingenjören-3-2016.pdf](http://www.ingenjoren.se/media/2016/07/Ingenjören-3-2016.pdf)
- Jansson, S.** *Professor Stefan Jansson on what makes a GMO, and the Scandinavian Plant Physiology Society.* Interview in international newssite, The Global Plant Council, 1/8 2016. <http://blog.globalplantcouncil.org/interviews/what-makes-a-gmo/>
- Jansson, S.** *Unika GMO-försök i Halland.* Interview in national newspaper, Lantbrukets affärstidning 19/6 2016 s 18
- Jansson, S.** *Förvånansvärt lite är känt om hur träden anpassar sig till vintern.* Interview in national newssite, Natursidan 22/11 2016. <http://www.natursidan.se/nyheter/forvanansvart-lite-ar-kant-om-hur-traden-anpassar-sig-till-vintern/>
- Jansson, S.** *Genmodifierad fotosyntes ökar skördarna.* Interview in National radio, Vetenskapsradion 17/11 2016. <http://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=6565248>
- Jansson, S.** *Så kan lantbruket bli 20 procent effektivare.* Interview in National TV, SVT Vetenskapens värld 17/11 2016 <http://www.svt.se/nyheter/vetenskap/sa-kan-lantbruket-bli-20-procent-effektivare>
- Jansson, S.** *Framtidens trädgårdsväxter är redan här.* Coverage and/or interview in:
- <http://www.tv4.se/nyheterna/klipp/han-odlar-gmo-p%C3%A5-tomten-3536035>
  - <http://www.svt.se/nyheter/lokalt/vasterbotten/genklippt-kal-i-professors-tradgard>
  - <http://www.vk.se/plus/1805611/forsta-crispr-maltiden-lagades-i-umea>
  - <http://www.forskning.se/2016/09/05/varldens-forsta-maltid-med-rattad-gronsak/>
  - <http://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=6508845>
  - <http://sverigesradio.se/sida/artikel.aspx?programid=415&artikel=6513621>
  - <https://sv.wikipedia.org/wiki/CRISPR/Cas9>
  - <http://aspiranten.se/framtidens-mat-blir-crispr-igare/>
  - <http://www.umgasmagazine.com/inthenews-sept9/>
  - <http://www.umea.se/arkiv/nyheter/toppartiklar/genforskareiumeabjodpaunikmaltid.5.9c02b0815706ce69d1dd3a.html>
  - Lantbrukets affärstidning 13/9 2016: Skördetid för kål med bortklippt gen

- Dagens ETC 160920: Forskare hoppas på ny genteknik
- <http://blogg.slu.se/forskarbloggen/en-crisp-ig-sallad/>
- <http://sverigesradio.se/sida/avsnitt/826797?programid=2702>
- <http://sverigesradio.se/sida/artikel.aspx?programid=109&artikel=6598211>
- <http://forskning.no/dna-genteknologi/2016/12/er-du-klar-til-gjore-arhundrets-viktigste-valg-uforberedt-pa-kjempedilemma>

**Jansson, S.** *Future garden plants are here.* Coverage and/or interview in:

- <http://www.sciencemag.org/news/2016/09/did-swedish-researcher-eat-first-crispr-meal-ever-served>
- <http://www.sciencemag.org/news/2016/09/top-stories-directionless-universe-crispr-cabbage-and-earthquake-mystery-solved>
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- <https://decorrespondent.nl/5365/deze-technieken-kunnen-tarwe-zonder-gluten-mogelijk-maken-alleen-komen-ze-nooit-het-laboratorium-uit/1308208343805-dc4ab0b4>
- <http://info.organic.org.tw/supergood/front/bin/ptdetail.phtml?Part=20161004&Rcg=100361>
- <http://www.mediaterre.org/actu,20161005100732,3.html>
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- <http://www.up-magazine.info/index.php/planete/securite-alimentaire/6161-vous-reprendrez-bien-un-peu-d-ogm-ou-vous-preferez-des-oge>
- <http://www.indobic.or.id/crispr-cas9-doesn-t-fall-under-eu-gm-definition/>
- <http://www.genscript.com/crispr-news.html>
- <http://www.zds-bonn.de/aktuelles/tagliatelle-mit-crispr-gemuese.html>

- <http://www.hercampus.com/school/u-toronto/exploring-future-genome-editing-cabbage>
- <http://www.bioteknologiradet.no/2016/10/tror-pa-crispr-mat-innen-fem-ar/>
- <http://www.nzz.ch/wissenschaft/biologie/crispr-y-vegetables-ld.121694>
- <https://lovecells.wordpress.com/2016/09/18/crispr-digest-12/>
- <http://www.progressivegrocer.com/expert-views-phil-lempert-videos/gmo-war-over>
- <http://www.manishchandra.org/is-the-gmo-war-over/>
- [http://m.39yst.com/xinwen/449100\\_3.shtml](http://m.39yst.com/xinwen/449100_3.shtml)
- <http://www.nicojo.nl/100980802>
- <http://www.thefacultylounge.org/2016/12/crispr-in-agriculture-an-overview-of-the-gene-edited-food-that-isnt-a-gmo.html>
- [https://issuu.com/naturvetare/docs/naturvetare\\_nr\\_7\\_2016/30?ff=true](https://issuu.com/naturvetare/docs/naturvetare_nr_7_2016/30?ff=true)
- <https://schillipaepa.net/2016/12/14/postfaktischer-adventskalender-teil-15-genome-editing/amp/>
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- [http://www.lidovsky.cz/nova-geneticka-revoluce-0wf-/zpravy-svet.aspx?c=A161226\\_161938\\_ln\\_zahranici\\_ele](http://www.lidovsky.cz/nova-geneticka-revoluce-0wf-/zpravy-svet.aspx?c=A161226_161938_ln_zahranici_ele)
- <http://forskning.no/dna-genteknologi/2016/12/er-du-klar-til-gjore-arhundrets-viktigste-valg-uforberedt-pa-kjempedilemma>
- <http://gizmodo.com/eight-futuristic-foods-youll-be-eating-in-30-years-1790570240>
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- <http://www.foodprocessing.com.au/content/prepared-food/news/swedish-researchers-prepare-a-meal-for-the-future-846847326>
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- <http://www.bioteknologiradet.no/2016/10/tror-pa-crispr-mat-innen-fem-ar/>
- <http://www.nzz.ch/wissenschaft/biologie/crispr-y-vegetables-ld.121694>
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- <http://www.ibv-blog.com/edito/scandinavie/>

**Lee, N.** *Hon vill förstå livets mysterier.* Interview. August 11. <http://www.umu.se/forskning/popularvetenskap/forskningsreportage/hon-vill-forsta-livets-mysterier//hon-vill-forsta-livets-mysterier.cid272042>

**Lee, N.** *Mossor och lavar i rymden.* Interview: <http://www.umu.se/om-universitetet/aktuellt/nyheter/nyhetsvisning//umea-universitet-vantar-med-spanning-pa-biologiska-prover-fran-rymden.cid270141>

**Lee, N.** *Finns det liv ute i rymden?* Inlägg i ungdomstidningen Kamratposten, 2016, no 7.

**Lee, N.** *Vi pratar med Natuschka Lee.* Researcher profile interview about biology in space. In the Swedish Popular Science Magazine: "Allt om Vetenskap", year 2016, volume 11, p. 25, <http://www.alltomvetenskap.se/nyheter/vi-pratar-med-natuschka-lee>

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

- 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.
- **Ingvarsson, Pär:** “Climate-adapted poplar through more efficient breeding and better tools for matching genotype and site - developing the poplar bio-economy market in Sweden and the Baltic” - Formas-funded project in collaboration with SweTree technologies.

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

- **Xiao-Ru, W.** Formas, 2015-2017, “Long-term sustainable forest production: knowledge-based strategies in seed orchard and reforestation operations”, 5 300 000 SEK.
- **Xiao-Ru, W.** Bo Rydins Stiftelse, 2017-2018, “Hur stor är pollenkontamineringen i fröplantager: Nivåer och konsekvenser för klimatanpassning och produktion”, 994 000 SEK.
- **Nilsson, O.** Vinnova 2017-2021. UPSC Centrum för Skogsbioteknik 35 000 000 SEK.
- **Nilsson, O.** KAW 2017-2021. Forest biology and biotechnology 48 000 000 SEK.
- **Jansson, S.** VR 2017-2020. How do trees survive the winter? 3 600 000 SEK.

## 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 and MSc theses*

**Emelie Ivarson.** 2016. PhD thesis: *Development of Lepidium campestre into a new oil and catch crop.* Alnarp: Sveriges lantbruksuniversitet. Doctoral thesis No. 2016:121. ISSN: 1652-6880, SLU.

