

C4F- Crops for the Future

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

Overall progress in 2019

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

Detailed research findings and progress

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



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

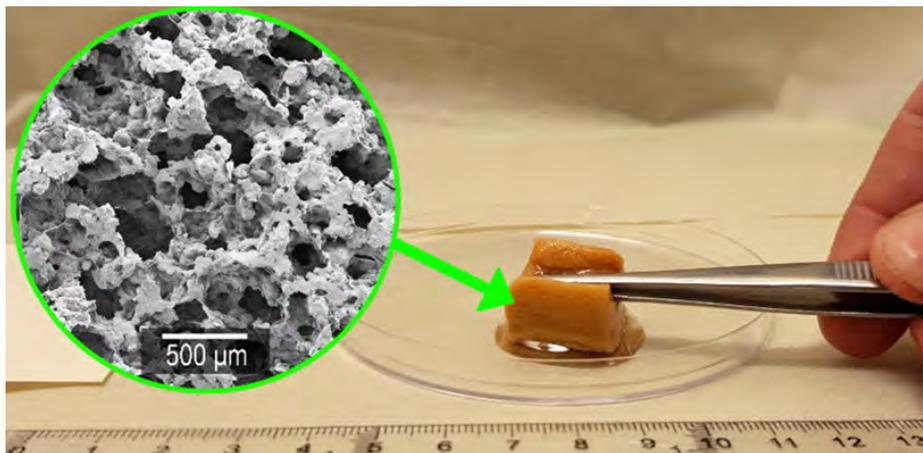


Fig 2. Bio-based sponges based on wheat gluten side-streams displaying high water uptake has been produced, showing petroleum-based sponges used for cleaning purposes and demonstrates that bio-based plastics have high market opportunities for more sustainable products in the future. Photo by Antonio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

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

The incorporation of PNF films was tried, but the results were inconsistent with trouble shooting ongoing. The non-protein part of faba beans has been investigated regarding the polysaccharide composition. One article has been published and manuscripts are in the pipeline of submission or draft regarding the above mentioned research activities.

New improved breeding lines have been developed in rice and barley, namely WRI1 rice, FATB rice and Yin-yang barley. Those lines can be used as proof of concept to develop new cereal varieties in breeding programs for oil production, biotic stress tolerance and high yield as well as high dietary fiber content. AtWRI1 can increase oil content in rice endosperm from 0.9% to 1.6% and a manuscript about this is under preparation.

ACS Sustainable Chemistry & Engineering

November 4, 2019 | Volume 7 | Number 21

pubs.acs.org/acscce

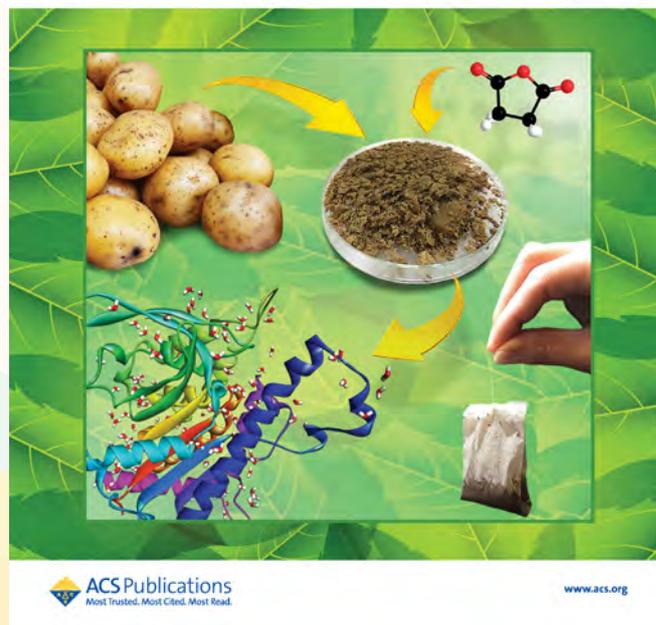


Fig 3. Potential utilization of biopolymers such as wheat gluten for the industrial production of porous materials that could perform in applications where fast and high liquid swelling are needed in daily-care products e.g. sanitary pads. Copyright of the photo belongs to American Chemistry Society.

