ETH zürich

World Food System Center Research Symposium 2019

Program and Posters

Thursday, 31 October 2019 | 17.15 - 21.00 | ETH Zurich, Audi Max (HG F 30)

This public symposium showcases research that the World Food System Center supports as well as other food system relevant research at ETH Zurich. This year's program will focus on contributions from current research to sustainable food systems and reaching the Sustainable Development Goals of the UN Agenda 2030.

The main program starts with a keynote address on the Future Food Initiative by Prof. Detlef Günther, ETH Zurich VP Research and Corporate Relations. The presentation sessions will feature presentations from five concluding research projects focused on (1) Nutritious, Safe and Sustainable Food for All and (2) Healthy Soils, Improved Livelihoods. A networking poster session focusing on ongoing research and Center activities offers you the chance to interact directly with researchers.

www.worldfoodsystem.ethz.ch

World Food System Center

The UN Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs), with their 169 targets, form the core of the 2030 Agenda. They balance the economic, social, and ecological dimensions of sustainable development, and place the fight against poverty and sustainable development on the same agenda for the first time.

The SDGs are to be achieved around the world, and by all UN member states, by 2030. Created through a multi-stakeholder approach, all states, including Switzerland, are called upon to implement the Goals by working together with business, NGOs, governments, the United Nations, and other actors. Only if all equally play their part, can we find shared solutions to the world's urgent challenges.

ETH Zurich is committed to sustainability in its core areas of research, teaching, campus, and dialogue with society. It furnishes the technical and scientific know-how for the long-term conservation of our planet's resources, trains people to achieve these goals, integrates sustainability as a principle into its decisions and actions, and is committed to dialogue with society for sustainable development in Switzerland and worldwide. Our work at the World Food System Center contributes directly to many of the United Nations Sustainable Development Goals, including Zero Hunger, Sustainable Consumption and Production, and Good Health and Well-Being.

Follow us on:

@ethzWFSC @ethzWFSC World Food System Center, ETH Zurich

Program

17:15 Welcome and Introduction	**Presented by:** **Prof. Michael Siegrist &** **Dr. Martijn Sonnevelt**
17:25 Keynote on the Future Food Initiative	**Prof. Detlef Günther** Vice President Research and Corporate Relations
17:35 Session 1: Nutritious, Safe and Sustainable Food for All	
New sustainable food formulations based on algae proteins	**Leandro Buchmann** Sustainable Food Processing
Application of *Lactobacillus reuteri* to naturally prevent *Campylobacter* colonization of chicken	**Dr. Anna Greppi** Laboratory of Food Biotechnology
Towards nutritional security through organic management of soil fertility in orange-fleshed sweetpotato systems in Mozambique	**Rafaela Feola Conz** Sustainable Agroecosystems
18:20 Session 2: Healthy Soils, Improved Livelihoods	
Microbial services for an environmentally and economically sustainable rooibos tea production	**Josep Ramoneda** Plant Nutrition
Nitrified urine fertilizer: A transdisciplinary approach to solutions-oriented community development	**Ben Wilde** Sustainable Agroecosystems
18:50 Concluding remarks	
19:00 Networking Poster Session and Reception	
20:45 Voting for Poster Session closes	
21:00 Symposium ends	

Presentations

The Center's Research Programs support new cross-disciplinary and solution oriented research to address food system challenges, with 33 projects totaling nearly 9 million CHF funded to date.

All projects are subject to a rigorous evaluation and an assessment process that takes into account scientific excellence and relevance to the programs. To fund these programs, we established the World Food System Grants Platform, which allows for working with industry and foundation partners in a pre-competitive way that ensures academic independence and industry relevance.

Our two current research programs, the Mercator Research Program on Organic Production Systems for Global Food Security and the Coop Research Program on Sustainability in Food Value Chains, provide support for new projects.

The **Mercator Research Program** on Organic Production Systems, funded by the Mercator Foundation Switzerland, supports research, education, and outreach that explores the role and potential of organic production systems (certified or non-certified) to contribute to global food security.

The **Coop Research Program** on Sustainability in Food Value Chains, supported by the Coop Sustainability Fund, enables research that addresses challenges and opportunities for sustainability in food value chains.

The Center strives to work together with others in partnerships to achieve together what no partner could achieve on their own. We formally develop both strategic and collaborative partnerships, and, in addition, we indirectly foster new partnerships at the project level. This partnership approach, which we developed during our first phase of operations, has been critical to the Center's success.

Presentation Abstracts

Session 1: Nutritious, Safe and Sustainable Food for All

Title: New sustainable food formulations based on algae proteins (NewAlgae)

Authors: Leandro Buchmann, Lukas Böcker, Martin Caporgno, Iris Haberkorn, Alexander Mathys
Sustainable Food Processing, ETH Zurich

Abstract: Currently, challenges derived from a growing world population and simultaneously decreasing arable land in combination with global warming require a change in supply chains. Microalgae could enable food production concepts considerably more sustainable than the existing value chains, as they could grow on infertile land with a high biomass productivity by using combustion gas as a CO_2 source to generate a wide range of food, material and energetic products. The principle objective of NewAlgae was the interdisciplinary development of innovative up- and downstream algae processing based on electroporation stress induction during cultivation, gentle extraction, advanced characterisation of techno-functional protein properties and further translation into the development of new product applications. Based on in-depth process characterization, the increase in cell proliferation by up to 15% of the prokaryotic microalgae *Arthrospira platensis* after nanosecond pulsed electric field treatment (nsPEF) could be demonstrated, while simultaneously increasing the economically highly relevant protein-pigment complex phycocyanin by up to 20% and maintaining the techno-functional properties of remaining *A. platensis* fractions. The project therefore supported the way towards global food security by technology driven innovations and specific product applications, with a direct impact on the achievement of at least five of the 17 Sustainable Development Goals.

This research is supported by the WFSC Coop Research Program. Further information is available at http://www.worldfoodsystem.ethz.ch/research/research-programs/CRP/NewAlgae.html.

Notes:

Session 1: Nutritious, Safe and Sustainable Food for All

Title: Application of *Lactobacillus reuteri* for naturally prevent *Campylobacter* colonization of chicken (Campy Chick)

Authors: Paul Tetteh Asare[a], Anna Greppi[a], Clarissa Schwab[a], Roger Stephan[b], Christophe Lacroix[a]

[a]Laboratory of Food Biotechnology, ETH Zurich; [b]Institute for Food Hygiene and Safety, University of Zurich

Abstract: Chicken meat is the main source for *Campylobacter* infection in humans. Campylobacteriosis is the most frequently reported food-borne illness in the European Union, linked to large economic losses. *Lactobacillus reuteri* is a commensal in chicken gastrointestinal tract (GIT) with the ability to produce reuterin from glycerol, a potent broad spectrum antimicrobial system.

The project investigates a novel microbial-based approach to naturally reduce *Campylobacter* contamination of chicken flocks using reuterin. We hypothesize that administration of reuterin-producing *L. reuteri* chicken isolates together with glycerol enables colonization in chicken GIT preventing *Campylobacter* colonization. We isolated 23 *L. reuteri* reuterin producers from chicken GIT, sequenced their whole genomes and assessed the absence of transmissible antibiotic resistant determinants. Strains produced high yield of reuterin, between 156 and 330 mM, from 600 mM of glycerol, and were sensitive to cefotaxime and penicillin. Reuterin was tested on a large panel of *C. jejuni* and *C. coli* isolates. Very low concentration of reuterin (1.5 and 3.0 μM, expressed in acrolein, the main active component of reuterin), completely inhibited the growth of all strains.

Our results show for the first time the high activity of reuterin for naturally preventing *Campylobacter* contamination in chicken flocks and enhancing meat safety.

This research is supported by the WFSC Coop Research Program. Further information is available at http://www.worldfoodsystem.ethz.ch/research/research-programs/CRP/CampyChick.html.