### *Supervision and teaching*

**Ingvarsson, P.** Supervisor for Jing Wang. 2016 Doctoral Thesis: *The genomic signatures of adaptive evolution in Populus.*

**Ingvarsson, P.** Teaching at the course “Evolutionary Biology”, Umeå University, 15 ETCS.

**Ingvarsson, P.** Teaching at the course “Genetics and Evolution”, Umeå University, 15 ETCS.

**Jansson, S.:** Supervisor for Erik Edlund 2016 Doctoral Thesis: *Regulatory Control of Autumn Senescence in Populus tremula.*

**Jansson, S.** Teaching at the course “Plant biotechnology and molecular breeding” 15 ETCS, 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.** Supervisor for international undergraduate student Mercedes Beatriz Alvarez Ortega, Pontificia Universidad Javeriana, Columbia. Topic: *Biology of nitrogen transformation in different environmental ecosystems on Earth.*

**Lee N.** Supervisor for international undergraduate student Nilita Mukjang, Science and Technology Service Center, Faculty of Science, Chiang Mai University, Thailand. Topic: *Plant microbiology.*

**Lee N.** Supervisor for master student Niki Andersson, Umeå University. Topic: *Biology and biodiversity of tardigrades in the world and in Sweden.*

**Lee, N.** Introduction to astrobiology, at the undergraduate Summer course Planetary Exploration in Kiruna, Umeå University, 7.5 ECTS, organized by the department of physics.

**Lee, N.** Introduction to viral and microbial ecology, at the undergraduate course “Inventeringsmetodik och systematics” at Umeå University. 15 ECTS.

**Nilsson O.**: Main supervisor for PhD-candidate **Shashank Sane**. Tentative title: *Regulation of phenology and the juvenility-to-maturity transition in trees*. Expected date for dissertation: December, 2017.

**Nilsson O.**: Main supervisor for PhD-candidate **Domenique André** Tentative title: *Regulation of the annual cycle of growth and dormancy in trees*. Expected date for dissertation: December, 2019.

**Nilsson, O.** Teaching at the course “Plant biotechnology and molecular breeding” 15 ETCS, Umeå.

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

**Nilsson, O.** Teaching at the course “Inledande ingenjörskurs i Bioteknik” (5MO072), 7.5 ECTS, Umeå University.

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

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

**Nilsson, O.** Teaching at the course “Plant biology – for future forestry”, 7.5 ECTS, SLU, Umeå.

**Street, N.R.** Supervisor for Master student Andreas Schneider. Title: *16S and ITS amplicon sequencing of Norway spruce and Swedish aspen*. MSc thesis. 30 ECTS. UmU.

**Street, N. R.** Supervisor for Master student Janis Szeremeta. Title: *Technical development of a 16S amplicon processing pipeline*. MSC thesis. 15 ECTS. UmU.

**Street, N. R.** Main supervisor for PhD candidate Bastian Schiffthaler.

**Street, N. R.** Main supervisor for PhD candidate Chanaka Mannapperuma.

**Street, N. R.** Co-supervisor for PhD candidate Alex Sullivan.

**Street, N.R.** Course organiser and teaching of the course “Functional Genomics”, 30 ECTS, Umeå university.

**Street, N.R.** Teaching at the course “Future Forests”, 15 ECTS, SLU Umeå.

**Wang, X-R.** Main supervisor for Master student Zandra Fagernäs. Title: *Biogeography of Norway spruce (Picea abies (L.) Karst.)*. Expected date for dissertation: 21 March 2017. 60 ECTS.

- Wang, X-R.:** Main supervisor for PhD-candidate Alex Sullivan. Tentative title: *Biogeography and evolutionary history of Norway spruce*. Expected date for dissertation: Oct, 2018.
- Wang, X-R.** Main supervisor for PhD-candidate Hanhan Xia. Tentative title: *Landscape genetics of Pinus tabuliformis*. Expected date for dissertation: June, 2018.
- Wang, X-R.** Co-supervisor for PhD-candidate Jingxiang Meng. Tentative title: *Hybridization and evolution in Pinus*. Expected date for dissertation: Oct, 2017.
- Wang, X-R.** Co-supervisor for PhD-candidate Biyue Tan. Tentative title: *Genomic selection for Eucalyptus breeding*. Expected date for dissertation: June, 2018.
- Wang, X-R.** Co-supervisor for PhD-candidate Haleh Hayatgheibi. Tentative title: *Quantitative and molecular genetics of lodgepole pine*. Expected date for dissertation: June, 2018.
- Wang, X-R.** Co-supervisor for PhD-candidate Helena Dahlberg. Tentative title: *Genetic diversity of managed Norway spruce forest*. Expected date for dissertation Dec, 2019.
- Wang, X-R.** Co-supervisor for PhD-candidate Li Zhao. Tentative title: *Dynamic response of aquatic microbial community to climate change*. Expected date for dissertation Dec, 2020.
- Wang, X-R.** Co-supervisor for PhD-candidate Fredrik Olajos. Tentative title: *Speciation in the Northern lakes*. Expected date for dissertation Dec, 2020.
- Wang, X-R.** Co-supervisor for PhD-candidate Sofia Nannes. Tentative title: *Climate change and regime shift in Northern ecosystems*. Expected date for dissertation Dec, 2020.
- Wang, X-R.** Teaching at the course “Evolutionary Biology” 15 ETCS, Umeå.
- Wang, X-R.** Teaching at the course “Theoretical Ecology” 15 ETCS, Umeå.
- Wang, X-R.** Teaching at the course “Genetics and Evolution” 30 ETCS, Umeå.
- Wang, X-R.** Teaching at the course “Forskarhandledning i praktiken” (Docent course), Umeå.

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

### Scientific publications

During 2016 Theme 2 has published 26 peer reviewed scientific articles in international journals. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.

- Ausin, I., Feng, S., Yu, C., Liu, W., Kuo, H.Y., Jacobsen, E.L., Zhai, J., Gallego-Bartolome, J., Wang, L., Egertsdotter, U., **Street, N.R.**, Jacobsen, S.E., Wang, H. 2016. DNA methylome of the 20-gigabase Norway spruce genome. *Proceedings of the National Academy USA*. doi:10.1073/pnas.1618019113
- Czaban, W., **Jämtgård, S.**, **Näsholm, T.**, Rasmussen, J., Nicolaisen, M., Fomsgaard, I.S. 2016. Direct acquisition of organic N by white clover even in the presence of inorganic N. *Plant and Soil*. doi: 10.1007/s11104-016-2896-z
- De Kauwe, M., Lin, Y-S., Wrigh, I.J., Medlyn, B.E., Crous, K.Y., Ellsworth, D.S., Maire, V., Prentice, C., Atkin, O.K., Rogers, A., Niinemets, Ü., Serbin, S.P., Meir, P., Uddling, J., Togashi, H.F., **Tarvainen, L.**, Weerasinghe, L.K., Evans, B.J., Ishida, F.Y., Domingues, T.F. 2016. A test of the ‘one-point method’ for estimating maximum carboxylation capacity from field-measured, light-saturated photosynthesis. *New Phytologist*. 210:1130-1144. doi: 10.1111/nph.13815

