Newsletter 4

March 2024

FOSC

ERA-NET Cofund on
Food Systems and Climate

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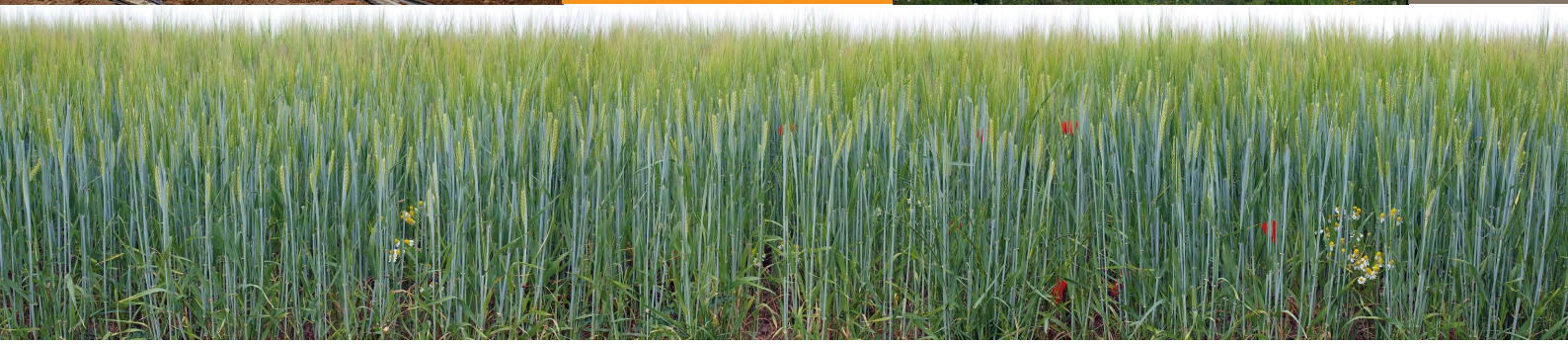


About FOSC

FOSC is the European Reseach Area Network (ERA-Net) Cofund action on Food Systems and Climate. FOSC is built upon and supported by the experience from FACCE-JPI and LEAP-Agri. The consortium consists of 28 partners from Europe, Africa and Latin America. FOSC pulls together resources for a joint research programme and is supported by the European Commission (EC) through an ERA-Net Cofund grant.

How to feed 10 billion people?

FOSC addresses one of our world's major challenges: How to feed 10 billion people by 2050. Ensuring food and nutrition security in the long-term while containing global warming within 1.5 or 2.5 °C, will require major changes on a societal-level and a systemic transformation of our food systems. Important aspects to acknowledge in this are:

- current patterns of food consumption and production increase pressure on already scarce natural resources;
- climate change undermines food systems and reduces food security;
- environmental degradation puts additional pressure on food production
- consumer behaviour patterns favour the predominantly short term vision of food systems; and
- availability of food is highly unequally distributed around the globe.

FOSC ambition

The ambition of FOSC is to implement a range of joint activities to contribute to the creation of a strong and effective trans-national research and innovation network between Europe, Africa, and Latin America.
FOSC aims as well to contribute to the coordination and synergism between national and international research programmes that are relevant to food security under climate change.

The challenge of achieving food and nutrition security within the context of sustainable food systems calls for increased investment and collaboration. It is aspired that the partnership will increase investments in R&D&I through a coordinated regional mechanism aimed at reducing fragmentation.

Activities of FOSC

FOSC initiates and organises additional activities to foster collaborations and enhance impact of research on food systems and climate in Europe and beyond:

- the preparation and implementation of a joint call for proposals (FOSC call 2019);
- the preperation and implementation of a joint call for proposals with ERA-NET SUSFOOD2 (FOSC and SF2 call 2021);
- the deployment of innovative instruments for alignment and collaboration in R&D&I;
- capacity strengthening;
- stakeholder engagement;
- support to policy making;
- organize trainings for researchers; and
- communication and dissemination of results emerging from activities.

FACCEJPI

LEAP-Agri

Knowledge Platform event and training

FOSC consortium and the FOSC project coordinators jointly participated in a successful workshop and training. The event took place on 25-26 October in Bari, Italy, and was organised by the FOSC partner CIHEAM-IAMB, the International Centre for Advanced Mediterranean Agronomic Studies.

Knowledge Platform event

The first day of the event focused on collaboration between the projects and the development of joint valorisation products. The activities were organized as part of the Knowledge Platform activities to develop valorisation products in clustered groups.

The joint development of valorisation products by projects started already in May and June 2023. The project coordinators formed working groups around specific themes to consider what kind of valorisation products could be created when the experience and outcomes of their projects is brought together. On 25 October, groups met in person, with some online participants joining, to advance the development of these valorisation items. Dr Magdalena GAJDZINSKA, Research Policy Officer DG-Research, started off the Knowledge Platform session, setting out key issues regarding valorisation of research results for policy makers and provided relevant information regarding training that would benefit projects teams. Project coordinators then divided into five groups to focus on their valorisation items. The groups had come together around the following topics:

1. Traditional Ecological Knowledge (TEK) in Research (NUTRiGREEN and MedAgriFood Resilience)
   NUTRiGREEN and MedAgriFood Resilience aim to create an 8-10 page digital manual/brochure presenting the value of focus on traditional ecological knowledge, referring to their projects.
2. Foresight for Resilient Food Systems (UrbanFOSC and SAFOODS)
   The UrbanFOSC and SAFOODS projects want to share knowledge on foresight in resilient food systems through an animated video.
3. Valorisation of waste for food and feed (AlgaeBrew; BlueCycling; CHIAM; ClimAqua; Olive3P; PHEALING; ThermoK and TrustFarm)
   Eight projects have teamed up to develop a perspective paper and policy brief on the valorisation of waste for food and feed.
4. Drought and Saline Stress (Biobelief, C4C, Create, SALAD, TrustFarm)
   Five projects have found a common theme of drought and saline stress and will develop an animated video to share general knowledge in the area but also case studies based on their research.
5. Business case study for dairy and citrus farms (SALAD and TrustFarm)
   SALAD and TrustFarm are collaborating to develop a business case studies as a leaflet and also propose development of a virtual reality game to engage farmers with change scenarios.

The project clusters presented their progress in the afternoon, receiving lively constructive feedback from all attendees including funders and external invited participants, to refine ideas for these valorisation products.

Training: amplifying research impact through open innovation and gender equality

The second day in Bari involved a training for the project coordinators. The training, arranged by CIHEAM, included two sessions. The first session focused on how to amplify innovation in research and the second session focused on gender equality.