Notes:

Session 1: Nutritious, Safe and Sustainable Food for All

Title: Towards nutritional security through organic management of soil fertility in orange-fleshed sweetpotato systems in Mozambique (ORMASP)

Authors: Rafaela Feola Conz[a], Engil Pereira[b], Maria Andrade[c], Johan Six[a]

[a]Sustainable Agroecosystems, ETH Zurich; [b]University of Texas, Rio Grande Valley; [c]International Potato Center, Mozambique

Abstract: Consumption of orange-fleshed sweetpotato containing a high concentration of β-carotene, an important precursor of vitamin A, was successfully adopted as a food-based strategy to combat vitamin A deficiency and malnutrition in Mozambique. However, sweetpotato cultivation removes high amounts of soil nutrients. In limited-resource communities, the absence of soil nutrient replenishment degrades the soil, threatening future food production. This study was conducted to investigate the potential of organic management of soil fertility to provide sufficient potassium, a limiting soil nutrient, for optimal plant performance, while preventing soil nutrient depletion and preserving the nutritional quality of storage root. Sweetpotato was fertilized with locally-sourced organic amendments (i.e.; poultry manure and cowpea residue), inorganic fertilizer and no amendment. Weed biomass incorporation was combined with the fertilizer treatments and compared to weed biomass removal. After two seasons, soil organic amendments preserved total carbon and nitrogen in soil, while non-amended and inorganic fertilized treatments depleted soil nutrient storage. Co-application of organic amendments and inorganic fertilizer preserved storage root yield and β-carotene concentration. This research demonstrated the beneficial effects of locally-accessible organic amendments in preserving soil fertility for long-term food production, supporting nutritional security. Moreover, the use of locally-accessible resources contributes to the development of sustainable food production systems.

This research is supported by the WFSC Mercator Research Program. Further information is available at http://www.worldfoodsystem.ethz.ch/research/research-programs/MRP/ORMASP.html.

Notes:

Session 2: Healthy Soils, Improved Livelihoods

Title: Microbial services for an environmentally and economically sustainable rooibos tea production (EcoInt)

Authors: Josep Ramoneda[a], Jaco Le Roux[b], Beat Frey[c], Hannes Gamper[d], Emmanuel Frossard[a]

[a]Plant Nutrition, ETH Zurich; [b]Biological Science, Macquarie University Syndney; [c]Rhizosphere Rocesses, WSL Birmensdorf; [d]Institute of Life Sciences, Scuola Superiore Sant Anna, Pisa

Abstract: The optimization of plant microbiomes in concert with soil fertility management can contribute to food security while minimizing environmental impacts of food production. Recent studies highlight that microbial diversity promotes the stability of microbiome functionality against stress, while the presence of particularly beneficial microbes contributes to particular functions being maximised. In South Africa, small-scale rooibos farmers are at risk due to increasing soil unproductivity, land ownership and ongoing desertification. Given the multiple associations of rooibos with both nitrogen-fixing rhizobia and mycorrhizal fungi, both in cultivated and wild rooibos populations, rooibos farmers have the opportunity to make use of a vast diversity of symbioses that could be optimized. We show that local fertilizer can be applied in rooibos nurseries to simultaneously promote larger rooibos plants and more diverse rhizobial communities. We found that particular rhizobium strains correlate significantly to plant functions, in particular to crop yield, root nodulation and nitrogen nutrition. Importantly, one of them dominated the roots of rooibos plants grown on mixtures of soils from cultivated and wild rooibos, a soil management measure that can also be implemented by rooibos farmers. In sum, we show that local, simple and low-cost soil management measures can improve benefits from rhizobial symbioses in rooibos, which could contribute to improving rural livelihoods and environmental sustainability in the long run.

This research is supported by the WFSC Mercator Research Program. Further information is available at https://worldfoodsystem.ethz.ch/research/research-programs/MRP/ecoint.html.

Notes:

Session 2: Healthy Soils, Improved Livelihoods

Title: Nitrified urine fertilizer: A transdisciplinary approach to solutions-oriented community development (NUFSOC)

Authors: Ben Wilde[a], Eva Lieberherr[b], Astrid Oberson[c], Engil Pereira[d], Alfred Odindo[e], Johan Six[a]

[a]Sustainable Agroecosystems, ETH Zurich; [b]Natural Resource Policy, ETH Zurich; [c]Plant Nutrition, ETH Zurich; [d]University of Texas, Rio Grande Valley; [e]University of KwaZulu-Natal

Abstract: The elimination of hunger and the increased provision of basic sanitation are the focus of two of the 17 Sustainable Development Goals (SDGs) of the UN Agenda 2030. Although traditionally viewed as distinct matters to be solved with disparate solutions, there is growing awareness that emerging ecological sanitation technologies have the potential to not only improve public health, but also to enhance sustainable agricultural production. In particular, a system designed and tested at the Swiss Federal Institute of Aquatic Science and Technology (Eawag), shows great promise as an ecologically sustainable, hygienically safe, and socially equitable alternative to traditional sanitation management that can, through the separation and biological processing of nitrogen- and phosphorus-rich urine, provide a sustainably sourced urine based fertilizer (NUF) to close the agricultural nutrient cycle. NUFSOC, through the design and implementation of a transdisciplinary research approach, sought to assess the biophysical and social implications of this novel fertilizer to support smallholder agricultural production in Kwazulu-Natal, South Africa. To do so, the following work packages were conducted: 1) a biophysical field experiment to quantify the agronomic and ecological implications of this amendment, 2) a participatory field trial to elucidate farmer perceptions of this fertilizer, and 3) an acceptance survey to understand consumer attitudes of food grown with NUF.

This research is supported by the WFSC Mercator Research Program. Further information is available at https://worldfoodsystem.ethz.ch/research/research-programs/MRP/NUFSOC.html.

Notes:

Posters

Poster Prizes

For our Networking Poster Session, the audience is kindly requested to cast their vote for which poster they would like to receive each prize. Ballot slips are available for all participants. Please place in the corresponding ballot box by 20:45.

We asked poster contributors to make their content visually accessible to a general public. Please judge the posters on the (1) excellence of content, (2) visual accessibility of content, (3) researcher interaction, and (4) relevance of the research to sustainable food systems and achieving the SDGs.

Best Overall Poster Prize: 1000 CHF award to be used for any food system related research, education, or outreach activity.

The Mercator Poster Prize: 1000 CHF to be used for any organic food or agriculture related research, education, or outreach activity. To be considered for this award, a poster should touch on the role of organic production systems in addressing food security.

-O denotes a poster is eligible for only the **Best Overall Poster Prize**

-OM denotes a poster is eligible for **both prizes**

Full poster abstracts are available at **www.bit.ly/wfsc-symposium2019**

Poster Abstracts

01-OM Buckwheat for more diverse crop fields and diets

Authors: M.M. Nay, E.A. Perez, S.L. Byrne, A. Walter, B. Studer

Affiliations: Molecular Plant Breeding, ETH Zurich; Crop Science, ETH Zurich; Teagasc Crop Science, Oak Park Carlow, Ireland

Contribution to Sustainable Food Systems: Buckwheat is an excellent food crop for pollinators, livestock and human consumers alike. By determining the suitability of different buckwheat accessions for their cultivation in Switzerland, we provide farmers with a valuable alternative to the major crops currently grown.

Abstract: Just three crops – wheat, rice and maize – provide globally the majority of calories in our diet. This overrepresentation of a few crop species leads to a limited diversity in our fields. To enhance the variety of crops on farm and in our diets, we are investigating the performance of different accessions of the pseudocereal buckwheat (*Fagopyrum esculentum*) in Switzerland. To characterize the diversity of the buckwheat crop, a panel consisting of over 150 buckwheat accessions with worldwide origin will be evaluated in multi-location field trials. In combination with genotypic data of the accessions, the genetic basis of several phenotypic traits will be determined. This study will allow to find superior buckwheat accessions that give farmers a valuable alternative to major cereals. Furthermore, it prepares the ground for buckwheat improvement through breeding.

02-OM Effect of the total replacement of soybean by feeds from Black Soldier Fly larvae in egg production

Authors: M. Heuel, C. Sandrock, A. Mathys, M. Gold, C. Zurbrügg, M. Kreuzer, M. Terranova

Affiliations: Animal Nutrition, ETH Zurich; Research Institute for Organic Farming (FiBL); Swiss Federal Institute of Aquatic Science and Technology (Eawag)

Contribution to Sustainable Food Systems: Caused by the high import rate for soybean in organic egg production it is important to investigate alternative and local protein sources. One of these could be insects. Therefore, it is important to examine their impact on the poultry performance.