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

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

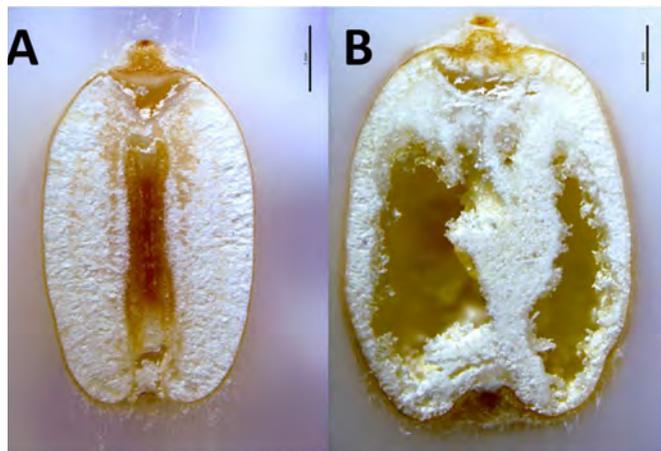


Fig 5. Transgenic wheat with oil production in endosperm. Sliced developing wheat kernels showing inner fluid-filled compartment for GM (right) expressing oat transcription factor WRI1 compared with WT (left). Scale bar: 1 mm. Photos by Per Snell.

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



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

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

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

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

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

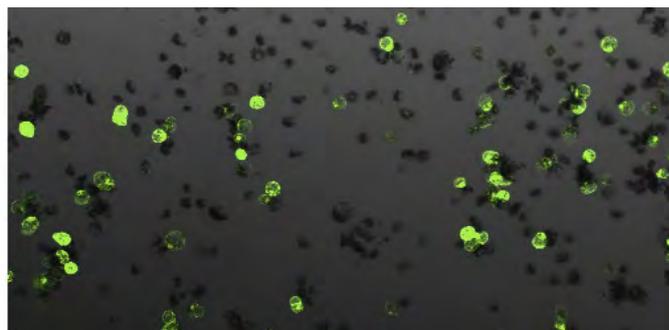


Fig. 5. Shoots (left) regenerated from protoplasts of *Lepidium campestre* and transfected protoplast expressing the marker gene GFP (right). Photos by Li-Hua Zhu (left) and Sjur Sandgrind (right).

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

Integration of genetic and chemical tools for modulating autophagy with luminous reporters has been used for monitoring autophagic flux with the ultimate goal to advance better understanding of

the autophagy regulation in crops. Manuscript on discovery of TFs activating autophagy-related (ATG) genes in *Arabidopsis* is in preparation. The results of establishment of the first chemical screening pipeline for the identification of specific plant autophagy modulators have been published. Structure-activity analysis of the identified plant autophagy-modulating compounds for subsequent photoaffinity labeling and target identification in vivo is ongoing.



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

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

In what has the research contributed to social benefit?