Innovation consultant, Donato Macario, led the first session, titled 'The importance of Human Centered approach behind a successful organization - Amplifying Research Impact through Open Innovation People-Centered and the Startup Mindset'.

Quote from Donato: 'The most important innovation we need is the human one, the one that starts with new mindsets and new ways of working'.

The session explored how scientific results can be leveraged through a human-centred approach derived from open innovation and a startup mindset. Donato demonstrated the value of collaboration with external stakeholders to bring new perspectives to the valorisation of scientific results; this represented a key element of the human-centred approach. Donato additionally presented ways that the startup mindset can transform research outcomes through an approach that is flexible, agile and value-seeking.

Project updates of the 2019 call

The FOSC projects of the 2019 call are well beyond their mid-term and showing good progress. The recent achievements and intermediate results of the 17 projects are presented below. New project updates are also available through the project websites, social media channels and the FOSC social media channels.

SALAD

SALAD has a number of updates to share, including launching the Saline Agri Map. The online platform presents an overview of saline agriculture projects. You can browse through the world map, click on projects of interest, and read more about each initiatives' details. SALAD also started the COST Action, 'Sustainable use of salt-affected lands' (SUSTAIN). This COST Action aims to build a global transdisciplinary network of scientific experts and engaged stakeholders in the field of salinity research in the context of food security, sustainability and the intensifying climate crisis.

Project partners collaborated in a joint call for action that has been issued to address the pressing global challenge of salinization intensified by climate change. The initiative originated from a dedicated session on sustainable saline agriculture held at the Water Pavilion during the 26th Conference of Parties (COP26) in 2021. It proposes essential steps to catalyse multilateral actions on saline agriculture at various levels. From July to August, Valentine Depras (Department of Geography, McGill University - Canada) pursued her undergraduate field work research on crop farmers' adaptations to soil salinity and water scarcity in Egypt, specifically the Nile River Delta, with a full report of this research available to read.

BLUE-CYCLING

The BLUE-CYCLING project partners have continued with their experiments and modelling work and have started to translate the research into commercial applications. The lab-scale sludge digestion system at the University of Gothenburg has been developed into a pilot-scale prototype, the technology has been patented, and a new industrial demonstration facility will be operational in 2024.

Work is in progress on evaluating optimal aquaponic system design parameters in different socio-economic and climatic conditions, as well as specific projects related to the further development of energy production and nutrient remineralization. Wageningen University has been working on the design of different types of aquaponic networks, ranging from conventional decoupled aquaponic systems to large aquaponics-centred eco-industrial food parks, using modelling of different types of flow within the networks to identify optimal configurations under different climatic conditions. The Leibniz-Institute of Vegetables and Ornamental Crops (IGZ) has been collaborating with SINTEF in planning aquaponic systems globally, considering economic and environmental performance. This involves simulating the optimal system design for different climates, economies, markets, and latitudes, and conducting Life Cycle Assessments. SINTEF is developing a versatile LCA-module which accommodates the dynamic workflows underlying the rapid development in the aquaponics industry. The module will be developed in a generic way to enable widespread use and will integrate with existing LCA software.

IGZ has been conducting experiments to understand the effects of fish feed composition, inorganic fertiliser supplementation, volatile fatty acids in the nutrient solution, and light regimes on plant physiological responses and resource use efficiency in decoupled aquaponic systems. The University of Greenwich has completed a series of trials on novel fish feeds for coupled aquaponic systems using black soldier fly and spirulina as replacements for fish meal and are now conducting comparative Life Cycle Assessments. Maseno University has constructed an aquaponic system to showcase water and nutrient-efficient food production systems. The system

The **FOSC** network received a no-cost **extension** from the Commission in December 2023. The network will r**un one year longer** until **30 September 2025**. This extension will allow the funded projects of the 2019 call to compensate the time lost due to COVID-19 and to finalize their research within the duration of the FOSC ERA-NET

is used by students for research projects, and also plays a pivotal role in training students and the local community in sustainable food production practices. Stellenbosch University has been developing a training manual for aquaponics. Two postgraduate diploma-level aquaponics modules which use hydrid learning, with most content available online and students required to spend minimum practical time on campus, have been developed and piloted.

URBANFOSC

UrbanFOSC has been busy undertaking mapping/ food system analysis and training over the past year. Project partners at the University of Constantine in Algeria have developed a map of formal and informal food retailers and aggregated data of households experiencing food insecurity by neighbourhood in Constantine. In addition, they have interviewed farmers regarding challenges with climate change and food production. With these data, they are completing a comprehensive food system analysis. Similarly in South Africa, UrbanFOSC has completed food system analysis and is working with local stakeholders in the co-design of interventions.

Additionally, the UrbanFOSC project coordinator offered spatial analysis training and used case examples from UrbanFOSC with Algerian partners and presented again with a larger African researcher network, Africa Food Environment Research Network (FERN).

SAFOODS

SAFOODS has made progress this year through an ideotyping workshop held in November in Yamoussoukro to co-design agri-food systems in fruit and vegetables that are resilient to climate change in Côte d'Ivoire. The workshop was led by a group of researchers and development workers from CIRAD, the Institut National Polytechnique Félix Houphouët-Boigny, the Université Nangui Abrogoua, the Université Jean Lorougnon Guédé, and the NGOs NITIDAE, FERT and IECD. For three consecutive days, the workshop brought together market gardeners, wholesalers and agro-suppliers, as well as representatives of NGOs and government advisory services. The participants pooled their knowledge to reflect on agri-food systems that are agro-ecologically efficient and capable to adapt to manifestations of climate change, such as pre- and post-harvest losses and pests.

The ideotyping approach involves designing theoretical (and therefore 'ideal') agri-food systems that appear to be coherent from an agronomic, economic and socio-technical point of view. To do this, participants have to identify and assemble innovations of various kinds (technical, organisational, institutional) in the areas of agricultural production, harvesting, marketing, processing and consumption. This 'coupled' innovation approach makes it possible to solve complex problems that could never be resolved by intervention at a single level. The ideotyping method was designed and developed in Senegal as part of the Fair Sahel and Santés & Territoires projects, as part of work at farm level. For the first time, the

method was tested in a new context, Côte d'Ivoire, and extended to the scale of the agri-food system.

TRUSTFARM

Over the past year, TrustFarm has used innovative technology and sustainable practices to increase production and minimise environmental impacts. In May, they saw evidence of an increase in wheat crop yields as a result, showing the success of their intercropping systems. TrustFarm held their fourth management meeting in July, at University of Bari Aldo Moro, Italy, a three day even which proved to be highly productive and impactful, working together towards common goals.