Abstract: In this study the utility of insects as ingredients of organic diets for laying hens as a potential novel and more sustainable protein and energy source was investigated. The used insect material (protein meal and larval fat) was obtained from Black Soldier Fly (BSF) larvae reared on two permitted substrates (primarily grain-based agrifood sidestreams and preconsumer foodwaste, respectively) and then integrated in the diets of laying hens to completely replace soybean cake and oil. Over the feeding period of seven weeks various performance characteristics, protein and energy utilization, as well as egg quality were analyzed. The results show that replacement of soy meal and oil by insect materials did not negatively affect performance of the hens or the quality of the eggs. It remains to be investigated if and to which degree unfavorable saturated fatty acids, characteristic for BSF, are incorporated in the egg.

03-OM Measurement and optimization of iron bioavailability in sustainably produced insect based foods and estimation of the nutritional potential as an alternative dietary iron source in human subjects

Authors: N. Hilaj, V. Galetti, P. Herren, D. Ambuhl, J. Grunder, M. Zimmermann, D. Moretti

Affiliations: Laboratory of Human Nutrition, ETH Zurich; Research Institute for Organic Farming (FiBL); Swiss Federal Institute of Aquatic Science and Technology (Eawag)

Contribution to Sustainable Food Systems: The projects links innovative nutritional questions (high iron bioavailability from insect foods) with the identification of insect species, which have a potentially extremely low environmental footprint, in particular organisms reared on plant by-products such as compost and wood.

Abstract: Edible insects are considered as an alternative source of proteins, but in addition are also rich sources of minerals. Our recent stable isotope studies in humans with adult crickets suggest the presence of an absorption inhibitor, which lowers iron absorption from cricket iron in humans, as well as from plant food iron. Chitin, a major component of insect biomass, is a known iron binder. Decreasing chitin content could allow the high amounts of iron in insects to be well-absorbed, and enhance the absorption of iron from plant-based foods. Several approaches to reduce chitin level will be investigated (selecting low chitin insect species, enzymatic degradation, and physical removal of chitin). Insects will be intrinsically labelled with the stable (no radioactivity; entirely safe) isotope ^{57}Fe. Iron bioavailability will be assessed in low and high chitin containing insect- and plant-based meals in human subjects.

04-OM Developing crop diversification measures to optimize bean production in North Macedonia

Authors: A. Singh, P. Krütli, P. Iannetta, C. Schöb

Affiliations: Agricultural Ecology, ETH Zürich; Transdisciplinarity Lab, ETH Zürich; The James Hutton Institute, Scotland

Contribution to Sustainable Food Systems: Our research promotes sustainable agriculture and food security SDG goals by developing cropping systems that would be resilient to extreme climate events, produce more food per unit area, improve ecosystem services such as soil fertility and be economically profitable.

Abstract: Mixed cropping provides vast opportunities for development of sustainable agricultural systems as it can enhance crucial ecosystem services and provide more food per unit area. Inclusion of legumes such as beans is particularly promising in mixed cropping as beans fix atmospheric nitrogen, reducing the need for synthetic fertilizers and, they further provide the nitrogen to neighboring plant species. Common beans are widely grown and consumed in North Macedonia. However, in recent years factors such as high temperature and water shortage have hampered bean production. Our project aims to optimize bean production in Macedonia by identifying crop and cultivar mixtures that are drought and heat tolerant. We will further test the effect of these measures on biodiversity and relevant ecosystem functions. The project will apply a transdisciplinary approach and Macedonian farmers will be continuously involved in project development via activities such as workshops, participatory field trials and demonstration events.

World Food System Center Research Symposium 2019

05-OM Stabilizing multiphase food systems with microalgae proteins

Authors: L. Böcker, L. Buchmann, P. Bertsch, D. Wenner, S. Teixeira, U. Krähenmann, J. Bergfreund, P. Fischer, A. Mathys

Affiliations: Sustainable Food Processing Laboratory, ETH Zurich; Food Process Engineering Laboratory, ETH Zurich

Contribution to Sustainable Food Systems: Microalgae proteins as a sustainable alternative resource offer solutions for 9 of the 17 SDGs. Especially, the investigated potential to stabilize food matrices such as emulsions and foams enables the replacement of animal protein, directly acting on SDGs 12 and 13.

Abstract: Microalgae gain increasing importance as alternative protein source for food production and biotechnological systems. Their protein-content of up to 60% bears potential for multiple functional applications in the food, nutraceutical and cosmetics industries. This potential coupled with microalgae's ability to be grown on non-arable land and to fixate CO_2 when cultivated photoautotrophically, motivates the foreseen impact on major challenges of the SDGs. Economic constraints and a low technical readiness level impede large scale applications of their bulk proteins. Thus, isolates from *Arthrospira platensis* were investigated to stabilize fluid interfaces in order to utilize such high value fractions in a cascading way following biorefinery principles. Stabilization of fluid interfaces comprises two major techno-functional applications of proteins: foaming and emulsifying capacity. Model foams were prepared and could be shown to exceed the overrun and foam stability of whey protein isolate. Investigations at the oil water interface revealed that the extracts' surface activity is not solely related to the protein fraction.

06-OM Optimization of microalgae-based biorefinery concepts by pulsed electric field treatments

Authors: I. Haberkorn, L. Buchmann, A. Mathys

Affiliations: Sustainable Food Processing Laboratory, ETH Zurich

Contribution to Sustainable Food Systems: The project contributes to sustainable food systems and reaching the SDGs by fostering the economic viability of microalgae cultivation using PEF as novel technology. Microalgae-livestock promotes sustainable agriculture with direct impact on achieving at least five of the 17 SDGs.

Abstract: A prospected world population of 9.7 bn people by 2050 necessitates increasing global food production by 50%. High-input, resource-intensive agricultural systems, which have caused water scarcities, soil depletion, and high levels of greenhouse gas emissions, cannot deliver sustainable food production. Microalgae-livestock promotes sustainable agriculture with direct impact on achieving at least five of the 17 sustainable development goals. To aid transforming microalgae value-chains into economically viable concepts, the applicability of pulsed electric fields (PEF) was investigated regarding microalgae growth promotion. Novel approaches using flow cytometry assisted cell count determination, integrative analytical investigations of single cells up to 107 Hz, and proteomics analysis were conducted to reveal possible stress response pathways. We provide processing windows for increased cell proliferation of prokaryotic and eukaryotic species, highlighting the potential of PEF as a resource efficient technology to sustainably transform single-cell based value-chains, an integral part for meeting future demands of sustainable food production.

07-OM Genetic improvement of climbing beans using genomics and machine learning

Authors: B. Keller, H.F. Buendia, A.E. Portilla Benavides, D. Ariza, E. Macea, B. Raatz, B. Studer

Affiliations: Molecular Plant Breeding, ETH Zurich; International Center for Tropical Agriculture (CIAT), Cali, Colombia

Contribution to Sustainable Food Systems: The rapid and efficient development of new bean varieties with higher seed iron content and improved yield stability contributes to a sustainable food production system that reduces poverty and malnutrition.

Abstract: Common bean *(Phaseolus vulgaris L.)* is of particular importance for food security and income of smallholder farmers in the tropics. Climbing beans, a distinct subgroup of common beans, have significantly higher yields and more positive effects on soil fertility than bush beans. However, phenotypic characterization of climbing beans for breeding purposes is laborious and expensive. Here, we linked phenotypic and genomic data using machine-learning algorithms in order to predict unknown phenotypes. We were able to predict yield and seed iron content with an accuracy of 0.5 and 0.4, respectively, measured as the correlation between predicted and observed values. Our results demonstrate the ability to select superior genotypes without testing them in the field first, which reduces phenotyping costs and increases the selection efficiency. In conclusion, genomic selection contributes to the faster development of new bean varieties, thereby improving productivity and food quality in a sustainable manner.