- Franklin, O.**, Aguetoni-Cambuí, C., Gruffman, L., Palmroth, S., Oren, R., **Näsholm, T.** 2016. The carbon bonus of organic nitrogen enhances nitrogen use efficiency of plants. *Plant Cell & Environment*. doi: 10.1111/pce.12772
- From, F., Lundmark, T., Mörling, T., Pommerening, A., **Nordin, A.** 2016. Effects of simulated long-term N deposition on *Picea abies* and *Pinus sylvestris* growth in boreal forest. *Canadian Journal of Forest Research*. 40: 1396-1403. doi: 10.1139/cjfr-2016-0201
- Hasselquist, N., Metcalfe, D., Inselsbache, E., **Stangl, Z.**, Oren, R., **Näsholm, T.**, Högberg, P. 2016. Greater carbon allocation to mycorrhizal fungi reduces tree nitrogen uptake in a boreal forest. *Ecology*. doi: 10.1890/15-1222
- He, H., Jansson, P-E., Svensson, M., Björklund, J., **Tarvainen, L.**, Klemedtsson, L., Kasimir, Å. 2016. Forests on drained agricultural peatland are potentially large sources of greenhouse gases – insights from a full rotation period simulation. *Biogeosciences*. 13:2305-2318. doi: 10.5194/bg-13-2305-2016
- Heskel, M.A., O’Sullivan, O.S., Reich, P.B., Tjoelker, M.G., Weerasinghe, L.K., Penillard, A., Egerton, J.J.G., Creek, D., Bloomfield, K.J., Xiang, X., Sinca, F., **Stangl, Z.R.**, Martinez-del la Torre, A., Griffin, K.L., Huntingford, C., **Hurry, V.**, Meir, P., Turnbull, M.H., Atkin, O. 2016. Convergence in the temperature responses of leaf respiration across biomes and plant functional types. *Proceedings of the National Academy USA*. 113:3832-3837.
- Immanen, J., Nieminen, K., Smolander, O-P., Kojima, M., Alonso Serra, J., Koskinen, P., Zhang, J., Elo, A., Mähönen, A.P., **Street, N.R.** et al. 2016. Cytokinin and auxin display distinct but interconnected distribution and signalling profiles to stimulate cambial activity. *Current biology*. 26: 1–8
- Metcalfe, D., Ricciuto, D., Palmroth, S., **Campbell, C.**, **Hurry, V.** Mao, J., Keel, S.G., Linder, S., Shi, X., **Näsholm, T.**, Ohlsson, K.E., Blackburn, M., Thornton, P.E., Oren, R. 2016. Informing climate models with rapid chamber measurements of forest carbon uptake. *Glob Chang Biol*. doi: 10.1111/gcb.13451
- Maaroufi, N. I., **Nordin, A.**, Palmqvist, K., **Gundale, M.J.** 2016. Chronic nitrogen deposition has a minor effect on the quantity and quality of aboveground litter in a boreal forest. *PLOS ONE* 11. doi: 10.1371/journal.pone.0162086
- Marquardt, K., **Vico, G.**, Eksvärd, K., Glynn, C., Dalin, P., Björkman, C., Weih, M. 2016. Farmer perspectives on introducing perennial cereal in Swedish farming systems: A sustainability analysis of plant traits, farm management, and ecological implications. *Agroecology and Sustainable Food Systems*. 40(5), 432-450
- Norén, L., Kindgren, P., **Stachula, P.**, Ruhl, M., Eriksson, M., **Hurry, V.**, Strand, Å. 2016. HSP90, ZTL and HY5 integrate circadian and plastid signalling pathways to regulate *CBF* and *COR* expression. *Plant Physiology*. 171:1392-1406.
- Norman, A.J., Stronen, A.V., Fuglstad, G., Ruiz-Gonzalez, A., Kindberg, J., **Street, N.R.**, Spong, G. 2016. Landscape relatedness: detecting contemporary fine-scale spatial structure in wild populations. *Landscape Ecology*. 32:181
- Oyewole, O.**, **Jämtgård, S.**, Gruffman, L., Inselsbacher, E., **Näsholm, T.** 2016. Soil diffusive fluxes constitute the bottleneck to tree nitrogen nutrition in a Scots pine forest. *Plant and Soil*. doi: 10.1007/s11104-015-2680-5
- Ruiz-Pérez, G.**, González-Sanchís, M., del Campo, A., Francés, F. 2016. Can a parsimonious model implemented with satellite data be used for modelling the vegetation dynamics and water cycle in water-controlled environments? *Ecological Modelling*. 324, 2016, 45-53, doi:10.1016/j.ecolmodel.2016.01.002.
- Ruiz-Pérez, G.**, Koach, J., Manfreda, S., Caylor, K., Francés, F. 2016. 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*. doi:10.5194/hess-2016-573

- Ruiz-Pérez, G.**, Medici, C., Latron, J., Llorens, P., Gallart, F., Francés, F. 2016. Investigating the behavior of a small Mediterranean catchment using three different hydrological models as hypotheses. *Hydrological Processes*. 30 (13), 2050-2062. doi:10.1002/hyp.10738.
- Sponseller, R., Gundale, M.D., Futter, M., Ring, E., **Nordin, A.**, **Näsholm, T.**, Laudon, H. 2016. Nitrogen dynamics in managed boreal forests: Recent advances and future research directions. *Ambio*. 45: 175-187.
- Stocker, B.D., I. Prentice, C., Cornell, S., Davies-Barnard, T., Finzi, A., Franklin, O., Janssens, I., Larmola, T., Manzoni, S., **Näsholm, T.**, Raven, J., Rebel, K., Reed, S., Vicca, S., Wiltshire, A., Zaehle, S. 2016. Terrestrial nitrogen cycling in Earth system models revisited. *New Phytologist*. 210: 1165-1168.
- Tarvainen, L.**, Lutz, M., Råntfors, M., **Näsholm, T.**, Wallin, G. 2016. Increased needle nitrogen contents did not improve shoot photosynthetic performance of mature nitrogen-poor Scots pine trees. *Frontiers in Plant Science*. doi.org/10.3389/fpls.2016.01051
- Tor-ngern, P.**, Oren, R., Oishi, A.C., Uebelherr, J.M., Parlmroth, S., **Tarvainen, L.**, Ottosson-Löfvenius, M., Linder, S., Domec, J-C., **Näsholm, T.** 2016. Ecophysiological variation of transpiration of pine forests: synthesis of new and published results. *Ecological Applications*. doi: 10.1002/eap.1423
- Vico, G.**, Manzoni, S., Nkurunziza, L., Murphy, K., Weih, M. 2016. Trade-offs between seed output and life span - A quantitative comparison of traits between annual and perennial congeneric species. *New Phytologist*. 209(1), 104-114
- Wang, J., **Street, N.R.**, Scofield, D.G., Ingvarsson, P.K. 2016. Natural selection and recombination rate variation shape nucleotide polymorphism across the genomes of three related populus species. *Genetics*. 202:1185
- Wang, J., **Street, N.R.**, Scofield, D.G., Ingvarsson, P.K. 2016. Variation in linked selection and recombination drive genomic divergence during allopatric speciation of European and American aspens. *Mol Biol Evol*. 33:1754-1767
- Weih, M., Pourazari, F., **Vico, G.** 2016. Nutrient stoichiometry in winter wheat: Element concentration pattern reflects developmental stage and weather. *Scientific Reports*. 6, 35958

## Scientific presentations

- Echevería, C., **Ruiz-Pérez, G.**, Francés, F. 2016. *How relevant is the interannual vegetation's dynamic in the water cycle at catchment scale?* Poster at EGU Meeting 2016, Vienna, Austria, April 17-22.
- Hurry, V.** 2016. *Life in a hothouse world*. Professor installation lecture at SLU, Umeå. May 13.
- Näsholm, T.** 2016. *Plant organic N nutrition*. Oral presentation. Heron Island, Australia, December 6-10.
- Ruiz-Pérez, G.**, Koach, J., Manfreda, S., Caylor, K., Francés, F. 2016. *Automatic calibration of a parsimonious ecohydrological model in a sparse basin using the spatio-temporal variation of the NDVI*. Oral presentation at EGU Meeting 2016, Vienna, Austria, April 17-22.
- Vico, G.**, Feng, X., Dralle, D., Thompson, S.E., Manzoni, S. 2016. *Drought-related leaf phenology in tropical forests – Insights from a stochastic eco-hydrological approach*. Oral presentation. AGU Fall Meeting, San Francisco, CA, USA, December 12-16.
- Vico, G.** 2016. *Managing water in agroecosystems under uncertainty: A probabilistic approach*. Oral presentation. Hydrologi Dagarna, Uppsala, Sweden, March 17.
- Vico, G.**, Manzoni, S., Way, D.A., **Hurry, V.** 2016. *Can leaf net carbon gain acclimate to keep up with global warming?* Oral presentation. Abstract EGU2016-8189, EGU General Assembly 2016, Vienna, Austria, 17-22 April.

**Vico, G.** *Acclimation of leaf net carbon gain under fluctuating and increasing temperatures.*  
Invited seminar. Soil and Water (SoWa), Faculty of Science, University of South Bohemia,  
České Budějovice, Czech Republic, November 14.

## Interviews and presence in media

Vico, G. *Extremväder en utmaning för odlarna.* Interviewed in December as part of the series  
Hej forskare! Of the *Uppsala Nya Tidningen*. The resulting article appeared on Jan 23rd,  
2017.