A target group discussion followed in August, which gathered together individuals from the Al Baraka Association to share and explore ideas and insights about agri-business. Discussion focused on farm seeds and prospects for the community, considering different seed varieties and their potential to revolutionise farming practices. Research on mixed barley durum couscous provided a topic of interest, in terms of bringing it to the market as a healthy food. Challenges to agricultural endeavours were also discussed, considering collaborative ways to overcome them. Soil was also an important topic at this event, with soil samples taken for analysis, to emphasise the importance of a focus on soil health for sustainable and productive agriculture.

In October and November, Trustfarm undertook further project actions. They held a workshop, 'Co-design of sustainable dairy sheep farming systems through innovative feeding practices' in France at the La Fage experimental unit. The La Fage experimental unit is the site of innovations in adapting feeding systems to combat climate change, best practices in barn drying techniques and cultivation of diverse forage crop mixtures and manure analyses for advancement of sustainable farming practices. Finally in November, the dedicated TrustFarm project team from INRA Morocco took key steps towards agroforestry and sustainable agriculture.

They distributed different species of trees (Moringa, Pistachio, Carob, Indian Plum) to assess their adaptation combined with other annual crops. The team is also working towards identifying the most suitable annual crops (barley or oat) to introduce alongside Atriplex, a request from farmers, to enhance soil and crop yields.

CLIMAQUA

The main objective of CLIMAQUA is to develop a flexible system to produce Galdieria sulphuraria biomass that can be used in a decentralized manner in the areas of aquaculture and fish processing, thus contributing to regional development and the reduction of greenhouse gases. The scientific, but also technical working objective of the project is the development of feed production technologies adapted to local environmental conditions based on A. platensis in combination with the treatment of low-value side streams and the recycling of nutrients from inorganic and organic wastewater, sludge, and fish residues from aquaculture. So far the CLIMAQUA project has found that Galdieria sulphuraria does grow heterotrophically on residues from aquacultures. The team developed a process for achieving high biomass concentrations and the production of Galdieria sulphuraria has been transferred to technical scale. Sufficient biomass has been produced for fish trails in Norway at Nofima.

Experiments are ongoing. The possibility of planning future spin-out research and development projects will be analyzed extensively, especially in areas that will contribute to the transferability of the project results to new aquaculture and feed applications using advanced technologies. To facilitate and complement the exploitation outlook of the results, the project will also make selected non-confidential public knowledge available to all the stakeholders. The use of the new knowledge generated for upskilling and for enriching curricula in European and African education will have a high impact for raising the knowledge base to prepare aquaculture and aquafeed industries for accelerating transition to the

environmental-benign, green economy. The project also aims to support policy makers and regulatory bodies in proper decision making.

ThermoK

The collaborative efforts to elucidate the mechanism for breakdown of feather keratin by thermophilic anaerobic members of the Fervidobacterium genus have continued. Six species/strains with different keratinolytic capacities have been completely genome sequenced at UiB using a combination of long and short read sequencing, and genome comparisons are currently ongoing in order to elucidate genetic differences related to feather keratin hydrolyzing capacity.

The French (CEA) and UiB partners have completed comparative transcriptomics and proteomics analyses using cultures grown on feather keratin versus glucose as substrates for the three most efficient keratinolytic strains, which have led to identification of potential key enzymes involved in this process as well as shedding light on central metabolic changes in cells when growing on keratin versus glucose as substrates.

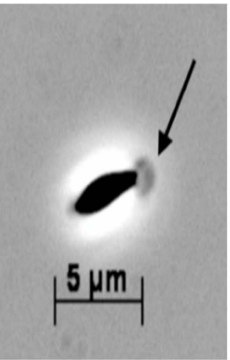
The South African (UFS) and UK (UoE) partners have performed structural and biochemical analyses of several enzymes. Two peptidases with enhanced expression under keratinolytic growth conditions have been structurally solved to high resolution by X-ray crystallography, which will reveal molecular mechanisms for keratin degradation. Additionally, a cocktail of three different heterologously expressed and purified enzymes has been shown to be able to degrade feather keratin in vitro, paving the way to developing an enzyme-based feather degradation process. An analysis of amino acid and peptide degradation products are being determined for potential valorisation of the waste product.

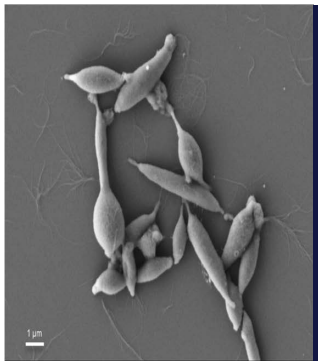
The project was presented at the Thermophiles 2023 conference at the University of Bangor, Wales, UK. In addition to regular online meetings, a mid-term hybrid project meeting was held in Avignon, France, in May 2023, where plans have been discussed to further boost collaborative works.

CHIAM

The CHIAM Project organized a kick-off meeting on November 16th 2021. Since then, many activities have been carried out by the project partners. The Kenyan partner, Deden Kimathi University of Technology, coordinates the project and has established a chia-oyster mushroom demo farm to support research activities and farmer's capacity building. Another Kenyan Partner, Keyrio Farm, grows oyster mushroom. The two Kenyan partners have managed to execute their tasks despite funding delays. The Algerian partner, Centre de Recherche Scientifique et Technique sur les Régions Arides (CRSTRA), focuses on chia cultivation and chemical characterization of chia seeds. CRSTRA gathers information about optimal conditions for chia seeds cultivation in six different sites from the east (Touggourt, El Outaya, M'Sila) to the west (Bechar, Naama, Sidi Belabbas) of Algeria. Those sites represent different climatic conditions that are beneficial to study the effect of climate on yield, nutritional value, chemical composition, and biological properties of chia seeds. In addition, a smart irrigation system has been installed for chia seeds cultivation. Simultaneously, the Egyptian partner, Agriculture Research Centre (ARC) conducts chia breeding to obtain strains that are adaptive to African soils and climate.