08-OM Host genotype x soil interaction in the composition of pathogenic and beneficial fungi of pea lines screened for root-rot resistance

Authors: L. Wille, M. Kurmann, M.M. Messmer, B. Studer, P. Hohmann

Affiliations: Molecular Plant Breeding, ETH Zurich; Plant Breeding, Research Institute of Organic Agriculture (FiBL)

Contribution to Sustainable Food Systems: Pea is a highly valuable protein source for human nutrition and animal feed (SDG 2). Additionally, pea is an important crop for N fixation in low-input farming systems (SDG 12). The project investigates resistance of pea against root rot pathogens considering plant-microbe interactions and promotes breeding programmes of resistant pea varieties (SDG 3).

Abstract: Fungal root diseases threaten pea *(Pisum sativum L.)* cultivation, and therefore a valuable protein source and important crop in low-input farming systems. Resistance in current pea varieties against multiple root pathogens is lacking. In order to acknowledge the rhizosphere microbiome as an integral part of the environment, eight pea genotypes with contrasting resistance levels were selected and tested on four soils with different disease pressure in a pot experiment. Along root rot assessments, pea pathogens and arbuscular mycorrhizal fungi were quantified in diseased roots using qPCR assays. The amount of fungal DNA in the roots differed among the pea genotypes and the four soils and a significant pea genotype x soil interaction was detected. Our results suggest differential roles of the microbes in pea root rot and highlight the importance of incorporating the complexity of the soil microbiome in resistance screenings of breeding programmes.

World Food System Center Research Symposium 2019

09-OM Farming systems affect hydraulic traits of crops

Authors: Q. Sun, A.K. Gilgen, V.H. Klaus, C. Signarbieux, N. Buchmann

Affiliations: Grassland Sciences, ETH Zurich; Laboratory of Ecological Systems, EPF Lausanne

Contribution to Sustainable Food Systems: Due to climate change, agricultural production systems will be progressively subjected to more frequent and severe weather events, such as prolonged summer drought. Adaptations of farming practices require assessing and improving the resilience of agricultural systems to ensure food security.

Abstract: We assessed the water status of a pea-barley mixture under drought conditions in organic and conventional farming systems with different tillage intensities. Hydraulic traits and water stress of crops were estimated using field-based measurements of leaf water potential and lab-based measurements of xylem vulnerability to cavitation using the Cavitron technique. The pea-barley mixture showed less loss of stem hydraulic conductivity under intensive tillage compared to conservation tillage, and under organic farming compared to conventional farming. It indicates that intensive tillage and organic farming could result in higher crop resistance to cavitation under drought. This might be attributed to increased water storage due to higher soil porosity under intensive tillage, and enhanced soil biota and organic carbon under organic farming. The outcome of this work will help to inform farmers and other stakeholders about necessary adaptations of soil and crop management to future climatic conditions.

10-OM Impact of Swiss cropping systems on soil hydraulic properties

Authors: E. M. Oliveira, R. Wittwer, Y. Liu, Q. Sun, A. K. Gilgen, V. Klaus, T. Keller, M. Van der Heijden, N. Buchmann

Affiliations: Grassland Sciences, ETH Zürich; Plant Microbial Interaction, Agroscope Reckenholz; University of Zürich; Swedish University of Agricultural Sciences

Contribution to Sustainable Food Systems: Increased frequency of drought events will threaten food production. Soil properties influence the severity of such events. Thus, in order to propose better adapted cropping systems, it is important to understand how their inherent physical properties respond to this disturbance.

Abstract: Climate change is a multifaceted phenomenon and multidisciplinary efforts are needed in order to understand its mechanisms of actions and achieve more informed and assertive mitigation and adaptation plans. Under different ecosystemns, it has been shown that soil development and soil properties are important modulators of ecosystems response to climate change. By its turn, agricultural soil management activities impacts soil properties in many different ways. In order to understand the most common Swiss cropping systems responses to drought, we run a three years diverse research project. In a first stage, we investigated soil hydraulic properties. Preliminary results suggest that organic inputs and conservation tillage positively influenced the water holding capacity, soil organic carbon and soil structure. The next step is to explore how these variables affect yields and drought resistance. In the long turn, our research will contribute to the understanding of which management types and soil management activities can contribute to climate change mitigation and adaptation.

11-OM Tracking growth phenology and physiology of a cropland in response to experimental drought and different cropping systems

Authors: Y. Liu, C. Bachofen, V. Klaus, G.S. Duarte, Q.Sun, A.K. Gilgen, E. Oliveira Hagen, R. Wittwer, M. Van der Heijden, N. Buchmann

Affiliations: Grassland Sciences, ETH Zurich; Ecological Farming, Agroscope Reckenholz, Tänikon

Contribution to Sustainable Food Systems: Our research assessed changes in crop yields using phenocam images to characterize the impact from severe drought on food production in different cropping systems. Results will help adopting management practices to sustain food production under climate change.

Abstract: Drought strongly affects plant phenology and thereby reduce ecosystem productivity and food production, jeoparidzing the Sustainable Development Goal 2 Zero Hunger. Organic farming and conservation tillage have been suggested to enhance drought resilience in croplands, but their impact needs further investigation. Thus, our project aims at understanding how drought affects crop growth and phenology in different cropping systems. First results based on the greenness index extracted from continuous phenocam images recorded in an unfertilized pea and barley mixture show a longer growing season to result in higher yields. Drought significantly shortened the growing season. Cropping systems had a minor effect on yield and did not buffer against the drought. In conclusion, drought directly shifted phenology and lowered yields, while neither organic farming nor conservation tillage mitigated the drought effect. Future analysis will investigate the situation in winter wheat where, due to intensive fertilization, stronger effects from cropping systems are expected.

12-OM Large-scale crop classification from satellite images

Authors: M.O. Turkoglu, J.D. Wegner

Affiliations: EcoVision Lab, ETH Zurich

Contribution to Sustainable Food Systems: Our research aims to develop an intelligent system to automatically predict cultivated crop types and detect over-fertilization in farmlands from satellite images. Thus, our research leads to more economic and environmental sustainability in food systems by making these time-consuming and labor-intensive tasks fully-automatic.

Abstract: Annual inspections of farmlands in Switzerland requires lots of human labor. Therefore, the Swiss Federal Office for Agriculture (BLW) initiated a four-year project in 2018 for developing an automatic system for farmland inspection from satellite images. For this project, we currently work on crop type classification method from publicly available Sentinal-2 images. Different crop types have different spectral and temporal characteristics. Therefore, in order to utilize this knowledge, we do sequence modeling. We use a recurrent neural network to process the data. Our model is fed with a temporal image sequence and it encodes both spectral and temporal information in the data and further makes the final prediction. We do not do any pre-processing; our model learns implicitly itself to discard uninformative noisy data e.g cloud, cloud shadow. Here, we present the project aim, the processing methods and the results/ validation for the model.

World Food System Center Research Symposium 2019

13-OM Use of nitrified urine fertilizer (NUF) in a hydroponic Bato bucket system

Authors: C. Staeheli, A. Hofmann, B. Wilde

Affiliation: Sustainable Agroecosystems, ETH Zurich

Contribution to Sustainable Food Systems: Human urine could be reused as fertilizer and lead to less usage of mineral fertilizer, which is expensive and energy consuming to produce. NUF may help developing countries obtaining a cheaper source of fertilizer and reuse urine waste from cities.

Abstract: The world is facing problems of sustainability more and more. Cropping systems, that use too many fertilizers or waste water sources are common. To tackle that problem, nitrified urine fertilizer was tested as a tomato plant fertilizer. This fertilizer is recycled from human urine, but unlike raw urine, it is treated for both pharmaceuticals and pathogens, thus making it hygienically safe. A nitrified urine fertilizer called "Aurin" from Eawag was used, which was officially allowed as a fertilizer in Switzerland by the federal office of agriculture (BLW) in 2018. In my experiment, the nitrified urine fertilizer was assessed as a fertilizer in consideration of plant nutrition and plant reaction to the new fertilizer compared to a general mineral fertilizer. On the other hand, the tomato plants were not grown in soil, but rather in a hydroponic Bato bucket system – one of the five treatments being a recycled system.