## Media and press coverage

### Press releases of Heskell et al:

- ARC Centre of Excellence in Plant Energy Biology  
The heat is on – researchers discover global patterns in plant responses to temperature  
<https://www.scimex.org/newsfeed/the-heat-is-on-researchers-discover-global-patterns-in-plant-responses-to-temperature>
- Columbia University  
Scientists Say Many Plants Don't Respond to Warming as Thought  
<http://www.ideo.columbia.edu/news-events/scientists-say-many-plants-dont-respond-warming-thought>

### Media coverage of Heskell et al:

- Global study backs Australian research on carbon:  
<http://www.theaustralian.com.au/national-affairs/climate/global-study-backs-australian-research-on-carbon/news-story/57c2729038a7af4091c0735838cad6f1>  
Was on page 2 of The Australian newspaper (Australian-wide daily paper) on March 22, 2016.
- Scientists say many plants don't respond to warming as thought:  
<http://phys.org/news/2016-03-scientists-dont-thought.html>  
Science news service.
- Plants Adapt to Climate Change Better Than Many Thought  
Daily Mail (London) – March 21, 2016.
- Plants Adapt to Climate Better Than Thought: Study  
Agence France-Presse – march 21, 2016.
- Scientists Say Plants Don't Respond to Warming As Thought  
Science Daily – March 21, 2016.
- Many Plants Don't Respond to Warming as Thought  
SciFeeds – March 21, 2016.
- [https://www.rtf.be/info/societe/detail\\_les-vegetaux-s-adaptent-mieux-au-rechauffement-qu-on-ne-le-craignait?id=9247508](https://www.rtf.be/info/societe/detail_les-vegetaux-s-adaptent-mieux-au-rechauffement-qu-on-ne-le-craignait?id=9247508)
- <http://mobile2.lematin.ch/articles/56f0d6a8ab5c375bb4000002>
- <http://m.zerohora.com.br/284/noticias/5183581/vegetais-se-adaptam-melhor-ao-aquecimento-global-do-que-se-pensava-diz-estudo>

### Other media coverage:

The He et al. study was highlighted in Göteborgs-Posten in October 2016. "Skogen kan vara lika stor miljöbov som bilen", Göteborgs-Posten Oct 9 2106. <http://www.gp.se/livsstil/skogen-kan-vara-lika-stor-milj%C3%B6bov-som-bilen-1.3839232>

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

- SweTree Nutrition AB
- Holmen Skog AB
- SweTree Technologies AB

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

- Lasse Tarvainen, "Phosphorus limitation of carbon assimilation in mature nitrogen fertilized Scots pine trees ", 133.000, SEK, Vidfelts fond. The motivation for this project arose directly from the TC4F funded study (Tarvainen et al., 2016, #4 on the reference list above).
- Giulia Vico "Climate-adapted poplar through more efficient breeding and better tools for matching genotype and site - developing the poplar bio-economy market in Sweden and the Baltic", Applicants: M. Weih, G. Vico, A.C. Rönnberg-Wästljung and A. Karacic (SLU), P. Ingvarsson (Umeå University, Sweden) A. Adler (SweTree Technologies AB, Sweden). Financer: Forest raw material and biomass - Research and development Projects 2016 (FORMAS). Amount: 7156 TSEK. This project is synergistic with the activities of G. Vico in TC4F.

## Investments in research infrastructure

Ongoing infrastructure support provided to the Flakaliden and Rosinedal forest research sites.

## Education

### *PhD theses and MSc theses*

**Andreas Schneider.** 2016. Master thesis: *16S and ITS amplicon sequencing of Norway spruce and Swedish aspen.* 30 ECTS. UmU.

**Janis Szeremeta.** 2016. Master thesis: *Technical development of a 16S amplicon processing pipeline.* 15 ECTS. UmU.

**Oskar Forsum.** 2016. PhD thesis: *On Plant responses to D-amino acids.* Umeå: Sveriges lantbruksuniversitet. Doctoral thesis No. 2016:19. ISSN: 1652-6880, SLU.

### *Supervision and teaching*

**Hurry, V.** Main supervisor for PhD-student Zsofia Réka Stangl. Thesis title: *Acclimation of plants to combinations of abiotic factors: connecting the lab to the field.* ISBN: 978-91-7601-700-5. Date for dissertation: 24<sup>th</sup> May, 2017.

**Hurry, V.** Main supervisor for PhD-student Julia Haas. Tentative thesis title: *Analysis of abiotic and biotic factors affecting conifer seedling establishment.* Expected date for dissertation: September, 2018.

**Hurry, V.** Main supervisor for PhD-student David Castro. Tentative thesis title: *Effect of fertilization over plant performance, rhizosphere community and osmotic stress survival.* Expected date for dissertation: September, 2020.

- Näsholm, T.** Main supervisor for PhD-student Nils Henriksson, Tentative thesis title: *Carbon and nitrogen relations in Boreal forests*. Expected date for dissertation: October, 2017.
- Näsholm, T.** Main supervisor for PhD-student Hyungwoo Lim. Tentative thesis title: *Nitrogen and precipitation interactions determine growth responses to fertilizer applications*. Expected date for dissertation: October, 2017.
- Street, N.** Main supervisor for PhD-student Bastian Schiffthaler.
- Street, N.** Main supervisor for PhD-student Chanaka Mannapperuma.
- Street, N.** Co-supervisor for PhD-student Alexis Sullivan.
- Street, N.** Course organiser and teaching at the course “Functional Genomics”, 30 ECTS, UmU.
- Street, N.** Teaching on the course “Future Forests”, SLU Umeå, 15 ECTS.
- Vico, G.** Co-supervisor for PhD-student Fereshteh Pourazari. Titel: Assessing resource use efficiency in annual and perennial crops. Defended her thesis in September 2016.
- Vico, G.** Main supervisor for Adrien Karolak, intern from University of Picardie ‘Jules Verne’, Amiens, France; research project on the determination of nitrogen use efficiency in winter wheat by means of a model-data intercomparison.
- Vico, G.** Course leader of the master level course BI 1007, “Biology and production of agricultural plants”, SLU Uppsala, 10 ECT.

## Theme 3 – Sustainable and adaptive forest management

### Scientific Publications

During 2016 Theme 3 has published 21 peer reviewed scientific articles in international journals. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.

- Böhlenius, H.**, Övergaard, R. 2016. Impact of seedling type on early growth of poplar plantations on forest and agricultural land. *Scandinavian Journal of Forest Research*. 31(8): 733-741.
- Böhlenius, H.**, Övergaard R, Jämtgård, S. 2016. Influence of soil types on establishment and early growth of *Populus trichocarpa*. *Open Journal of Forestry*. 6, 361-372.
- Böhlenius, H.** Övergaard, R. Asp, H. 2016. Growth response of hybrid aspen (*populus × wettsteinii*) and *Populus trichocarpa* to different pH levels and nutrient availabilities. *Canadian Journal of Forest Research*. 46(11): 1367-1374, 10.1139/cjfr-2016-0146.
- Clery, M. R., Blomquist, M., Vetukuri, R.R., **Böhlenius, H.** Witzell, J. 2016. Susceptibility of common tree species in Sweden to *Phytophthora cambivora*, *P. plurivora* and *P. cactorum*. *Forest pathology*. doi: 10.1111/efp.12329.
- De Long, R.J, Dorrepaal, E., Kardol, P., **Nilsson, M-C.**, Teuber, L.M., Wardle, D.A. 2016. Understory plant functional groups and litter species identity are stronger drivers of litter decomposition than warming along a boreal forest post-fire successional gradient. *Soil Biology and Biochemistry*. 98, 159-170.
- Felton, A., Hedwall, P-O., Lindbladh, M., Nyberg, T., Felton, A., **Holmström, E.**, Wallin, I., Löf, M., Brunet, J. 2016. The biodiversity contribution of wood plantations: Contrasting the bird communities of Sweden's protected and production oak forests. *Forest Ecology and Management*. 365, 51-60.