In the case of oyster mushroom production, the Hungarian partners, Pilze-Nagy Kft., performed tasks to assess the cultivation technique and market possibilities of oyster mushroom in Kenya. This partner designed an automatic substrate production system that can be placed in a small container and provides high production security based on agricultural by-products of small Kenyan farms. The agricultural by-products are rice straw, banana leaves, corn stalks, corn leaves, elephant grass, and including chia seed hull. They are potential biomass to grow oyster mushroom. Another Hungarian






partner, Bay Zoltan Nonprofit Ltd. for Applied Research, evaluates the suitability of these biomass for oyster mushroom cultivation. Hungarian partners (Pilze-Nagy Ltd. and Bay Zoltan Nonprofit Ltd. for Applied Research) supported DeKUT partners in the establishment of oyster mushroom production site in Kenya. In the meantime, a mushroom growing module was installed in Hungary, which is being tested. Different substrate preparation methods are being examined and compared. Chia cultivation was also started in Hunagry to provide enough raw materials for substrate tests. Hungarian partners invited the Kenyan students and colleagues from the Hohenheim University to strengthen the research collaboration.

University of Hohenheim, German project partner, started the fortification of maize gruel as the staple food in Kenya with chia and oyster mushroom. The fortification is expected to improve its protein, dietary fiber, mineral contents. Two students from DeKUT conducted research at Hohenheim University applied the Nelder-Mead Simplex method for product optimization, focusing on technological effects of chia and oyster mushroom incorporation in the products. The products were evaluated for chemical and nutritional composition as well as the physical and functional properties. The Hungarian Partner, PILZE, supported the product development by providing oyster mushrooms and information about their nutritional quality and knowledge about the African eating habits. Earlier cooperation between DeKUT and UH showed that the nutritional values of Kenyan chia seeds grown on different sites and chia seeds available in Germany are comparable.

SECUREFOOD2050

The SecureFood2050 project has published two papers in 2023, in Separations journal and in Ecological Engineering journal, to disseminate the work they undertook in 2022-23. Part of the team's work has involved monitoring the safety and quality of food products, looking at a broad spectrum of contaminants and how they might diffuse along the agricultural production chain. The open access Separations article, titled, '*Experimental Design and Multiple Response Optimization for the Extraction and Quantitation of Thirty-Four Priority Organic Micropollutants in Tomatoes through the QuEChERS Approach'*, focuses on the chemical contamination of fruit and vegetables, specifically tomatoes as a staple of a Mediterranean diet. Contamination of tomatoes by polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and nitro-PAHs can occur from contaminated soils and water. The SecureFood2050 team developed an approach, fully described in the research article, to investigate tomato contamination in a manner that saves time and is more eco-friendly than traditional procedures.

Another aim of the SecureFood2050 project involves replacement of freshwater with treated waste water (TWW) obtained by using an innovative concept of constructed wetlands (CWs) in which an artificially aerated bed is integrated with a biochar-based filtration section. The second SecureFood2050 project article, titled, *'A critical review on using biochar as constructed wetland substrate: Characteristics, feedstock, design and pollutants removal mechanisms'*, appearing in Ecological Engineering journal, critically reviews updated literature on CWs that integrate biochar in the substrate. This publication focuses on the characteristics of biochar that are generally integrated into this treatment ecotechnology and the processes used to prepare the materials, including conditions of thermal conversion and the kind of feedstock used (e.g., agricultural, food, and wood wastes, sewage sludge and algal marine feedstock).

CRRIsP

The CRRIsP project team has been busy with research trials and conferences in 2023. In June, the trial in Jagersfontein (South Africa) was harvested over two days. The trial involved testing the performance of eight cultivars to determine the best for Jagersfontein farming conditions. The harvest proved to be impressive and farmers were pleased with the quality of harvested potatoes. The second day of events included a visit by Ngaka Modiri Molema District Municipality director (Mr Marava)

who advised the farmers about the support services available from the Northwest Department of Agriculture and Rural Development. The CRRIsP team thanks Jagersfontein farmers and the Bashega Business Development Team for collaboration and Wesgrow Potatoes and Potato Seed Production for their partnership and support. The project team also finished harvesting one of the CRRIsP sites in Potchefstroom (North West). Planting here occurred under mainly rainfed conditions. The CRRIsP team thanks Zwido farm for their partnership.

In September, another season of CRRIsP research trials began in KwaZulu-Natal, South Africa with small-scale farmers. The team interviewed small-holder farmers participating in potato production in KwaZulu-Natal (South Africa). The interviews were conducted to gain knowledge of their farming practices and perspectives on current constraints and anticipated futures in relation to climate change. These activities were done as a case study aimed at gathering information that can inform research agendas as small-holders are less well-positioned to voice their interests and mobilize the support of researchers in addressing their technology challenges. The South African team from North-West University was joined by the Dutch partner from Wageningen University & Research to interview farmers. The interviewing team joined the team planting summer research trials used by Minenhle Nosipho Phungula for her PhD studies and were impressed by the farmer participation in this activity.

During 5-9 September, PhD student Minenhle Nosipho Phungula attended the IX South-Eastern Europe Symposium on Vegetables and Potatoes and had a chance to orally present research work at the international conference. The conference covered various topics ranging from cultivation practices and quality, greenhouse technology, climate change, and sustainable production, smart agriculture, postharvest, and many more.

BICEPS

The BICEPS project is now in a phase of intensive experimentation and laboratory work. The project has established on-farm field experimental sites for biochar studies in two locations in Kenya (Kwale and Embu) and one location in South Africa (Okhalamba) which are now in their second or third season depending on site. In the experimental sites BICEPS researchers are studying the effect of biochar amendment on maize cultivation. In particular the researchers focus on how biochar affects the N cycling and the water use efficiency which are factors that might explain why biochar amendment leads to higher yields.

The project also interacts with the farming community and the field experiments are used as demonstration sites used to showcase biochar effects for the farmers. In Okhalamba the local farming community was invited to a field day on 28 February 2023 and about 100 farmers attended. Apart from information on how to produce and use biochar, the farmers were also visiting the experiment and were invited to share their reflections and provide feedback. In 2024 the results from the biochar experiments will be analysed and published. Based on the experimental results and interviews with farmers the economy of biochar integration will be assessed and potential obstacles to adoption identified. The project will also make a life-cycle analysis (LCA) on the climate impact of biochar utilization in the three local contexts.

NutriGreen

The longest running activity within the NUTRiGREEN project is the Agrometeorological Learning, which was initiated in the first year of the project and implemented in collaboration with the Association Koassanga. This activity involves the daily recording of minimum and maximum temperatures and rainfall by volunteer weather data collectors. The collected data is then summarised in monthly and annual charts. On 13 October 2023, the third meeting took place to discuss and exchange the collected

weather data with seven of the weather data collectors. The participants compared the temperatures, rainy days and precipitation levels for different months and locations.