14-OM Biological Control: Fighting below ground insect pests with entomopathogenic *Pseudomonas b*acteria, nematodes and fungi

Authors: A. Spescha, M. Brunner, F. Scheibler, P. Flury, A. Guyer, G. Grabenweger, M. Maurhofer

Affiliation: Plant Pathology, ETH Zurich; Plant Protection, Agroscope

Contribution to Sustainable Food Systems: Below ground insect pests cause major losses, especially since most insecticides have been banned and resistance against bacterial *Bacillus thuringiensis* toxins has already developed. Therefore, a new bacterial biological control method is very important for organic agriculture and integrated pest management.

Abstract: Below ground pests are difficult to control because either no effective control methods exist or suitable insecticides are or will be banned due to their negative effects on the soil and non-target organisms. We evaluate the potential of a specific group of plant-beneficial fluorescent *Pseudomonas* bacteria with entomopathogenic activity for insect control. In a first screening, *Pseudomonas* strains were successfully tested against the cabbage root fly *Delia radicum*, an important pest in vegetable production. In a second step, entomopathogenic fungi and nematodes were screened for effectivity against *Delia* and promising isolates combined with the best *pseudomonads* to increase the reliability and efficacy of biocontrol measures. First results suggest that these biocontrol agents can be used in combination as the different organisms did not inhibit each other's infectiousness. We will further evaluate the efficacy of selected combinations and hopefully provide a new approach for the biological control of soil-dwelling pest insects.

15-OM Diversity-functioning relationships in agroecosystems: from crops over weeds to soil microbes

Authors: L. Stefan, C. Schöb

Affiliations: Agricultural Ecology, ETH Zurich

Contribution to Sustainable Food Systems: Intercropping contributes to increasing the sustainability of food systems, for it optimizes crop resource uses and increases diversity, which in turn provides ecosystem services such as increased nutrient cycling or reduced weed invasion, thus reducing chemical input needs.

Abstract: Biodiversity–ecosystem functioning relationships are a major research topic in ecology. However, applying this ecological concept to agricultural systems has rarely been done. Here, we conducted a diversity experiment using crop species and determined how diversity and functioning of crop communities extend to diversity and functioning of weed and soil microbial communities. We hypothesized that increasing crop diversity would lead to an increase in soil microbial diversity, but a decrease in weed diversity; likewise, highly productive mixtures would show higher soil microbial activity, but lower weed biomass. At all levels, we expected higher diversity to go along with increased productivity and activity. Preliminary results suggest that crop diversity positively affects crop yield, that weed biomass negatively correlates with crop yield and crop diversity, and that soil microbial activity is influenced mostly by abiotic factors and crop yield. This holistic approach provides evidence for intercropping as a sustainable method of food production.

16-OM The context dependence of resource partitioning in crop mixtures

Authors: N. Engbersen, C. Schöb

Affiliations: Agricultural Ecology, ETH Zurich

Contribution to Sustainable Food Systems: By investigating the potential of biodiversity for agroecosystems and getting a mechanistic understanding of these benefits in diverse cropping systems, we aim to achieve a more sustainable yet productive agriculture.

Abstract: Biodiversity can increase productivity in agricultural ecosystems due to a better use of resources. However, we still have a limited understanding of how environmental conditions such as climate and soil fertility modulate the effect of biodiversity on productivity. To better understand this effect in crop mixtures, we measured nitrogen and carbon content of crop plants (cereals, legumes and 4 different herbs) growing at four different diversity levels and at different stress levels (climatic: semiarid vs. humid, soil-fertility: nutrient-poor vs. nutrient-rich). We expect increasing crop diversity to lead to increased leaf N and C content and increased seed production compared to monocultures, but less than in isolated single plants. This would explain increased resource partitioning for crop species mixtures compared to monocultures, while demonstrating resource competition in monocultures and mixtures. Furthermore, we expect the difference in resource uptake of mixtures compared to monocultures to be more pronounced under more stressful conditions.

World Food System Center Research Symposium 2019

17-OM Exploring trajectories of shifting-cultivation landscapes through games: the case of Assam (India)

Authors: S. Bos, T. Cornioley, A. Dray, P. Waeber, C. Garcia

Affiliations: Forest Management and Development, ETH Zurich

Contribution to Sustainable Food Systems: Understanding what motivates indigenous farmers to depart from traditional subsistence practices and move to market oriented cash crop production as the result of local and global change is essential to better address sustainable economic development, biodiversity conservation and livelihood security.

Abstract: Understanding landscape change starts with understanding what motivates farmers to transition away from one system, shifting cultivation, into another, like plantation crops. We explored the resource allocation strategies of Karbi farmers living next to Kaziranga National Park in Northeast India. Together we developed a model of the local farming system in the form of a role-playing game. Using this model, we simulated 18 years of farming, and analysed the impacts of the farmers' decisions together. Once new economic opportunities arrived, the farmers were eager to embrace those options where investment costs are low. Returns on these investments were not automatically re-invested in further long-term, more expensive and promising opportunities. Instead, most is spend on improving the household living standards, and especially on the education of the next generation. The landscape changed profoundly due to the farmers' strategies. However, old practises that ensure food security are not easily given up.

18-OM Racing to recover: What determines smallholder responses to extreme weather events?

Authors: W. Thompson, S. Bonilla-Duarte, P. Kruetli, B. Kopainsky, A. Aguiar, J. Joerin, E. Chavez, J. Six

Affiliations: Sustainable Agroecosystems, ETH Zurich

Contribution to Sustainable Food Systems: Extreme weather events, such as hurricanes, have severe impacts on our food system, particularly for vulnerable smallholder farmers. The ability of smallholder farmers to recover from such shocks is important not only for their own livelihoods but also for the functioning of the food system as a whole.

Abstract: Extreme weather events such as hurricanes have severe impacts on our food system, particularly for vulnerable smallholder farmers. The ability of smallholder farmers to recover from such shocks is important not only for their own livelihoods but also for the functioning of the food system as a whole. Here we investigate how flooding induced by hurricanes Maria and Irma in 2017 impacts organic and conventional smallholder banana farmers in the Dominican Republic. We assess what determines their rate of recovery through a novel combination of on farm assessment-linked to regional scale remote sensing. We look to identify levers to enhance the resilience of this food system through an overall transdisciplinary approach.

19-OM Forest enrichment with Brazil Nut - An economic perspective

Authors: L. Bronzini, A. Müller, F. Chiriboga Arroyo

Affiliations: Institute of Environmental Decisions, ETH Zurich; Ecosystem Management, ETH Zurich

Contribution to Sustainable Food Systems: Making reforestation and enrichment in Brazil Nut concessions of Peru more financially competitive can ensure the maintenance of traditional nature-close forest management in vast areas of the region. This contributes directly to the SDGs 1, 2, 12, 13 and 15.

Abstract: Brazil Nut is one of the few globally traded NTFPs. Its production of 30 megatons is a substantial part of the global nut production. Also, it often goes hand in hand with the preservation of nature-close and highly divers rain forests and their services for humans. In order to keep the concession-based smallholder Brazil nut production in Madre de Dios, Peru, competitive with more intense alternative land uses (mining, cattle herding), it is crucial to extract a certain production volume per area. Planting activities have thus seen a significant increase in the region in the past decade. Different practices have been identified and proven to work. Many institutions and NGOs have thus started to offer support for smallholders. Previous studies have though rarely addressed the involved financial implications from a smallholder perspective. Collecting information on enrichment practices and involved costs and benefits will help identifying financial leeway for those 30'000 people living from Brazil Nut in the region.

20-OM Effects of organic farming on ecosystem services and grassland multifunctionality: the ServiceGrass Project

Authors: V. Klaus, N. El Benni, A. Lüscher

Affiliations: Grassland Sciences, ETH Zurich; Research Division Competitiveness and System Evaluation, Agroscope, Tänikon; Forage Production and Grassland Systems, Agroscope, Reckenholz

Contribution to Sustainable Food Systems: Our project studies how different types of grassland management affect yields and public ecosystem functions, such as recreational value, habitat function, and carbon fixation, in order to deduce recommendations on management practices that increase grassland multifunctionality for farmers and society.