- Felton, A., **Nilsson, U.**, Sonesson, J., Felton, A.M., Roberge, J-M., Ranius, T., Ahlström, M., Bergh, J., Björkman, C., Boberg, J., Drössler, L., **Fahlvik, N.**, Gong, P., **Holmström, E.**, Kesitalo, C., Klapwijk, M., Laudon, H., Lundmark, T., Niklasson, M., **Nordin, A.**, Pettersson, M., Stenlid, J., Sténs, A., Wallertz, K. 2016. Replacing monocultures with mixed-species stands: Ecosystem service implications of two production forest alternatives in Sweden. *Ambio*, 45, 124–139, DOI 10.1007/s13280-015-0749-2.
- Gundale, M.J.**, Almeida, J.P., Wallander, H., Wardle, D.A., Kardol, P., **Nilsson, M-C.**, Fajardo, A., Pauchard, A., Peltzer, D., Ruotsalainen, S., Mason, B., Rosenstock, N. 2016. Differences in endophyte communities of introduced trees depend on the phylogenetic relatedness of the receiving forest. *Journal of Ecology*. 104:1219-1232.
- Gundale, M.J.**, **Nilsson, M-C.**, Pluchon, N., Wardle, D.A. 2016. The effect of biochar management on soil and plant community properties in a boreal forest. *Global Change Biology Bioenergy*. 8, 777–789.
- Holmström, E.**, Ekö, P-M., **Hjelm, K.**, Karlsson, M., **Nilsson, U.** 2016. Natural regeneration on planted clearcuts – The easy way to mixed forest? *Open Journal of Forestry*. 6: 281-294.
- Holmström, E.**, **Hjelm, K.**, Karlsson, M. **Nilsson, U.** 2016. Scenario analysis of planting density and pre-commercial thinning: will the mixed forest have a chance? *Eur. J. Forest Res.* 135, 885-895.
- Holmström, E.**, **Hjelm, K.**, Johansson, U., Karlsson, M., Valkonen, S., **Nilsson, U.** 2016. Pre-commercial thinning, birch admixture and sprout management in planted Norway spruce stands in South Sweden, *Scandinavian Journal of Forest Research*, DOI:10.1080/02827581.2015.1055792.
- Kardol, P., Spitzer, C.M., **Gundale, M.J.**, **Nilsson, M-C.**, Wardle, D.A. 2016. Trophic cascades in the bryosphere: the impact of global change factors on top-down control of cyanobacterial N<sub>2</sub>-fixation. *Ecology Letters*. 19: 967-976
- Kolstad, A.L., Asplund, J., **Nilsson, M-C.**, Ohlson, M., Nybakken, L. 2016. Soil fertility and charcoal as determinants of growth and allocation of secondary plant metabolites in seedlings of European beech and Norway spruce. *Environmental and Experimental Botany*. 131: 39-46.
- Liziniewicz, M., **Nilsson, U.**, Agestam, E., Ekö, P-M., Elfving, B. 2016. A site index model for lodgepole pine (*Pinus contorta* Dougl. var. *latifolia*) in northern Sweden. *Scandinavian Journal of Forest Research*. 31, 583-591.
- Lundmark, T., Bergh, J., **Nordin, A.**, Fahlvik, N., Poudel, B. 2016. Comparison of carbon balances between continuous-cover and clear-cut forestry in Sweden. *Ambio*, 45, 203-213.
- Nilsson, U.**, **Berglund, M.**, Bergquist, J., **Holmström, H.**, Wallgren, M. 2016. Simulated effects of browsing on the production and economic values of Scots pine (*Pinus sylvestris*) stands. *Scandinavian Journal of Forest Research*, DOI:10.1080/02827581.2015.1099728
- Pluchon, N., Vincent, A.G., **Gundale, M.J.**, **Nilsson, M-C.**, Kardol, P., Wardle, D.A. 2016. The impact of charcoal and soil mixtures on decomposition and soil microbial communities in boreal forest. *Applied Soil Ecology*. 99: 40-50.
- Stuiver, B.M.**, Wardle, D.A., **Gundale, M.J.**, **Nilsson, M-C.** 2016. Seedling responses to changes in canopy and soil properties during stand development following clear-cutting. *Forest Ecology and Management*. 378: 31-43.
- Stuiver, B.M.**, **Gundale, M.J.**, Wardle, D.A., **Nilsson, M-C.** 2016. Corrigendum to “Nitrogen fixation rates associated with the feather mosses *Pleurozium schreberi* and *Hylocomium splendens* during forest stand development following clear-cutting”[*Forest Ecol. Manage.* 347 (2015) 130–139] *Forest Ecology and Management*. 375, 309
- Subramanian, N.**, Bergh, J., Johansson, U., **Nilsson, U.**, Sallnäs, O. 2016. Adaptation of forest management regimes in Southern Sweden to increased risks associated with climate change. *Forests*, 7(1): doi:10.3390/f7010008.



## Scientific presentations

- Holmström, E.** 2016. *Site productivity*. Presentation at a conference at Canterbury University, Christchurch, NZ, February 10-12.
- Holmström, E.** 2016. *Silviculture in mixed forests*. Presentation at the conference “Growing mixed forests – Waste or value for the future?” arranged by Nordgen. Växjö September 20-21.
- Nilsson, U.** 2016. *Site productivity*. Presentation at a conference at Canterbury University, Christchurch, NZ, February 10-12.
- Nilsson, U.** Moderator at the conference “Growing mixed forests – Waste or value for the future?” arranged by Nordgen. Växjö September 20-21.

## Popular scientific presentations at meetings and excursions

- Böhlenius, H.** 2016. *Vilt och skador i odlingarna*. Invited speaker at the seminar ”Odlapoppel & hybridasp!” at Skogforsk research station Ekebo. June 2.
- Böhlenius, H.** 2016. Invited speaker at National Poplar Commission of Sweden yearly meeting.
- Fahlvik, N. & Nilsson U.** 2016. Mortality models, workshop, Helsinki Finland. Aug 10-11.
- Fahlvik, N. & Nilsson, U.** 2016. *Silviculture in Scots pine*. Presentation at excursion arranged by Southern Swedish Forest Research Centre. October 6.
- Holmström, E., Nordin, A., Nilsson-Hegetorn, M-C., Nilsson, U.** 2016. Workshop on mixed forests. March 10-11.
- Holmström, E.** 2016. *Management of mixed forest stands*. Presentation at excursion arranged by Future Forests. June 18.
- Holmström, E.** 2016. *Establishment of mixed forest stands*. Web seminar arranged by Skogssällskapet. October 25.
- Holmström, E.** 2016. *Creating mixed species stands by pre-commercial thinning*. Presentation at excursion arranged by Skånes Skogs- och Betesvårdsförening. November 23.
- Nilsson, U.** 2016. *Spacing of planted seedlings*. Workshop arranged by Holmen Skog, Umeå, January 12.
- Nilsson, U.** 2016. *Production of Scots pine and Norway spruce*. Seminar Skogforsk, Sävar, January 14.
- Nilsson, U.** 2016. *§6 regeneration*. Presentation at workshop arranged by the Forest Agency. Stockholm, January 19.
- Nilsson, U.** 2016. Presentation at a workshop on Polytax arranged by the Forest Agency. Stockholm. January 26.
- Nilsson, U.** Presentation at the annual board meeting of Gustafsborgs säteri. Perstorp. January 30.
- Nilsson, U.** 2016. Diversified forest management. Presentation at excursion arranged by KSLA. Linköping, April 27.
- Nilsson, U.** 2016. *Regeneration and thinning*. Presentation at excursion arranged by Skogssällskapet. Katrineholm. May 25.
- Nilsson, U.** 2016. *Silviculture in Scots pine and lodgepole pine*. Presentation at excursion arranged by Skogssällskapet. June 1.
- Nilsson, U.** 2016. *Scots pine in northern Sweden*. Presentation at conference arranged by Föreningen Skogen. August 31.
- Nilsson, U.** 2016. *Pre-commercial thinning*. Presentation at excursion arranged by Skogssällskapet. Riga, Lithuania, September 28-29.
- Nilsson, U.** 2016. *Thinning of Scots pine and Norway spruce*. Web seminar arranged by Skogssällskapet. November 1.

- Nilsson, U.** 2016. *Pre-commercial thinning*. Presentation at seminar arranged by Forest Agency, Gothenburg, November 16.
- Nilsson, U.** 2016. *Thinning and browsing damage*. Presentation at seminar arranged by Skogssällskapet. Krusenbergs Bruk, November 24.
- Nilsson Hegethorn, M-C.** 2016. *Skogsbrand och skötsel i ett varmare klimat*. Invited speaker at Svenska skogsplantor. Brevens Bruk, November, 16.
- Nilsson Hegethorn, M-C.** 2016. *Återhämtning hos vegetation, markorganismer och ekosystemprocesser efter brand – i bestånd med och utan skogsbruk*. At Sveaskog.
- Nordin, A. & Nilsson, U.** 2016. Continuous cover forestry, workshop in Helsinki, Finland. April 19-20.

## Interviews and presence in media

- Böhlenius, H.** 2016. Gallring skall ge svar. Tidningen Skogen.
- Holmström, E.** 2016. Interview by Lars Klingström ”Mer blandskog kan minska betesskadorna”. Skog och Framtid Nr 2, 2016.
- Holmström, E.** 2016. Snogeholm landscape laboratory, Scapé 15, September.
- Holmström, E.** 2016. Interview by Marie Axelsson ”Hur får lövinblandning bäst resultat?” Ta i Trä, Derome.

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

- FRAS – Future silviculture in Southern Sweden. Research program that is 50% financed by the forest sector in southern Sweden.

## Investments in research infrastructure

- Field experiments on establishment of fast growing broadleaves.
- National field experiments on growth of different tree species.
- National field experiments on establishment and growth of Scots pine and Norway spruce.
- Survey study comparing production and biodiversity of Scots pine and Norway spruce in southern Sweden.
- Survey study comparing production and biodiversity in mixed stands and monocultures.

## Education

### *PhD theses*

**Samuel Egbäck.** 2016. PhD thesis: *Growth of genetically improved stands of Norway spruce, Scots pine and loblolly pine*. Alnarp: Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences. Acta Universitatis agriculturae Sueciae, 2016:4.

**Narayanan Subramanian.** 2016. PhD thesis: *Impacts of climate change on forest management and implications for Swedish forestry. Analysis based on growth and yield models*. Alnarp: Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences. Acta Universitatis agriculturae Sueciae, 2016:58.