In the period from July to November 2023, a comparative sorghum study was conducted in collaboration with the locally based Koassanga Association in the Central Plateau, in Burkina Faso. The effects of local seed varieties, local fertilisers in combination with high-quality organic fertiliser and high-quality seed from the Koassanga Association on various yield indicators were investigated. Taking agroecological practices into account, the smallholders compared the different combinations on four adjacent comparison fields of 10m2 each. In parallel, the same trial was conducted in the four villages, Razoutenga, Andem, Daygratenga, and Lelexe. Data analysis is currently underway, but it was already clear during a visit in October that high-quality fertiliser is the decisive factor in increasing production.

From April to July 2023, Master's student Bright Little-Tetteh from the "Institut Agro Rennes-Angers" completed an internship supported by the SLE and the NUTRiGREEN project, with stays in Berlin and Senegal. In his research, he analysed the research approaches and the implementation of the NUTRiGREEN project. In September, he successfully completed his master's thesis entitled "Democratising climate knowledge: An assessment of community knowledge generation through Climate Field Lab activities in Senegal". The NUTRiGREEN team used the Tropentag 2023 in Berlin to present three posters and a lecture. Awa Touré and Saïd Rehema, two young scientists from Senegal, participated and were supported by the NUTRiGREEN project and the Friends of SLE.

C4C

The C4C project is continuing all planned activities regarding phenotypic, molecular, metabolomic characterization and breeding aimed at tackling heat and drought stresses due to climate change in crops such as rice, wheat, and eggplant. In particular, Stellenbosch University (SU) in South Africa has been collaborating with University of Milan (UNIMI) in Italy and Research Center for Genomics and Bioinformatics (CREA-GB) in Italy with the goal to monitor the cell wall modifications of different rice and eggplant tissues from contrasting genotypes subjected to drought stresses. UNIMI has identified genes involved in rice and barley seeds response to heat and drought stresses and studied their expression profile and is confirming their effective involvement in the process through their gene-editing mediated silencing. UNIMI also carried out metabolomic analyses on eggplant fruits and vegetative tissues from the Moroccan field water stress trial. University of Kasdi Merbah Ouargla (UKMO) in Algeria, characterized wheat local varieties adapted to the desert under salt and drought stresses condition by carrying out experiments both in vitro, in pots and in open field conditions which confirmed the better performance of the selected varieties. CREA-GB has evaluated, so far, plantlets of about 150 accessions of its eggplant collection for water-deficit stress in strictly controlled environmental conditions, evidencing that genetic variation for this trait is present. The work is in progress to complete the remaining accessions. In collaboration with UNIMI, an RNAseq experiment to disclose the eggplant genetic mechanisms of adaptation to low water is in progress; moreover, plantlets carrying homozygous CRISPER/CAS9 edited mutation in different genes known to be involved in water stress and drought tolerance have been obtained. Meanwhile, Bati Akdeniz Agricultural Research Institute (BATEM) in Turkey and Université Mohammed Premier (UMP) in Morocco are carrying out field experiments with commercial cultivars, landraces and experimental eggplant segregant progenies from interspecific crosses, employing also beneficial micro-organisms, to compare the effect of normal and half irrigation rate on the yield and physiological and phenotypic plant features.

CREATE

In an effort to disseminate the valuable outputs generated within the CREATE Project, which will end on December 31, 2023, stakeholder meetings were organized. These meetings involved engaging with the Research Institutes of the Turkish Ministry of Agriculture and Forestry for four products selected for Turkish case: hazelnuts, figs, apricots and grapes. As a result of those meetings, the outputs of the examined products were shared and the opinions of the experts were received. Furthermore, the project team held a closing meeting and stakeholder workshop in Ankara on 28 November 2023. In addition to the partners from Turkiye, project partners from Morocco and the Netherlands attended the meeting. The physical presence of our partners added depth to the discussions as they shared their unique project findings.

Following the closing meeting, a stakeholder workshop was organized and four separate tables were set up each dedicated to one of the specified products. Discussions were held at the established tables regarding the project results of that product and the effects of climate change. The collaborative atmosphere at these tables allowed for a comprehensive exploration of key topics. At the end of the workshop, the results of these discussions were summarized and presented by a representative of each table which encapsulated the diverse perspectives shared during the workshop, offering a comprehensive overview of the project's results and its potential implications. CREATE has also recently disseminated findings on carbon footprint of apricot, cacao and oranges in infographics.

PHEALING

The PHEALING project activities 2023 were initiated through a meeting held in Nairobi, Kenya from 11 to 13 January. Team members from the University of Bonn (Germany), KU Leuven (Belgium), and the Universities of Nairobi and Murang'a University of Technology in Kenya attended the meeting. The University of Kwazulu-Natal team members from South Africa participated in the meeting virtually. During the same dates, the team also visited several cassava fields in Mitaboni and Kangundo, in Machakos County and spoke with the farmers to learn more about local approaches for overcoming cassava perishability in Kenya (Figure 1). The field visit and meeting was very instrumental to link the research activities with the needs of the local farmers. On 9-12 July, Dr Julia Holbein represented PHEALING team at the 10th European Symposium on Plant Lipids in Amsterdam, Netherlands, to present her postdoctoral project on examining the effect of the different post-harvest storage on suberin and associated waxes in the periderm of cassava storage roots. This knowledge is key to better understand mechanisms of wound healing in cassava tissue that could be used to improve the shelf-life of cassava. On 18-20 September 2023, Christiana Dapuliga, PhD candidate from the University of Kwazulu-Natal in South Africa presented her PHEALING project at the 75th annual meeting of the German Society for Hygiene and Microbiology (DGHM) in Lübeck, Germany. She demonstrated the application of Lytic Bacteriophage to tackle the threat caused by bacterial pathogens and its potential use in food and related industries. The team of KU Leuven in collaboration with the University of Liège (Belgium), also contributed to the output of the PHEALING project by reporting their works in the high impact journal Green Chemistry, including some very promising results on edible coatings made from peels to extend the shelf-life of fruits.

The PHEALING team's published paper (October 2023) is titled, 'Towards green chemicals and edible coatings from barks and peels with near critical extraction of suberin'. It describes the extraction of suberin from agricultural byproducts such as potato and cassava peels that could end up as waste. Suberin contains fatty acid that can be sprayed on fruit to reduce water loss rate and thus shelf life of produce, to reduce food losses. The research article showcases the method of extraction of suberin, by a single-step, catalyst-free and low waste means of production. The extract can be used in cassava

and potato growing regions. The main challenge identified with the extraction method involved the energy requirement for heat during the process, but the paper provides suggestions regarding process viability. Lastly, on 1 December, an online meeting was convened to review project progress. Several students are also conducting their MSc thesis on research activities related to the PHEALING project.