Abstract: Sustainable agriculture delivers not only private ecosystem services, i.e. market goods, but also public ecosystem services, i.e. non-market goods and services. Agricultural intensification undermines the delivery of many public ecosystem services. Organic farming can decrease the environmental impact of intensive food production and might therefore be able to sustain the delivery of both private and public ecosystem services. However, this has never been comprehensively tested for organically managed grasslands. In the project ServiceGrass, we explore effects of organic grassland farming on 18 different ecosystem services and their simultaneous provisioning, referred to as multifunctionality, in Swiss grasslands. To assess the delivery of ecosystem service of grassland at farm-level, we will combine plot-level measurements with the Farm Accountancy Data Network. Findings of this project will underline strengths and weaknesses of organic and conventional farming systems in delivering private and public ecosystem services, helping to improve grassland farming for a more sustainable future.

21-OM Why are there regional differences in the uptake of organic farming?

Authors: M. Chautems, R. Finger, R. Huber

Affiliations: Agricultural Economics and Policy, ETH Zurich

Contribution to Sustainable Food Systems: Understanding why the adoption of organic farming is higher in certain regions is crucial to design efficient support mechanisms. This will speed up the development of organic farming and help us to move toward a resource-efficient and sustainable food system.

Abstract: From nowadays 14%, BioSuisse has the ambitious target to reach 25% of organic farms in Switzerland by 2025. This will require a well-though promotion strategy in regions with a low density of organic farms. The heterogenous distribution of organic farms can be explained either by spatially heterogenous locational factors (e.g. disadvantageous climate) or by the role of farmers interactions and other forms of spatial dependence. Our findings show that both elements plays a role in the adoption of organic farming, but that the role of spatial dependence is comparatively small. However, while the role of spatial dependence remains stable during the last 18 years, the importance of spatially heterogenous factor significantly decreases. Most organic conversions used to happen in the mountainous and urban regions, but the rural lowland is now experiencing a similar rate of conversion. Those results indicate that supporting the creation of peer networks is a valuable strategy to promote organic farming.

22-OM Towards a more energy-efficient and upscalable electrohydrodynamic drying of food

Authors: K. Iranshahi, A. Martynenko, T. Defraeye

Affiliations: Swiss Federal Laboratories for Materials Science and Technology (Empa); Department of Engineering, University of Milan, Italy; Department of Engineering, Truro, Canada

Contribution to Sustainable Food Systems: By targeting SDG 2, this promising technology provides faster drying with more nutritional content in dried material and less energy consumption compared to conventional dryers. Since it is non-thermal drying, damage to heat-sensitive compounds (e.g. vitamins, antioxidants) reduces.

Abstract: Electrohydrodynamic (EHD) drying is an innovative, non-thermal drying technology, which is predominantly used to dry agricultural food products. Here, dehydration is induced by invoking ionic wind via a high voltage discharge between two electrodes. Employing exergy analysis, mechanistic modeling and simulation, this study proposes an optimized emitter-collector electrode configuration. Energy efficiency analysis has been carried out for different sub-processes, namely ion production, ionic flow generation and convective dehydration. First, the impact of mesh wire diameter and mesh porosity on the electric field intensity, the Coulomb force, resulting airflow, and the fruit drying rate was explored. Secondly, a more optimal mesh configuration is designed as a trade-off between drying time, and energy consumption. Compared to conventional collector meshes, with this optimal configuration, similar airflow distribution and drying rate were obtained, but with almost ten times lower energy consumption. The improved mesh collector design is an important step towards energy efficient industrial-scale EHD drying.

23-O Effects of Spirulina intake on growth and metabolism of pregnant sows

Authors: R. Lugarà, M. Kreuzer, K. Giller

Affiliations: Animal Nutrition, ETH Zurich

Contribution to Sustainable Food Systems: Spirulina is a novel food, which can be produced sustainably. It provides proteins, fatty acids, bioactive components and other nutrients, and is applied as a supplement to prevent malnutrition and also suggested to ameliorate metabolic problems.

Abstract: *Arthrospira platensis* (Spirulina) is considered a 'superfood'. It is a rich source of nutrients, particularly proteins (60-70% of its dry weight), and bioactive compounds, which likely mediate the numerous postulated metabolic health effects. This makes Spirulina a promising herbal supplement for ameliorating or preventing the metabolic syndrome as a consequence of obesity. Due to their strong similarities to human physiology, pregnant pigs are used in this project as a model of maternal obesity to investigate potential direct and offspring effects of maternal Spirulina intake on the pigs' metabolism. In the first part of the experiment, gilts were fed *ad libitum* either a control diet or a diet rich in saturated fats and simple sugars (to mimic a Western diet). Half of the sows of each diet group were supplemented with Spirulina. Particular focus was given so far to weight gain, feed intake and blood metabolic markers in the mothers.

24-O Is replacing soybean meal and feeding a grass-silage based diet to growing bulls an option for increasing the sustainability of Swiss intensive beef production?

Authors: M. Kurrig, M. Kreuzer, B. Reidy, A. Scheurer, K. Giller

Affiliations: Animal Nutrition, ETH Zurich; School of Agricultural, Forest and Food Sciences (HAFL), Zollikofen

Contribution to Sustainable Food Systems: The sustainability of Swiss intensive beef production systems may be improved by increasing the shares of grassland-derived feeds, which are not competing with human food supply, and by replacing imported soybean meal (SBM) with alternative and preferably local protein sources.

Abstract: The present study evaluated the effects of replacing soybean meal by faba beans, pumpkin seed cake or Spirulina in a forage-based diet (50% grass silage, 30% maize silage, 20% concentrate) on fattening and slaughtering performance as well as on the nitrogen utilisation of growing bulls. Furthermore, a diet not supplemented with additional protein was tested. No significant differences between diets were found with respect to dry matter intake, average daily gains, feed conversion ratio and carcass quality. The results indicate that soybean meal can be replaced by any of the tested protein sources in a grass-silage based diet. However, an approximately 50% higher urinary nitrogen excretion was observed when supplementing any of the additional protein sources. This means that the supplemented protein was lost via urine. Thus, diets containing 50% grass silage seem to provide sufficient metabolisable protein to growing beef x dairy crossbred bulls.

World Food System Center Research Symposium 2019

25-O Combining oral vaccination and niche competition to fight antimicrobial resistance gene-reservoirs

Authors: V. Lentsch, C. Moresi, W. Hardt, D. Kümmerlen, M. Diard, T. Keys, E. Wetter-Slack

Affiliations: Laboratoy of Food Immunology, ETH Zurich; Institute of Microbiology, ETH Zurich; Schweinemedizin, Vetsuisse-Faculty, University of Zurich; Biozentrum, University of Basel

Contribution to Sustainable Food Systems: Our research should not only lead to the reduction of antimicrobial resistant bacteria on meat as well as plants and crops but by preventing disease in food producing animals it should also lead to further reduction of antibiotic usage in livestock.

Abstract: Antibiotic resistance poses an existential threat to global health. Despite the big effort of European countries to minimize antibiotic use, antibiotic resistance is still on the rise. Many antimicrobial resistant (AMR) bacteria are found in the intestinal tracts of humans and livestock. This large AMR-gene reservoir and the low fitness cost for bacteria of carrying AMR genes makes solitary reduction of antibiotic usage insufficient to tackle the current crisis. To approach this problem we follow a two-pronged strategy that combines inactivated oral vaccines with engineered bacterial competitors. The antibody response raised by vaccination will decrease the competitive fitness of the targeted strain and inhibit transfer of AMR-carrying plasmids to other bacterial species. To increase the robustness of this system further, we will introduce an avirulent, non-antibiotic resistant competitor strain that will take over the occupied gut niche. Whilst this should lead to elimination of the targeted species, it will also prevent disease outbreaks in farms that are often associated with the removal ofprophylactic antibiotics. We have proven the validity of our approach in a murine model of non-typhoidal Salmonellosis, where we could dramatically reduce pathogen loads and intestinal inflammation. Currently, our oral vaccination techniques are being tested in pigs, and a preliminary study has demonstrated no adverse reactions to the vaccine preparations.