### *Supervision*

**Nilsson, U.** Main supervisor for PhD-candidate Egbäck, Samuel. *Growth of genetically improved stands of Norway spruce, Scots pine and loblolly pine*, Dissertation: February 2016.

**Nilsson, U.** Main supervisor for PhD-candidate Subramanian, Narayanan. *Impacts of climate change on forest management and implications for Swedish forestry. Analysis based on growth and yield models.* Dissertation: May 2016.

**Nilsson, U.** Main supervisor for PhD-candidate Nilsson, Oscar. Tentative title: *Management and production of Scots pine and Norway spruce in Sweden.* Expected date for dissertation: May 2020.

**Nilsson, U.** Main supervisor for PhD-candidate Goude, Martin. Tentative title: *Hybrid models of production in Scots pine and Norway spruce in Sweden.* Expected date for dissertation: January 2021.

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

### Scientific publications

During 2016 Theme 4 has published 19 peer reviewed scientific articles in international journals and 1 book chapter. Authors marked in bold represents researchers that have been financed by, or are associated to, the research program.

Doan, T.T.P., **Carlsson, A.S., Stymne, S., Hofvander, P.** 2016. Biochemical characteristics of AtFAR2, a fatty acid reductase from Arabidopsis thaliana that reduces fatty acyl-CoA and –ACP substrates into fatty alcohols. *ACTA Biochimica Polonica*. 63: 565-70.

Gutierrez-Beltran, E., Denisenko, T.V., Zhivotovsky, B. **Bozhkov, P.V.** 2016. Tudor Staphylococcal Nuclease: biochemistry and functions. *Cell Death and Differentiation*. 23: 1739-1748.

**Hofvander, P.,** Ischebeck, T., **Turesson, H.,** Kushwaha, S.K., Feussner, I., **Carlsson, A.S., Andersson, M.** 2016. Potato tuber expression of Arabidopsis WRINKLED1 increase triacylglycerol and membrane lipids while affecting central carbohydrate metabolism. *Plant Biotechnology Journal*. 14:1883–1898.

**Ivarson, E., Ahlman, A., Lager, I., Zhu, L-H.** 2016. Significant increase of oleic acid level in the wild species *Lepidium campestre* through direct gene silencing. *Plant Cell Reports*. 35(10):2055-63. DOI 10.1007/s00299-016-2016-9.

Klionsky, D.J. et al. (including **Bozhkov, P.V.**). 2016. Guidelines for the use and interpretation of assays for monitoring autophagy (3<sup>rd</sup> edition). *Autophagy* 12: 1-222.

**Kuktaite, R., Newson, W.R., Rasheed, F.,** Plivelic, M.S., Hedenqvist, M.S., Gällstedt, M., **Johansson, E.** 2016. Monitoring nano-structure dynamics and polymerization in glycerol plasticized wheat gliadin and glutenin films: relation to mechanical properties. *ACS Sust Chem Eng*. 4:2998-3007.

**Li, X.,** Mei, D., Liu, Q., Fan, J., Singh, S., Green, A., Zhou, X-R., **Zhu, L-H.** 2016. Down-regulation of crambe fatty acid desaturase and elongase in Arabidopsis and crambe resulted in significantly increased oleic acid content in seed oil. *Plant Biotech. J.* 14: 323–331.

Moschou, P.N., Gutierrez-Beltran, E., **Bozhkov, P.V.,** Smertenko, A.P. 2016. Separase promotes microtubule polymerization by activating CENP-E-related kinesin Kin7. *Developmental Cell*. 37: 350-361.

Moschou, P.N., Savenkov, E.I., **Minina, E.A.,** Fukada, K., Reza, S.H., Gutierrez-Beltran, E., Sanchez-Vera, V., Suarez, M.F., Hussey, P., Smertenko, A.P. **Bozhkov, P.V.** 2016. *EXTRA SPINDLE POLES* (Separase) controls anisotropic cell expansion in Norway spruce (*Picea*

- abies*) embryos independently from its role in anaphase progression. *New Phytologist*. 212: 232-243.
- Muneer, F., Andersson, M., Koch, K., Hedenqvist, M., Gällstedt, M., Plivelic, T.S., Menzel, C., Rhazi, L., Kuktaite R.**, 2016. Innovative gliadin/glutenin and modified potato starch green composites: Chemistry, structure and functionality induced by processing. *ACS Sust Chem Eng*, 4(12), 6332-6343.
- Rasel, H., Johansson, T., Gällstedt, M., Newson, W., **Johansson, E.**, Hedenqvist, M. 2016. Development of bioplastics based on agricultural side-stream products: Film extrusion of *Crambe abyssinica*/wheat gluten blends for packaging purposes. *J Appl Pol Sci*. 133, 42442:1-13.
- Rasheed, F., Kuktaite, R.**, Hedenqvist, M.S., Gällstedt, M., Plivelic, T., **Johansson, E.** 2016. The use of the plant as a “green factory” to produce high strength gluten-based plastics. *Green Chem*. 18:2782-2792.
- Smertenko, A., Moschou, P., Zhang, L., Fahy, D. **Bozhkov, P.** 2016. Characterization of cytokinetic mutants using small fluorescent probes. *Methods in Molecular Biology*. 1370: 199-208.
- Volkova, N., **Li X., Zhu, L-H.**, Adlercreutz, P. 2016. Combination of modern plant breeding and enzyme technology to obtain highly enriched erucic acid from *Crambe* oil. *Sustain Chem Process*. 4:1 DOI 10.1186/s40508-016-0045-x.
- Von Arnold, S., Larsson, E., Moschou, P.N., Zhu, T., Uddenberg, D., **Bozhkov, P.V.** 2016. Norway spruce as a model for studying regulation of somatic embryo development in conifers. In: (Yill-Sung Park, Jan M Bonga, Heung-Kyu Moon, eds) *Vegetative Propagation of Forest Trees*. National Institute of Forest Science (NIFoS). Seoul, Korea. pp 351-372.
- Wu, Q., Yu, S., Kollert, M., Mtimet, M., Roth, S.V., Gedde, U.W., **Johansson, E.**, Olsson, R.T., Hedenqvist, M.S. 2016. Highly absorbing antimicrobial biofoams based on wheat-gluten and its biohybrids. *ACS Sust Chem Engineer*. 4:2395-2404.
- Yu, S., Chen, F., Wu, Q., Roth, S., Brüning, K., Schneider, K., **Kuktaite, R.**, Hedenqvist, M. S. 2016. The structural changes of gluten/glycerol plastics at dry and moist conditions and during tensile tests. *ACS Sust Chem Eng*. 4(6), 3388–3397.
- Zhu, L.H., ... Li X.**, et al. 2016. Dedicated industrial oilseed crops as metabolic engineering platforms for sustainable industrial feedstock production. *Sci. Rep.* 6:22181, DOI: 10.1038/srep22181.
- Zhu, L-H.** 2016. *Crambe abyssinica*, Book Chapter 7, pp 195-205. In: *Industrial oil crops* (McKeon T.A., Hayes D.G., Hildebrand D.F. and Weselake R.J. eds), published by AOCS Press.

## Scientific presentations

- Cardoso, C.**, 2016. *Chemical genetics of plant autophagy*. Poster presentation at 5<sup>th</sup> Nordic Autophagy Network Meeting. Keflavik, Iceland, August 31 – September 2.
- Guan, R., Kushwaha, S.K., **Li, X., Hofvander, P., Zhu, L.H.** 2016. *Molecular mechanisms underlying oil synthesis and seed development in Crambe abyssinica*. 12th International Symposium on Biocatalysts and Agricultural Biotechnology (ISBAB), Hong Kong, China, October 17-19.
- Muneer, F., Newson, W. R., Kuktaite, R.**, Gällstedt, M., Hedenqvist, M., Plivelic, T. S. **Johansson, E.** 2016. *Structural and mechanical properties of wheat gluten and potato protein composites as affected by processing temperature and plasticizer*. Oral presentation at 14<sup>th</sup> International Symposium on Bioplastics, Biocomposites and Biorefining, Guelph, Canada. May 31 – June 3.