BIO-BELIEF

The Bio-Belief project has, overall, made significant progress towards achieving its project goal to meet the growing demand for food and to tackle the detrimental effects of climate change, particularly soil water deficit due to drought conditions, on food crop performance. By specifically focusing on common beans as a food crop, the consortium will ultimately develop a more drought-resilient highly-nutritious plant food to ensure food security and to prevent "hidden hunger" which is a lack of vitamins and minerals required for human and animal growth and development.

In particular substantial progress has been made recently by the consortium towards characterizing various common bean genotypes. An important key finding was that the investigated common bean plant material varied in terms of morpho-agronomic traits, when plants, either in the greenhouse or in the field, were characterised by CREA-GB and the University of Pretoria measuring a great number of phenotypic traits (e,g. plant habit, leaf, flower and pod characteristics) as well as seed traits for nutritional quality with presence/absence of lectins, reduced phytic acid content and increased iron content (CNR-IBBA and CREA-AN). More detailed soil water deficit experiments are currently carried out in Italy with plants grown until flowering in the greenhouse, while in South Africa plants are grown under field conditions where field experiments are carried out at three different locations in the country by also using a rain shelter system.

Significant progress has also been made to characterize seeds from bean plants grown under soil water deficit conditions in a greenhouse to assess whether the nutritional quality of the seed can be affected by soil water deficit. In particular, analyses of the chemical composition (phytic acid, free phosphorous, starch, raffinosaccharide and protein content) of seeds harvested from plants subjected to water deficit stress were performed by CNR-IBBA. Some genotypes accumulated more starch and raffinosaccharide in response to soil water deficit stress. Seed storage protein profiles of all lines investigated by SDS-PAGE analysis were also different regarding protein accumulation mainly among the Italian and South African genotypes. However, the seed weight after soil water deficit stress was not different for seeds derived from stressed and unstressed plants. Detailed nutritional-chemical analyses have been conducted by CREA-AN on cooked seeds produced from plants grown in the field at CREA-GB (Northern Italy). The consortium finally also made progress in ultimately estimating also the bioavailability of iron and carotenoids when using an in vitro digestion system.

Finally, active communication between consortium members included one face-to-face meeting in 2023 between partners at CNR-IBBA in Milan and at CREA-GB in Montanaso Lombardo (Lo). A further face-to-face project member meeting will be in January 2024 at C2VN-AMRU in Marseilles (France) to discuss the current status of the project and to plan any remaining urgent activities still to perform. Dissemination of our project activities included in 2023 Italian partners (CREA-GB, CREA-AN and CNR-IBBA) participating with poster presentation at ILS4 (International Leguminosae Society), presenting preliminary results at the C2VN Students' Annual Day and introducing the Bio-Belief project to plant scientists at the University of Colorado, Fort Collins, USA interested to use beans for the prevention of cancer. Also, a third paper was published with the title "In order to lower the antinutritional activity of serine protease inhibitors, we need to understand their role in seed development" in Front. Plant Sci.

Sus-Agri-CC

Since its inception on September 1st, 2021, the Sus-Agri-CC project has been a hive of dynamic activity, engaging in a multitude of endeavours, from meetings to trials and experiments conducted under both controlled and open field conditions. A significant milestone was achieved on June 5th, 2023, with a pivotal meeting that brought together project members, featuring the physical presence of our esteemed partners from Japan and Mexico in Morocco. The primary focus was on the strategic scheduling of diverse field experiments that promise groundbreaking insights. Following the meeting, site visits were conducted, offering an up-close view of the open field experiment's progression. This allowed the project to refine methodologies and specify key parameters crucial for monitoring various tests.

Central to the Sus-Agri-CC lies the pursuit of understanding the agronomic value of carefully selected biostimulants. Applied alone or in strategic combinations—composts, arbuscular mycorrhizal fungi (AMF), and plant growth-promoting rhizobacteria (PGPR) —Sus-Agri-CC's goal is to enhance yields and fortify resistance to abiotic stresses in cereals (wheat, quinoa, and maize) and horticultural crops (tomato and lettuce) within the open field setting. In a series of five experiments conducted from February to July 2023, focusing on the five crops, the project explored the potential of various local composts, indigenous AMF, and PGPR, applied alone or in combinations under drought conditions. Growth and agro-physiological parameters were meticulously measured, with specialized sensors, including the PR2 soil moisture profiling and TDR soil sensor reader, strategically deployed for modeling. Encouragingly, positive outcomes were observed, particularly with the application of double and triple combinations involving AMF+PGPR, AMF+Compost, and AMF+PGPR+Compost. These combinations showcased enhanced plant fitness, increased seed and fruit yields, and heightened tolerance to water limitation.

The collaborative synergy with Cadi Ayyad University (Marrakech – Morocco), and esteemed partners CIRAD (Montpellier, France) and IPK (Gatersleben, Germany) has provided a robust platform for delving into the effects of biostimulants on metabolic and transcript patterns. The ongoing comprehensive omics analysis, covering proteomics, transcriptomics, metabolomics, and ionomics, promises to unravel the impact of biostimulants on essential food and biomass plant responses to environmental factors. The project aims to synthesize this wealth of data into predictive models for crops, fostering groundbreaking advancements in sustainable agriculture.

Project updates of the 2021 call

The projects of the 2021 joint call with SUSFOOD2 and FOSC are approaching their mid-term. There will be an online mid-term workshop in May 2024. The recent achievements and intermediate results of the 5 projects are presented below. New project updates are also available through the project websites, social media channels and the FOSC social media channels.

MedAgriFoodResilience

MedAgriFoodResilience project has been busy meeting their goals. They held their midterm meeting in El Oued in October, with a visit to the CRSTRA and to University of Biskra, project partners, as well as a field visit to the traditional oases of El Oued.
The project completed several deliverables that are freely downloadable from the dedicated page on the project website. Deliverables include downloadable GIS databases of Assisi and Spoleto study site in Italy, the tree agroforestry system in Ait Souab-Ait Mansour region in Morocco and Ghout Oases of El Oued, Algeria. A list of cultivated species and varieties in each study region, using an agrobiodiversity assessment, has also been produced as a deliverable. In Assisi-Spoleto, the report notes other agricultural activities associated with cultivation of olive trees such as cereals, vines, fruit trees and mixed crops. In El Oued, agrobiodiversity has suffered declines within the ancient agrosystem, with date palm cultivation predominating, and in other cases only few fruit trees grown. The Ait Souab-Ait Mansour area produces barley, wood and argan oil, and farmers cultivate 53 species including cereals, fruits and vegetables, for instance. The research presented in this deliverable provides valuable comparative insights into each study region.