26-O Nose to Tail – safety assessment of slaughtering byproducts

Authors: D. Etter, M. Morach, N. Käppeli, M. Hochreutener, S. Johler, J. Julmi, R. Stephan

Affiliations: Laboratory of Food Microbiology, ETH Zurich; Vetsuisse Faculty, University of Zurich

Contribution to Sustainable Food Systems: The microbial safety assessment of slaughtering byproducts is crucial in order to release these products for human consumption. Our study adds value to a nutritionally rich product by demonstrating that it poses no health risk if handled with good manufacturer's practice. This ultimately reduces food waste and promotes nose to tail eating.

Abstract: Many parts of pork meat processing are currently not used for human consumption in Switzerland, although they are of great nutritional value. Therefore, data on the occurrence of pathogenic organisms on byproducts is extremely scarce and the prevalence and population structure of *Staphylococcus aureus* on meat processing side streams is unknown. Hence, abattoir byproducts of pork origin including ear, forefoot, heart, intestine, liver, rib bone, sternum, bladder, stomach, hind foot and tongue originating from six abattoirs were screened for *S. aureus*. The obtained isolates were investigated by *spa* typing and DNA microarray analysis to reveal their genomic profile

and population structure. Analysis of bacterial isolates revealed that pork byproducts do not pose a greater health risk to consumers than conventional meat cuts in regards to *S. aureus*. Adequate handling should therefore ensure food safety and reduce food-waste.

27-O Symbiosis opportunities between food and energy system: the application of manure based biogas as heat source for greenhouses

Authors: V. Burg, F. Golzar, G. Bowman, S. Hellweg, R. Roshandel

Affiliations: Environmental Engineering, ETH Zurich; Swiss Federal Research Institute of Forest, Landscape and Snow (WSL); Energy Engineering, Sharif University of Technology, Tehran, Iran

Contribution to Sustainable Food Systems: The use of manure-based biogas as heat source for greenhouses is presented as a promising concept within the food-energy nexus. The system presents many advantages associated with sustainable agriculture, such as reducing energy demand, mitigating GHG emissions, and economical land-use.

Abstract: The concept of symbiosis, a mutually beneficial relationship in biology, can be applied between food and energy systems, which are key features for a sustainable agriculture. Here, we focus on the spatial analyse of the potential manure based biogas as heat source for greenhouse as a symbiosis opportunity in a food/energy nexus, thus contributing to sustainable food systems. Greenhouse systems are promising technologies in the concept of food-energy nexus, allowing for year-round supply, water savings, and economical land use. Additionally, manure resources available for bioenergy is high and largely underused. Through a feasibility study, we couple the potential waste heat supply from manure-based biogas and the greenhouse heat demand. Hence, we quantified the feasibility of producing food from greenhouses in Switzerland. Thus, systems with combined agricultural biogas production and greenhouse cultivation are feasible in Switzerland and our method can be applied to other regions.

28-O Prospects of Digital Agricultural Policy

Authors: M. Ehlers, R. Huber, R. Finger

Affiliations: Agricultural Economics and Policy, ETH Zurich

Contribution to Sustainable Food Systems: Agricultural policy is the key public policy field for ensuring sustainable food systems. The use of digital technology in agricultural policy promises to more effectively address social, economic and environmental sustainability goals, but could also challenge some.

Abstract: Digital technologies are increasingly used in agricultural production, including up- and down-stream supply chains of the agri-food industry. While there are great expectations of digitalisation, limited attention is given to digitalisation of agricultural policy. This is surprising as agriculture is a heavily regulated sector with many policy challenges. We investigate how digitalisation affects agricultural policy on two levels. First, we investigate conceptually how digital technologies can impact on the choice of and the design of agricultural policy measures such as regulatory standards and subsidies. Second, we explore future prospects of digital agricultural policy with help of a Delphi study, combined with a scenario development workshop that utilises expert knowledge. This yields distinct scenarios of digital agricultural policy in Europe that can guide further research and policy making. They help contextualising future options, barriers and risks of using digital technology to support agricultural policy measures.

29-O Freezing of vegetables for maximal cell survival

Authors: S. Schudel, K. Prawiranto, T. Defraeye

Affiliations: Laboratory for Biomimetic Membranes and Textiles, Swiss Federal Laboratories for Materials Science and Technology (Empa); Plants and Plant Product Devision, Agroscope

Contribution to Sustainable Food Systems: Freezing is crucial to extend the shelf life of perishable products and to reduce food waste. The investigation of the freeze process enables the improvement of current freezing protocols and helps the development of sustainable solutions.

Abstract: Freezing is a standard method to preserve perishable agricultural products like fruits and vegetables and to increase their off-season availability. Nevertheless, freezing of highly aqueous plant tissue causes the formation of ice crystals and cellular damage, which reduces product quality (e.g. by drip loss and reduced firmness). To maximize cell survival for industrial scale freezing, a detailed insight in the freezing process and the microstructural changes in frozen vegetables cells is required. We analyzed the quality of thawed carrots, bell peppers and cucumbers testing various freezing methods. The tissue microstructure was investigated by X-ray computed tomography. We found, that convective dehydrofreezing of bell pepper leads to significantly firmer products than conventional freezing at -20°C. For carrots, all tested freezing methods lead to enhanced quality compared to conventional freezing. For cucumbers, conventional freezing with or without pretreatments provoked less tissue damage than freezing at ultra-low temperatures.

30-O Digital twins: The next hot topic in fresh-produce cold chains!

Authors: C. Shrivastava, T. Defraeye

Affiliations: Laboratory for Biomimetic Membranes and Textiles, Swiss Federal Laboratories for Materials Science and Technology (Empa)

Contribution to Sustainable Food Systems: Reducing food loss and making the refrigerated supply chain greener is critical towards reaching the global Sustainable Development Goals (SDGs), especially SDG 2 (Ending Hunger), SDG 3 (Ensuring good health and well-being), SDG 9 (Fostering sustainable industrialization and innovation) and SDG 12 (Ensuring sustainable consumption and production patterns).

Abstract: The globalization of food systems has increased the dependency on refrigerated supply chains for the long-haul transport of fresh-produce. However, these cold chains are associated with significant losses as every shipment experiences a unique cooling history, consequently manifesting a unique quality evolution. A digital twin is a virtual representation of a horticultural produce in the cold chain, which is linked to its real-world counterpart by sensor data that monitors the environmental parameters in real supply chains. This study presents a case study of digital twinning in the citrus cold chain, employing a physics-based mechanistic model to demonstrate in-silico the variation in food quality evolution for different shipments. Here, trade-offs are identified between temperature-dependent biochemical degradation reactions, mass loss, risk of condensation, phytosanitary risks, and chilling injury. The developed digital twin is instrumental in understanding when and where fruit quality loss occurs in each supply chain, and accordingly predicting the remaining shelf life days. This can improve the cold chain efficiency and logistics, contributing towards reducing food loss.

31-O Digit Soil

Authors: S. Meller, K. Normak, H. Iven, V. Růžička, E. Frossard

Affiliations: Plant Nutrition, ETH Zurich; Swiss Federal Research Institute of Forest, Landscape and Snow (WSL)

Contribution to Sustainable Food Systems: We are creating solutions for better soil management, responding to the needs of a more responsible production (SDG 12), in protecting the soil biotope (SDG 15) and advising farmers for building more resilient farming systems (SDG 2 and SDG 13).

Abstract: Healthy soils are of major importance for resilient farming systems since it provides balanced nutrient availability, good soil structure, and high microbial activity. Many important soil processes still remain poorly understood and it remains difficult to reliably advise farmers on soil management. In microbiology robust measurements of soil are important to precisely model the underlying processes, however due to equipment limitations they tend to be only possible in laboratories. Samples taken in remote areas can degrade over time which makes these measurements less reliable. We propose an idea for a new device which would be capable of doing robust measurements *in situ* and therefore alleviate this problem. Eventually, we aim at having a standardized collection mechanism across research laboratories worldwide and make a research network creating a large scale dataset of soil samples.