- Jeppsson, S., Lager, I., Zhu, L-H., Carlsson, A., Stymne, S.** 2016. *Crambe abyssinica DGAT1 and DGAT2 isoform identification and characterization*. Poster presentation at 23th International Symposium on Plant Lipids, Goetingen, Germany, July 3-8.
- Kuktaite, R., Andersen, E.B.C., Newson, W.R., Rasheed, F., Muneer, F., Plivelic, T. S., Hall, S., Johansson, E.** 2016. *Exploring plant protein structure in food and non-food products with the use of X-ray scattering and other techniques*. The 4<sup>th</sup> International Conference on Neutrons and Food, Lund, Sweden, May 31 – June 2.
- Kuktaite, R.** 2016. Chemical side of SLU, *Designing the structures under the light of MAX IV: A story about the plant based polymeric systems*. Invited talk, MAX IV, Lund, August 23 – 24.
- Li, X., Zhu, Li-Hua.** 2016. *Increased monounsaturated wax ester production in theseed oil of Crambe abyssinica*. Poster presentation at 23th International Symposium on Plant Lipids, Goetingen, Germany, July 3 – 8.
- Bozhkov, P.** 2016. *Separase: A key actor in cell polarity*. Plenary lecture, Plant Protease Conference. Oxford, UK; April 10 – 12.
- Bozhkov, P.** 2016, *Manipulating autophagy to improve plant fitness*. Plenary lecture at The 4<sup>th</sup> Meeting of the Spanish Research Network on Autophagy. Madrid, Spain, June 10-12.
- Bozhkov, P.** 2016. *Autophagy in plant development*. Invited talk at workshop on Plant Proteostasis. Barcelona, Spain, September 27 – 28.
- Snell, P., Grimberg, Å., Hofvander, P.** 2016. *WRINKLED1 promoter activity assay reveals complex regulatory network*. Poster at the 22nd International Symposium on Plant Lipids, Göttingen Germany, Juny 5.

## Popular scientific publications

- Newson, W.R., Johansson, E.** 2016. Sustainable packaging from an agricultural product side-stream. Fakta från Partnerskap Alnarp. LTV-fakultetens faktablad 2016:19
- Johansson, E., Newson, W.R., Kuktaite, R., Fredlund, K., Malik, A.H.** 2016. Biobaserad utsädespelletering – gynnsamt för miljön och för utveckling och tillväxt hos den unga sockerbetan. Fakulteten för landskapsarkitektur, trädgårds- och växtproduktionsvetenskap, Info nr 4, 2016.
- Kuktaite, R.** Miljövanlig plast av stärkelse och protein kan läggas i komposten. SLU nyheter, 25th November, 2016. <http://www.slu.se/ew-nyheter/2016/11/miljovanlig-plast-av-starkelse-och-protein-kan-laggas-i-komposten/>

## Interviews and presence in media

- Hansson R., and **Johansson E.** 2016. Framtidens vardagsprodukter – med eller utan olja? Vetenskapsradion 7, September.
- Hofvander P.** 2016. Sockerbeta on TV4, August <http://www.tv4.se/nyheterna/klipp/svensk-genmodifierad-sockerbeta-snart-h%C3%A4r-3472074>
- Kuktaite R.** 2016. Interview with SLU reporter about “Compostable plastics made from potato and wheat” and “Miljövanlig plast av stärkelse och protein kan läggas i komposten”, November. <http://www.slu.se/ew-nyheter/2016/11/miljovanlig-plast-av-starkelse-och-protein-kan-laggas-i-komposten/>  
<http://www.slu.se/en/ew-news/2016/11/compostable-plastics-made-from-potato-and-wheat/>
- Kuktaite R.** 2016. Interviewed with MAX IV in Lund on Studying of structure and morphology in bio-based materials using the synchrotron light, [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)

- Langton M.** 2016. Interview with P4 extra om biomaterial från proteiner, August.
- Langton M.** 2016. Report on Proteinextraktion från mjölmask in Klotet, February.
- Langton M.** 2016. Report on Proteinextraktion från mjölmask in Kossornas planet, August.
- Langton M.** 2016. Report on Proteinextraktion från mjölmask in P4 Uppland, December.
- Zhu L-H.** 2016. Interview with Vetenskapsradio: Här odlas mänskligt blod i tobak, November.  
<http://sverigesradio.se/sida/artikel.aspx?programid=406&artikel=6565335>
- Zhu L-H.** and Bülow L. 2016. Interview with TT: Hon gör vegetariskt blod av tobak i Alnarp, November. <http://www.sydsvenskan.se/2016-12-07/hon-gor-vegetariskt-blod-av-tobak>
- Zhu L-H.** 2016. Interview with Sveriges Radio P4 Norrbotten om fältkrassing. November.

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

- Collaboration with Lantmännen in research of carbon metabolism in barley and oat. **Sun, Q.**
- With SweeTree Technologies on the manipulation of autophagy for improving plant productivity. This collaboration has led to the following patent application:
- **Bozhkov, P., Minina, E.,** Moschou, P., Hofius, D., and **Stymne, S.** Transcriptional stimulation of autophagy improves plant fitness. *Patent Application 1551593-5*
- Collaboration, joint interests and contact with several industries such as Lyckeby Starch AB, Syngenta and ISCA Technologies for carbon flow subproject and pheromone subproject. **Hofvander, P. et al.**
- New Partnership Alnarp project for collaboration with Syngenta Flower division in Netherlands
- Syngenta Seeds AB – Partnerskap Alnarp project *Proteinbaserad utsädespelletering - för förbättrad utsädeskvalitet.* Project leader: **Johansson, E.**, co-applicant: **Newson, W.**
- Lantmännen ek for – Partnerskap Alnarp project *Utveckling av gluten till förnybar barriärplast (ProPlast).* Project leader: **Newson, W.**, co-applicant: **Johansson, E.**
- Syngenta Seeds AB – Partnerskap Alnarp project *Biobaserat bindningmaterial för tillväxtsubstrat för växter.* Project leader: **Johansson, E.**, co-applicant: **Newson, W.**
- Lantmännen ek for – VINNOVA UDI project *Förnyelsebara plastmaterial av vetegluten, uppskalning och upprening för att möta industrins behov.* Project leader: Mikael Hedenqvist KTH, participants **Newson, W., Johansson, E.**
- 23 Organisation consortium, (19 being industry) - MISTRA project STEPS (ongoing from 2015) **Newson, W., Johansson, E., Kuktaite, R.**
- SCA AB and Lantmännen ek for – VINNOVA project Problöja (ongoing from 2015) **Newson, W., Johansson, E.**
- Collaboration with Lantmännen on Mistra Biotech program and FORMAS project on oil crop improvement. **Zhu, L-H.**

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

- Lantmännen grant, 1.653 MSEK for 2016-2018 (thanks to the TC4F research). Project title “Från korn till havre med fokus på betaglukan innehåll i kärna” with project No 2015H024.
- Collaboration with Sveaskog has obtained and resulted in one published publication and one under review.
- Applications in collaboration with *KTH, Lantmännen, RISE (=SP+JTI)* are still under evaluation.
- STEPS, Mistra project (LU main applicant)

- FORMAS, “Novel potato starch and wheat protein textile materials”, PI: **Kuktaite, R.**
- FORMAS, Precise Breeding of Oilseed Species using the CRISPR/Cas9 System. PI **Zhu, L-H.**

## Education

### *PhD theses and MSc theses*

**Axel Carl-Vilhelm Ögell Benediktsson.** 2016. Master thesis: *Expression and characterization of phytoalbumin genes from sugar beet (*Beta vulgaris L.*) in tobacco (*Nicotiana benthamiana*).* Uppsala: Sveriges lantbruksuniversitet.

**Emelie Ivarson.** 2016. PhD thesis: *Development of *Lepidium campestre* into a new oil and catch crop.* Alnarp: Sveriges lantbruksuniversitet. Doctoral thesis No. 2016:121. ISSN: 1652-6880, SLU.

**Pernilla Elander.** 2016. Master thesis: *Understanding biological roles of long chain base desaturation of plant sphingolipids.* Uppsala: Sveriges lantbruksuniversitet.

### *Supervision and teaching*

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

**Bozhkov, P. and Minina, E.** Main supervisor and co-supervisor, respectively, for MSc- student Pernilla Elander. Title of the thesis: *Understanding biological roles of long chain base desaturation of plant sphingolipids.* Defended in October, 2016.

**Carlsson, A.** Main supervisor and **Lager, I., Zhu, L-H., Stymne, S.** 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: 2019.

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

**Hofvander, P.** Main supervisor and **Carlsson, A.** and **Grimberg, Å.** co-supervisors for PhD-student Per Snell. Tentative title: *Genetic and metabolic regulation of oil and other storage products in higher plants.* Expected date for dissertation: October, 2019.

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

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

**Hofvander, P.** Teaching at the course “Plant Biochemistry”, BI1146, 7.5 ECTS, Alnarp.

**Hofvander, P.** Teaching at the course “Applied Plant Biotechnology”, BI1061, 15 ECTS, Alnarp.

**Hofvander, P.** Teaching at the course “Advanced Plant Breeding and Genetic Resources”, BI1057, 15 ECTS, Alnarp.

**Johansson, E. and Newson, W.** Main supervisor and co-supervisor, respectively, for PhD-student Antonio Capezza. Tentative title: *Novel biodegradable superabsorbent materials obtained from different plant proteins.* Expected date for dissertation: September, 2020.