The project team published in the open access Biodiversity and Conservation journal on innovative and sustainable uses of argan products and byproducts for development of rural communities in Morocco. They also published a second article in Biodiversity and Conservation journal about ecotone changes over the last six decades in the Prosecco Hills of Conegliano and Valdobbiadene UNESCO site and in the Olive Groves of the Slopes between Assisi and Spoleto GIAHS site.

IPSUS

A trans-national and inter-disciplinary consortium across six countries (UK, Italy, Romania, France, Turkey, and Morocco) has co-designed the project IPSUS to address Net Zero opportunity by connecting sustainable protein shift and food waste valorisation. The proposed work in exploring, analysing, and comparing value chains of potatoes, pumpkin, hazelnuts, grape pomace seaweed, and BSG was more intensive and complex than originally estimated and therefore selected crops (potato, hazelnuts, and BSG across countries as well as seaweed in the UK and pumpkin in Turkey) have been chosen to prioritize the FLW analysis.
A framework has been developed to model upcycling opportunities of cross-country comparable food loss and waste of selected focal commodities (potatoes, hazelnuts and BSG) through value chain analysis. This has additionally helped to identify key knowledge gaps or areas of complexity. A set of value chain reports following the agreed structure were developed by each partner country for BSG, hazelnuts, and potatoes. These reports are now informing a food safety-based risk analysis to identify key aspects for quality loss, monitoring and to design critical control points that are required to ensure the by-products can safely be used for protein extraction.
A literature review was performed to identify the potential food safety hazards in all six focal commodities from production and processing sidestreams. Despite the handful of literature, deeper understanding of safety of upcycled plant and seaweed proteins is clearly missing, particularly for BSG (e.g. microbial stability of raw materials due to high water content) and seaweeds (e.g. presence of heavy metals). It has also been confirmed that the amount of protein in by-products varies depending

on the crop and the type of sides-streams. E.g. BSG contains a very high protein (20-33% depending on sources) whereas seaweed and potato skin have only 14% and 4.5% protein respectively which would have clear decision making influence on techno-economics during upscaling i.e. how much protein to get at what price.
The computational prediction of allergenicity and toxicity potential of proteins from potato, hazelnuts, pumpkin, seaweed, grape pomace, and BSG has also been assessed, as well as enzyme activity assay-based nutritional end point characterisation. This will be supported via western blot-based experimental evaluation of allergenicity potential of proteins from potato, hazelnuts and BSG using commercially available antibodies.
The wet extraction of protein has been performed on Seaweed, pumpkin and BSG. A detailed study on wet extraction of seaweed protein (using Palmaria palmata as an example) clearly demonstrated that novel pre-treatments like ultrasound and high pressure homogenisation can improve the protein extraction efficacy by multiple folds. Further studies are ongoing for protein extraction from BSG which undoubtedly has a bigger challenge due to the presence of lignocellulosic fractions.
A literature review for assessing protein quality criteria has been performed for plant-based meat and cheese alternatives in Italy. A market trend analysis on upcycled proteins and a qualitative consumer study via focus group interviews have been performed.

SmartDairy

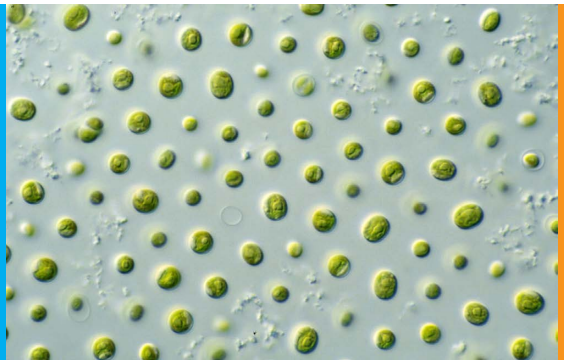
The SmartDairy project has been engaged in many varied activities including project meetings, attending conferences, conducting surveys, model development, and publications. Work on the work packages involving all partners has resulted in the publication of a transformation framework for the food industry in EuroChoices. It has also resulted in the development of four impact pathway maps specific to the country case studies in the project; Finland, Italy, Ireland, and the UK. These impact pathway maps allowed each country team to provide insight into their specific case study to other project partners. They will be made available on the project website during the course of 2024.

Each country team also initiated country specific work packages. In Finland, data collection via in-depth interviews has been completed. These interviews focused on the public's relationship with dairy and dairy alternative products as well as the role that dairy production and consumption play in the larger Finnish culture. In Italy, development of a sophisticated model to simulate the effects of changing policy and production methods within the dairy production chain is ongoing. This model allows for market interactions between producers and processors to be simulated while also accounting for the impact of different governmental polices and changes in consumer demand for dairy products.
In Ireland, development of a living lab to test the feasibility of a voluntary carbon market to encourage the adoption of climate friendly production practices is ongoing. Survey development to assess the dairy farmers' and the public's valuation of a reduction of greenhouse gas emissions from dairy production is also ongoing. In the UK farmer interviews on sustainable production technologies have been completed. Interview insights were used to develop a survey to assess consumer willingness to pay for dairy products produced using these sustainable technologies. Data analysis from this survey will begin soon and development for a follow-up farmer survey is underway.

Alongside continued progress towards project milestones, the project actively participated in conferences, hosting sessions and presenting results at several conferences including the AES, EAAE, and YHYS.

AlgaeBrew

The AlgaeBrew consortium met in September at the University of Camerino, Italy. The project is now at its halfway point and entering its second phase. The



project team carried out a comprehensive review of progress to date and a collaborative discussion about future plans. These plans include:

- Upscaling of algae production using brewery wastewater
- Ongoing omega 3 lipid extraction optimisation
- First joint publication soon
- Algaebrew online seminar planned for April 2024 (open to the public)
- Commencement of aquaculture feed trials and biofertiliser trials using algae biomass grown on brewery wastewater

The first phase of the project primarily focused on the growth of different species of microalgae on brewery by-products, and the optimisation of different conditions that affect the growth of the microalgae and accumulation of the target omega-3 PUFAs at University College Dublin. The team found that brewery wastewater is a suitable growth medium for a broad spectrum of freshwater and saltwater microalgae species, leading to developing strategies to further improve the growth and lipid profile of the microalgae, such as through fed-batch cultivation. The results generated served as a basis for scale up in Autumn of 2023, involving the use of a 1,000 litre tubular photobioreactor at Swansea University to generate biomass for phase two of the project.