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

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

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

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



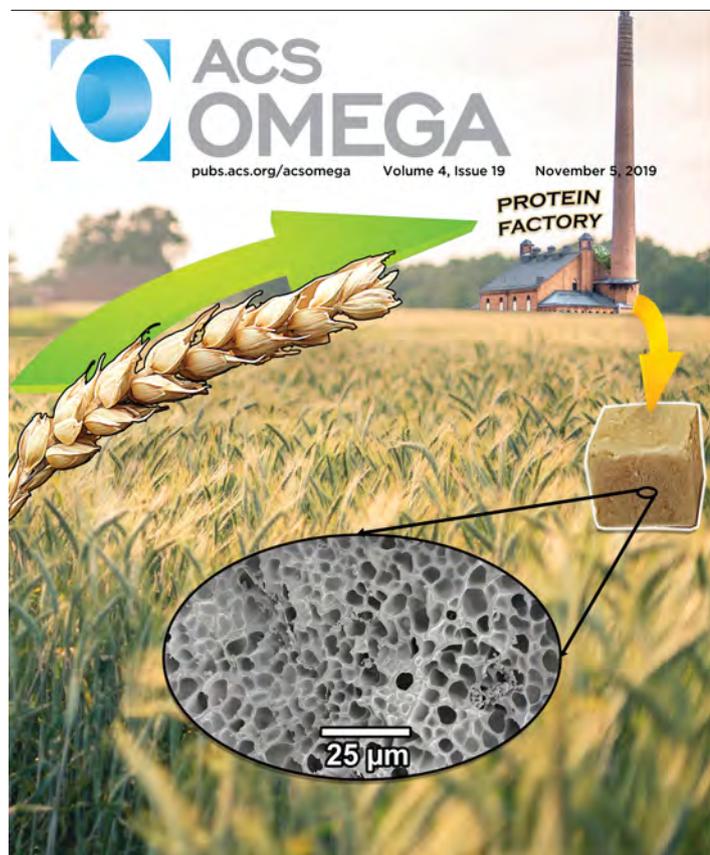
Program leader Eva Johansson



Theme leader and vice program leader Li-Hua Zhu

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

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



C4F - Crops for the Future

Scientific publications

1. Berndtsson E, Nynäs AL, **Newson W**, **Langton M**, Andersson R, **Johansson E**, **Olsson ME**. The underutilised side streams of broccoli and kale – valorisation via proteins and phenols. Sustainable governance and management of food systems: Ethical perspectives 2019. Sep. 19. (pp. 74-81). Wageningen Academic Publishers.
2. **Capezza AJ**, Glad D, Özeren HD, **Newson WR**, Olsson RT, **Johansson E**, Hedengvist MS. (2019). Novel sustainable super absorbents: a one-pot method for functionalization of side-stream potato proteins. ACS Sust Chem Eng. <https://doi.org/10.1021/acssuschemeng.9b04352>
3. **Capezza AJ**, Wu Q, **Newson WR**, Olsson RT, Espuche E, **Johansson E**, Hedengvist MS. (2019). Superabsorbent and fully biobased protein foams with a natural cross-linker and cellulose nanofibers. ACS Omega 4:18257-18267.
4. **Ceresino EB**, **Kuktaite R**, Sato HH, Hedengvist MS, **Johansson E**. (2019). Impact of gluten separation process and transglutaminase source on gluten based dough properties. Food Hydrocolloids 87:661-669. Popular scientific publications (reports etc)
5. Capezza A, **Newson W**, Olsson R, Hedengvist M, **Johansson E**. (2019). Advances in the use of protein-based materials: towards sustainable naturally sourced absorbent materials. ACS Sust Chem Eng 7: 4532-4547.
6. Chen E, Xu Y, Ma B, Cui H, **Sun C***, Zhang M*. (2019). Carboxyl-Functionalized Europium Nanoparticles-Based Fluorescent Immunochromatographic Assay for Sensitive Detection of Citrinin in Monascus Fermented Food. Toxins 11, 605.
7. Das O, Rasheed F, Kim NK, **Johansson E**, **Capezza AJ**, Kalamkarov AL, Hedengvist MS. (2019). The development of fire and microbe resistant sustainable gluten plastics. J Clean Prod 222:163-173.
8. Das O, Hedengvist MS, **Johansson E**, Olsson RT, Loho TA, **Capezza AJ**, Raman RKS, Holder S. (2019). An all-gluten biocomposite: Comparisons with carbon black and pine char composites. Comp Part A: Appl Sci Manufact. 120:42-48.
9. **Dauphinee AN**, **Cardoso C**, Dalman K, Ohlsson JA, Berglund Fick S, Robert S, Hicks GR, **Bozhkov PV**, **Minina EA**. (2019). Chemical screening pipeline for identification of specific plant autophagy modulators (Breakthrough technologies). Plant Physiol. 181, 855-866. (Recommended by F1000Prime).
10. Gargiuloa L, **Grimberg Å**, Repo-Carrasco-Valencia R, Carlsson AS, Melea G. 2019. Morpho-densitometric traits for quinoa (Chenopodium quinoa Willd.) seed phenotyping by two X-ray micro-CT scanning approaches; Journal of Cereal Science 90.
11. Jeppson S, Demski K, **Carlsson AS**, **Zhu L-H**, Banas A, Stymne S and Lager I. 2019. Crambe hispanica Subsp. abyssinica Diacylglycerol Acyltransferase Specificities Towards Diacylglycerols and Acyl-CoA Reveal Combinatorial Effects That Greatly Affect Enzymatic Activity and Specificity. Front. Plant Sci. 10:1442, doi: 10.3389/fpls.2019.01442
12. **Li J**, **Pylypchuk I**, **Johansson D**, **Kessler VG**, **Seisenbaeva GA** & **Langton M**. Self-assembly of plant protein fibrils interacting with superparamagnetic iron oxide nanoparticles. Scientific Reports. (2019). 9:8939. <https://doi.org/10.1038/s41598-019-45437-z>.
13. **Li X**, **Guan R**, Fan J and **Zhu L-H**. 2019. Development of Industrial Oil Crop Crambe abyssinica for Wax Ester Production through Metabolic Engineering and Cross Breeding. Plant and Cell Physiology. 60 (6): 1274-1283.
14. Kushwaha SK, **Grimberg Å**, **Carlsson AS**, **Hofvander P**. 2019. Charting oat (Avena sativa) embryo and endosperm transcription factor expression reveals differential expression of potential importance for seed development; Molecular Genetics and Genomics, 1-15.