**Johansson, E. and Newson, W.** Main supervisor and co-supervisor, respectively, for Licentiate candidate, Anna-Lovisa Nynäs. Tentative title: *Proteins from green biomass in food structures.* Expected date for dissertation: November, 2018.

- Kanagarajan, S.** Main supervisor for MSc-student Axel Carl-Vilhelm Ögell Benediktsson. Title: *Expression and characterization of phytoalbumin genes from sugar beet (Beta vulgaris L.) in tobacco (Nicotiana benthamiana)*. Defended in October.
- Lager, I.** Course leader and teaching at the course “Plant Biochemistry” (BI1146), 7.5 ECTS, Alnarp.
- Langton, M.** Main supervisor for MSc-student Anni-Kaisa Stengård at University of Helsinki. Title: *Extraction and fibrillation of lupin proteins*, 40 ECTS. Expected date for examination, May 2017.
- Zhu, L-H.** Main supervisor and **Lager, I., Stymne, S.** co-supervisors for PhD-student Emelie Ivarsson. Title: *Development of Lepidium campestre into a new oil and catch crop*. Alnarp: Sveriges lantbruksuniversitet. Defended in December.
- Zhu L-H.** Main supervisor; **Selvaraju Kanagarajan**, co-supervisor for PhD-student Magnus Carlsson. Tentative title: *Human hemoglobin production in plants*. Expected date for dissertation: 2019.
- Zhu, L-H.** Course leader and teaching at the course “Växtfysiologi”, BI1189, 15 ECTS, Alnarp.
- Zhu, L-H.** Course leader and teaching at the course “Applied Plant Biotechnology”, BI1061, 15 ECTS, Alnarp.
- Zhu, L-H.** Course leader and teaching at the course “Advanced Plant Breeding and Genetic Resources”, BI1057, 15 ECTS, Alnarp.





# TC4F Personnel 2016

## Board

Göran Ståhl, SLU  
 Håkan Schroeder, SLU  
 Marianne Sommarin, UmU  
 Ove Nilsson, SLU

## Management Group

Eva Johansson, Program Director, SLU  
 Annika Nordin, Deputy Program Director, SLU  
 Stefan Jansson, Team leader theme 1, UmU  
 Bengt Andersson Gull, Representative, Skogforsk  
 Vaughan Hurry, Team leader theme 2, SLU  
 Urban Nilsson, Team leader theme 3, SLU  
 Li-Hua Zhu, Team leader theme 4, SLU  
 Per Olofsson, Financial Administrator, SLU

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

Name	Gender & Position	Part of full time financed by TC4F (%)
<b>Sara Abrahamsson</b>	F, Researcher	2
<b>Bengt Andersson Gull</b>	M, Research station manager	17
<b>Nicolaus Delhomme</b>	M, Senior research engineer	0
<b>Jihua Ding</b>	F, Post doc	0
<b>Domenique André</b>	F, PhD student	0
<b>Pär Ingvarsson</b>	M, Professor	0
<b>Gunnar Jansson</b>	M, Researcher	3
<b>Stefan Jansson</b>	M, Professor	0
<b>Adam Klingberg</b>	M,	2
<b>Natuschka Lee</b>	F, Researcher	0
<b>Tim Mulin</b>	M, Researcher	1

<b>Ove Nilsson</b>	M, Professor	0
<b>Kathryn Robinson</b>	F, Researcher	30
<b>Mark Rühl</b>	M, Post doc	0
<b>Sane Shashank</b>	M, PhD student	100
<b>Nathaniel Street</b>	M, senior lecturer	40
<b>Alfredo Zambrano</b>	M, Post doc	0
<b>Bo Zhang</b>	M, Post doc	0
<b>Xiao-Ru Wang</b>	F, Professor	0
<b>Ulfstand Wennström</b>	M, Researcher	1
<b>Johan Westin</b>	M, Researcher	20

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

<b>Name</b>	<b>Gender &amp; Position</b>	<b>Part of full time financed by TC4F (%)</b>
<b>Torgny Näsholm</b>	M, Professor	0
<b>Lasse Tarvainen</b>	M, Postdoc	100
<b>George Jocher</b>	M, Postdoc	30
<b>John Marshall</b>	M, Professor	0
<b>Hyungwoo Lim</b>	M, PhD student	0
<b>Nils Henriksson</b>	M, PhD student	0
<b>Sandra Jämtgård</b>	F, Researcher	0
<b>Dörte Randewig</b>	F, Postdoc	0
<b>Oskar Franklin</b>	M, Associate Professor	0
<b>Ross McMurtrie</b>	M, Professor	0
<b>Vaughan Hurry</b>	M, Professor	0
<b>Görel Sundström</b>	F, Postdoc	100
<b>Kathryn Robinson</b>	F, Postdoc	50
<b>Zsofia Stangl</b>	F, PhD student	50
<b>Julia Haas</b>	F, PhD student	0
<b>David Castro</b>	M, PhD student	0
<b>Giulia Vico</b>	F, Assoc. Professor	50
<b>Guiomar Ruiz-Pérez</b>	F, Postdoc	100
<b>Nathaniel Street</b>	M, Assoc Professor	40
<b>Kerstin Richau</b>	F, Postdoc	100
<b>Chanaka</b>	M, PhD student	0
<b>Mannapperuma</b>		
<b>Niklas Mähler</b>	M, Postdoc	0
<b>Annika Nordin</b>	F, Professor	25

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## Theme 3 – Sustainable and adaptive forest management

Name	Gender & Position	Part of full time financed by TC4F (%)
<b>Marie-Charlotte Nilsson-Hegethorn</b>	F, Professor	0
<b>Michael Gundale Nilsson, Urban</b>	M, Docent	25
<b>Euan Mason</b>	M, Professor	0
<b>Hampus Holmström</b>	M, Professor	20
<b>Magnus Mossberg</b>	M, Researcher	10
<b>Tomas Lämås</b>	M, Technician	10
<b>Nils Fahlvik</b>	M, Docent	10
<b>Emma Holmström</b>	M, Researcher	50
<b>Henrik Böhlenius</b>	F, PhD	100
<b>Oscar Nilsson</b>	M, Researcher	50
<b>Karin Johansson</b>	M, PhD-student	100
	F, Researcher	50

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

Name	Gender & Position	Part of full time financed by TC4F (%)
<b>Li-Hua Zhu</b>	F. Professor	0
<b>Eva Johansson</b>	F. Professor	15 for coordination
<b>Chuanxin Sun</b>	M. Researcher	15
<b>Yunkai Jin</b>	M. Guest researcher	0
<b>Folke Sitbon</b>	M. Professor	0
<b>Alexandra Olarte</b>	F. Researcher	25
<b>Maud Langton</b>	F. Professor	0
<b>Anni-Kaisa Stengård</b>	F. Master student	0 (Helsinki University)
<b>Roger Andersson</b>	M. Professor	0
<b>Xue Zhao</b>	F. PhD-student	0
<b>Kerstin Dalman</b>	F. research engineer	35
<b>Elena Minina</b>	F. senior researcher	0
<b>Catarina Cardoso</b>	F. postdoc	0
<b>Sofia Marmon</b>	F. researcher	0
<b>Pernilla Elander</b>	F. master student	0
<b>Peter Bozhkov</b>	M. professor	0
<b>Per Hofvander</b>	M. Researcher	30
<b>Åsa Grimberg</b>	F. Researcher	50
<b>Mariette Andersson</b>	F. Researcher	10
<b>Helle Turesson</b>	F. Research engineer	0
<b>Anders Carlsson</b>	M. Professor	5

<b>Ann-Sofie Fält</b>	F. Technician	10
<b>Per Snell</b>	M. PhD student	0
<b>Faiza Rasheed</b>	F. Post-doc	100
<b>Sven-Erik Svensson</b>	M. PhD-student	35
<b>Ramune Kuktaite</b>	F. Researcher	10
<b>William (Bill) Newson</b>	M. Post-doc	0
<b>Joel Marklund</b>	M. PhD-student	50
<b>Maria Luisa Prieto-Linde</b>	F. Technician	0
<b>Faraz Muneer</b>	M. PhD-student	0
<b>Elaine Ceresino</b>	F. PhD-student	0
<b>Anna-Lovisa Nynäs</b>	F. PhD-student	90
<b>Antonio Capezza</b>	M. PhD-student	0
<b>Xueyuan Li</b>	M. Research Assistant	50
<b>Annelie Ahlman</b>	F. Technician	20
<b>Emelie Ivarson</b>	F. PhD student	10
<b>Selvaraju Kanagarajan</b>	M. postdoc	20
<b>Ida Lager</b>	F. Researcher	0
<b>Simon Jeppsson</b>	M. PhD student	0
<b>Sten Stymne</b>	M. Professor Emeritus	0

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