Olive3P

Olive3P aims to identify innovative ways to recover and reuse olive harvest branches, olive stone and liquid effluents from the olive milling process. Instead of letting these resources go to waste, the project will turn them into valuable products through smart processes. Olive3P contributes to more sustainable and eco-friendly olive oil production. The project team has been working on optimisation of biochar and activated carbon using solid wastes, making strides in determining the most efficient conditions for producing high-quality activated carbon. First results have been published in Molecules journal. A second phase of the project has been underway to test use of activated carbon to remove polyphenols from olive mill effluent. The team has taken a significant step forward by using olive mill effluent, in combination with cheese whey, as a growth medium for cultivating a yeast strain. Foundations have also been laid for assessing the olive oil food system through interviews conducted with Algerian olive oil producers.

The upcoming second phase will include identifying optimal conditions that foster production of high-quality carotenoid-rich yeast biomass. Upon achieving favourable results in the laboratory, the Olive3P team will transition to a scale-up phase at DOZEN in Turkey. Scaling up is crucial for translating findings into practical applications. One of the upcoming tasks involves testing the impact absorbed polyphenols, both with and without activated carbon on olive seedlings contaminated with verticillium fingus to assess their efficiency as a biopesticide. In addition, Olive3P will delve into the application of desorbed polyphenols from activated carbon as a biopreservatives for olive table storage. In parallel, the project will encompass a comprehensive life cycle analysis, mass and energy balance assessment, and a socio-economic analysis of the olive oil food system in Morocco, Algeria and Turkey. These evaluations are essential to understanding the broader implications and sustainability of Olive3P initiatives.

Introducing the FOSC partners

The FOSC Partnership is a dedicated collaboration on Food Systems and Climate spanning three continents. For this newsletter, Elizabeth Vander Meer interviews some of our partners. We present their ideas about FOSC by asking them questions about their motivation to join FOSC, their hopes for FOSC and the important themes and needs regarding Food Systems in their country. In this edition we give the floor to Research Council of Norway (RCN) and Fund for Scientific Research, Belgium (NFRS) - many thanks to Maan Singh Sidhu and Joel Groeneveld for their time!

RCN

The Research Council of Norway is a funder in the FOSC consortium and Norwegian researchers contribute to four projects. RCN is also a contributing partner in the Work Package 4 follow-up and monitoring of the funded projects. We speak in this interview with Maan Singh Sidhu, special adviser for the division for sustainable social development.

What was your organisation's motivation to join FOSC?

Research and innovation for sustainable food systems in a changing climate is an important part of the Research Council's work on strengthening international cooperation. The aim of the FOSC reflects well with the Norwegian Government's long-term plan for research and higher education as well as with the Research Council's strategy and motivated us to join FOSC. We want to secure closer alignment (co-funded projects) between national and international instruments and to contribute to reaching Norwegian research and innovation policy goals.
The effects of globalization, new trends, challenges and the need for re-structuring the food and agriculture industry is becoming increasingly important at the regional, national and international level. We also wanted to work with international partners to better enable Norwegian research and innovation to contribute to solve national and global challenges within the sustainable food production and food systems.

What do you see FOSC achieving/what do you hope it will achieve?

The excellent contribution of FOSC is strengthening transcontinental research, projects, and network towards food and nutrition security and sustainable agriculture under a changing climate.
The same applies for finding partners for new international project and to participate in an application for Horizon Europe funding. Formal networks meetings enable us to work together with our professional colleagues from other countries, with people who have backgrounds in different disciplines and with representatives of other sectors. This helps us to find the multidisciplinary knowledge-gaps that need to be covered. Moreover, the science-based knowledge and outcomes from FOSC will contribute to future value creation in food and agriculture industry and the public sector, environmentally friendly technology and greater sustainability. It will foster collaborations and enhance impact of research on food systems and climate in Europe and beyond.

Can you identify important themes and needs regarding food systems in your country?

Ensuring that all people have access to sufficient, safe and healthy food that is produced in a sustainable way is a key global challenge today. In order to achieve the SDGs, we need to think along new lines and take a holistic approach. Therefore, Norway wants to increase sustainable, climate-resilient food production and wants to increase productivity from agriculture, fisheries, and aquaculture sectors. Increase sustainable value creation, economic development and private sector development in the food sector that ensures stable access to healthy and safe food, innovative technologies and reduces food waste is also an important theme for us. Improved

FOSC is organizing an **event** in Marrakesh **Morocco** on **15-17 October 2024** hosted by the **Moroccan ministry MESRSI**. The event will comprise a meeting of the FOSC **General Assembly**, a **training** for the project coordinators and all the results produced by the **FOSC Knowledge Platform** will be presented.

nutrition and sustainable consumption patterns due to improved knowledge and access to healthy and varied diets, safe food and clean drinking water is another important need for us.

FNRS

FNRS is the Fund for Scientific Research-FNRS (F.R.S-FNRS) in Belgium and is a funder on the FOSC consortium. Belgium researchers contribute to three research projects. We speak in this interview with Joel Groeneveld.

What was your organisation's motivation to join FOSC?

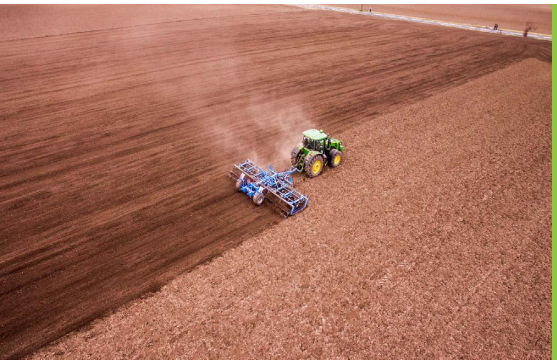
The FNRS is a research funding agency that finances research in all scientific domains. In European programmes, this translates into participating in all networks that allow for the organisation of open calls for research projects. The FNRS learned about FOSC through our participation in the programmes of the FACCE JPI and LEAP-AGRI.

What do you see FOSC achieving/what do you hope it will achieve?

The FNRS hopes that FOSC will contribute to more cooperation between Africa and Europe on Food systems and that it will pave the way for even more ambitious cooperation that will contribute to more sustainable food systems in the future.

Can you identify important themes and needs regarding food systems in your country?

Belgium is a small country with a very intensive food production system. This produces way too much pollution (nitrogen in particular), which is not sustainable in the long run. We need to find new ways of producing that are more respectful of the environment and we will need to work in cooperation within Europe and beyond to be able to produce food more equitable in the future.



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