15. Ma B, Yu H, Fang J, **Sun C**, Zhang M* (2019) Employing DNA binding dye to improve detection of Enterocytozoon hepatopenaei in real-time LAMP. Scientific Reports, 9, 15860. doi: 10.1038/s41598-019-52459-0.
16. Mendoza A, **Moriana Torro R**, Hillborg H, Strömberg E. (2019). Super-hydrophobic zinc oxide/silicone rubber nanocomposite surfaces. Surfaces and interfaces, 14, ss.146-157. DOI:10.1016/j.surfin.2018.12.008.
17. **Muneer F**, **Johansson E**, Hedenqvist MS, Plivelic TS, **Kuktaite R** (2019). Impact of pH modification on protein polymerization and structure-function relationships in potato protein and wheat gluten composites. Int J Mol Sci 20:58.
18. **Snell P**, **Grimberg Å**, **Carlsson AS**, **Hofvander P**. 2019. WRINKLED1 is subject to evolutionary conserved negative autoregulation; Frontiers in Plant Science 10, 387.
19. Requena R, Jiménez-Quero A, Vargas M, **Moriana R**, Chiralt A, Vilaplana F. (2019). Integral Fractionation of Rice Husks into Bioactive Arabinoxylans, Cellulose Nanocrystals, and Silica Particles ACS Sustainable Chemistry and Engineering, 7, (6), ss.6275-6286. DOI:10.1021/acssuschemeng.8b06692.
20. Rodriguez Furlan C, **Minina EA**, Hicks GR. (2019) Remove, recycle, degrade - Regulating plasma membrane protein accumulation. Plant Cell doi: 10.1105/tpc.19.00433.
21. Tagami A, Gioia C, Laubert M, Budnyak T, **Moriana R**, Lindström M, Sevastanova O. (2019). Solvent fractionation of softwood and hardwood kraft lignins for more efficient uses: Compositional, structural, thermal, antioxidant and adsorption properties. Industrial Crops and Products, 129, ss.123-134. DOI:10.1016/j.indcrop.2018.11.067.
22. Vazquez D, Berger A, Prieto-Linde ML, **Johansson E** (2019) Can nitrogen fertilization be used to modulate yield, protein content and bread-making quality in Uruguayan wheat? J Cereal Sci. 85:153-161.
23. Ye X, Lendel C, **Langton M**, Olsson RT, Hedenqvist MS, 2019. Protein nanofibrils: Preparation, properties, and possible applications in industrial nanomaterials. Chapter 2 in Industrial Applications of Nanomaterials. <https://doi.org/10.1016/B978-0-12-815749-7.00002-5>.
24. Ye X, Junel K, Gällstedt M, **Langton M**, Wei X-F, Lendel C, Hedenqvist M, 2018. Protein/Protein Nanocomposite Based on Whey Protein Nanofibrils in a Whey Protein Matrix. ACS Sustainable Chemistry & Engineering, Volume 6, Issue 4, 2. April 2018, Pages 5462-5469. DOI: 10.1021/acssuschemeng.8b00330.
25. Ye X, Hedenqvist M, **Langton M**, Lendel C, 2018. On the role of peptide hydrolysis for fibrillation kinetics and amyloid fibril morphology. RSC Adv., 2018, 8, 6915. DOI: 10.1039/c7ra10981d.
26. Åhman I, **Kim S-Y** and **Zhu L-H**. 2019. Plant Genes Benefitting Aphids—Potential for Exploitation in Resistance Breeding. Front. Plant Sci. 10:1452. doi: 10.3389/fpls.2019.01452

Popular scientific publications

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

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

Interviews and presence in media

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

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

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

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

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

Scientific presentations

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

Berndtsson E, Nynäs A-L, **Newson W**, **Langton M**, Andersson R, **Johansson E**, and **Olsson ME**, 2019. The underutilised side streams of broccoli and kale – valorisation via proteins and phenols. Sept. 2019., 6th LEAAP International Symposium on Energy and Protein Metabolism and Nutrition

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Popular scientific presentations at meetings or excursions

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

- Klimatstabila grödor i fokus, Lantmannen nr 2 2019

- Äpplen för must och cider tas fram av SLU-forskare, Expertsvar, se, 4 Feb 2019

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

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

- Proteinskiftet väntar, Agfo Weekly, 13 June 2019.

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

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

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

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

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

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

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

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

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

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

Collaboration with industry and/or other parts of society

- Chalmers University of Technology
- Förening u.p.a.
- ISCA Technologies
- KTH- Kungliga Tekniska högskolan
- Lantmännen
- Lilla Harie
- Lyckeby Starch AB
- LINXS- MAX IV and ESS network within the use of latest Infrastructure X-ray and neutron scattering methods
- LRF
- MariboHilleshög
- RISE
- Sveriges Stärkelseproducenter

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

- Grogrund project: "Yin-yang basserade markörer för förädling av spannmål" for 2019-2022
- Lantmännen Research Foundation: "Marker-assisted backcrossing of yin-yang barley with Lantmännen's elite varieties" for 2020-2021
- Vinnova Problöja, Vinnova Plant Protein Factory UDI steg 2 och Vinnova SSAP, steg 1

Investments in research infrastructure

- Co-applicant and received financing for latest Confocal Laser Scanning Microscope
- New HPLC equipment installed with autosampler
- Rheometer
- 3-D Printer

Education

a) PhD theses, MSc theses, Bachelor theses

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

Mingliang Fei. (Male). 2019. Breeding of barley with high fructan in grain and study of the mechanism. Hunan Agricultural University, China.

b) Supervision and teaching

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

C4F- Crops for the Future

Name	Gender & Position	Part of full time financed by TC4F
Eva Johansson	F, Professor, C4F leader	15%
Li-Hua Zhu	F, Professor, C4F vice leader	10%
Sven-Erik Svensson	M, PhD student	35%
Ramune Kuktaite	F, Researcher	0
William (Bill) Newson	M, Postdoc	12%
Joel Marklund	M, PhD student	0
Maria Luisa Prieto-Linde	F, Lab technician	0
Faraz Muneer	M, PhD student	0
Elaine Ceresino	F, PhD student	0
Anna-Lovisa Nynäs	F, PhD student	100%
Antonio Capezza	M, PhD student	0
Emilia Berndtsson	F, PhD student	50%
Marie Olsson	F, Professor	0
Anders Ekholm	M, Lab technician	0
Selvaraju Kanagarajan	M, Researcher	0%
Sjur Sandgrind	F, Postdoc	0
Sungyong Kim	M, PhD student	17%
Xueyuan Li	M, Research assistant	45%
Magnus Carlsson	M, PhD student	50%
Sungyong Kimi	M, Postdoc	0
Rui Guan	F, Postdoc	0
Chuanxin Sun	M, Docent	15%
Yunkai Jin	M, Postdoc	20%
Salim Hossain Reza	M, Postdoc	20%
Folke Sitbon	M, Professor	0
Maud Langton	F, Professor	0
Anja Herneke	F, PhD student	30%
Klara Nilsson	F, PhD student	20%
Sojla Pietäjänen	F, PhD student	0
Rosanna Moriana	F, Researcher	20% until Aug. 2019
Daniel Johansson	M, Researcher	15% from Nov. 2019
Daniel García García	M, Postdoc	0

Xinran Liu. (Sherry)	F, Internship	0
Alicia Vernay	F, Exchange student	0
Büşranur Harmancı	F, Exchange student	0
Saeid Karkehābadi	M, Researcher	0
Per Hofvander	M, Researcher	20%
Åsa Grimberg	F, Researcher	40%
Mariette Andersson	F, Researcher	0
Anders Carlsson	M, Professor	0
Helle Turesson	F, Research engineer	0
Ann-Sofie Fält	F, Lab technician	10%
Mirela Beganovic	F, Lab technician	25%
Per Snell	M, PhD student	0
Peter Bozhkov	M, Professor	0
Kerstin Dalman	F, Research engineer	0
Adrian Dauphinee	M, Postdoc	0
Pernilla Elander	F, PhD student	0
Elena Minina	F, Researcher	0
Anna Åsman	F, Postdoc	50%
Sanjana Holla	F, PhD student	0