32-O Variable rate technologies – costs and benefits of increasing information accuracy

Authors: K. Späti, R. Huber, R. Finger

Affiliations: Agricultural Economics and Policy, ETH Zurich

Contribution to Sustainable Food Systems: Considering heterogeneous production conditions within fields is expected to increase the efficiency of nitrogen fertilization and reduce nitrogen losses from agriculture. We calculate the profitability of precision agriculture techniques to identify management options for increasing sustainability in small-scaled farming systems.

Abstract: Improving nitrogen use efficiency is crucial for tackling systematic agricultural challenges. Nitrogen fertilization with site-specific management using variable rate technologies (VRT) is expected to increase nitrogen use efficiency and reduce nitrogen losses by tailoring nitrogen application to crop, soil and other environmental traits. One of the key barriers to VRT adoption is that the cost of VRTs can outweigh the benefits for the mostly small-scaled family farms that still prevail in Europe. Recently, technological developments have broadened the range of cost-effective technologies for crop scanning (e.g. satellites, drones) and nitrogen application. These are not yet included in VRT literature. We conceptually investigate the applicability of different VRTs in small-scale farming systems, depending on different economic and ecological conditions (e.g. field size, heterogeneity etc.). Results from our conceptual model show which type of technology (or suite of technologies) is profitable under different environmental conditions and different institutional arrangements for technology use.

World Food System Center Research Symposium 2019

33-O The optimal drought index for designing weather index insurance

Authors: J. Bucheli, T. Dalhaus, R. Finger

Affiliations: Agricultural Economics and Policy, ETH Zurich

Contribution to Sustainable Food Systems: Weather index insurance can mitigate financial climate risks (SDG 13). This removal of financial downside risks helps to overcome poverty traps (SDG 1), improves farmers' well-being (SDG 3) and facilitates economic growth in the agricultural sector (SDG 8).

Abstract: Climate change increases drought risks in most of currently arable regions. Weather index insurance can absorb financial consequences of catastrophic drought events. However, the risk-reducing potential depends on the underlying drought index that should indicate drought losses accurately. We here propose weather index insurance using prominent drought indices that are based on precipitation, soil moisture and evapotranspiration. Taking winter wheat production in Eastern Germany as case study, we find that several drought indices can reduce risk exposure, but the evaporative stress index is on average superior. Yet, our results show that there is not a universally best drought index, but a need for farm-specific identification of the most risk-reducing underlying drought index to achieve the greatest risk reduction.

34-O Country-wide high-resolution vegetation height mapping with Sentinel-2

Authors: N. Lang, K. Schindler, J.D. Wegner

Affiliations: EcoVision Lab, Photogrammetry and Remote Sensing, ETH Zurich

Contribution to Sustainable Food Systems: Our aim is to stop commodity driven deforestation in the tropics to mitigate climate change. Monitoring forests at large scale allows to make informed sourcing decisions, which is the first step towards sustainable and deforestation free supply chains.

Abstract: The aim of this joint ETH Zurich-Barry Callebaut project is to develop an objective, automated tool to guide sustainable agribusiness. Commodities like palm oil have been strong drivers of deforestation in tropical regions, which is a worldwide problem accelerating climate change, destroying the livelihood of local communities and animals. However, quantifying its actual impact is difficult because one has to consider carbon, climate, biodiversity, and local communities. Therefore, the High Carbon Stock (HCS) Approach accounts for all important factors to protect primary rainforest, while ensuring the rights of traditional communities. Our research project focuses on supervised Machine Learning (deep learning) to classify landscape in satellite images and to identify and monitor high-carbon stock forests by following the HCS approach. Our presented method allows to map vegetation height (as an HCS indicator) at country-scale with a 10 m resolution using publicly available satellite images from ESA's Sentinel-2 mission.

35-O Irrigation modernization: Towards a more sustainable use of freshwater resources in citrus production?

Authors: S. Pool, F. Frances, A. Garcia-Prats, C. Puertes, M. Pulido-Velazquez, C. Sanchis-Ibor, M. Schirmer, H. Yang, J. Jimenez-Martinez

Affiliations: Water Resources and Drinking Water, Eawag; Systems Analysis, Integrated Assessment and Modelling, Eawag; Research Institute of Water and Environmental Engineering (IIAMA), Polytechnic University of Valencia; Valencian Center for Irrigation Studies, Polytechnic University of Valencia; Environmental Science, University of Basel; Civil, Environmental and Geomatic Engineering, ETH Zurich

Contribution to Sustainable Food Systems: Understanding the effects of irrigation modernization (under changing land use and climate conditions) on the availability of regional water resources is fundamental to support decision makers in achieving a more sustainable future in irrigated agriculture.

Abstract: Understanding how water resources management in agricultural areas can promote a more sustainable use of water is essential for securing future food production. Spain, and in particular the citrus production in Valencia, is an example where decisions at water management level have led to a gradual modernization of irrigation technologies at the farm level by changing from traditional flood irrigation systems to pressurized drip systems. In this study, we specially adapted a hydrological model to simulate the difference in water balance components as a function of irrigation method and crop type. We found that the subsequent spatially distributed multi-variable evaluation was an essential step in evaluating the success of the implementation of drip and flood irrigation into the hydrological model. Our results help to improve the understanding of the functioning of hydrological systems under change and can serve a basis for recommendations towards a more sustainable future in irrigated agriculture.

36-O Elucidating farm system economics as influenced by agroforestry in West Switzerland.

Authors: U. Le Goff, D. Barjolle, J. Six

Affiliations: Sustainable Agroecosystems, ETH Zurich

Contribution to Sustainable Food Systems: In a context of climate change, biodiversity downfall and declining soil fertility, agroforestry may provide part of the answer to instill sustainable agriculture. This project aims to unravel the economic uncertainties influencing the development of agroforestry systems in Switzerland.

Abstract: In the context of climate change, biodiversity downfall and declining soil fertility, agroforestry may provide part of the answer to instill sustainable agriculture. By integrating trees in existing farm systems, it can mitigate climate change, provide habitat for biodiversity, and reduce erosion risks, among other ecosystem services. Through a scientific monitoring of existing old and new farm systems involved in agroforestry over 8 years and across 4 Cantons, this project will provide information on the relevance of agroforestry for Switzerland to meet its numerous objectives. To meet this ambition, a transdisciplinary team of researchers involving FiBL, UniNE, Agroscope and ETHZ and more than 100 farmers is developed. The ETHZ will focus on the economic and carbon sequestration aspects of agroforestry, which will be integrated with other measures (e.g. erosion mitigation) to assess ecosystem services provided by agroforestry at the farming system level.

37-O Critical resilience – Poverty traps and power relations in face of climate change– The case of tomato value chain in Ghana

Authors: K. Benabderrazik, L. Jeangros, J. Six

Affiliation: Sustainable Agroecosystems, ETH Zurich

Contribution to Sustainable Food Systems: This research focuses on enhancing tomato farmer's resilience in face of climate change, aiming to identify the dynamics that drives poverty and food insecurity traps in the Upper East region of Ghana. This work thus directly tackles SDGs 1&2.

Abstract: The Upper East region of Ghana displays one of the highest rates of poverty and food insecurity of the country. To secure their livelihood, farmers try to integrate the economy through the selling of cash crops, mainly tomatoes. However, the region is characterized by increasing pressure from climate change events. For rain-fed agriculture, climate dependency generates production variability. When coupled with market failures and price volatility, farmers are left in a poverty trap. This study aims to understand ways to enhance tomato farmer's resilience in face of climate change. Data collected from experts' interviews and a survey enables to depict the interactions and dynamics within this agri-food system. Ultimately, we argue that integrating power relations into food systems analysis provide better insights on ways, not only to adapt, but to transform in face of a shock. We believe this approach will bring us a step forward to a critical resilience.

38-O PubliFarm Research Days: Chewing cows, apple trees and earth worms – An on-farm science experience for the public

Authors: S. Keller, N. Buchmann

Affiliations: Grassland Sciences, ETH Zurich

Contribution to Sustainable Food Systems: PubliFarm is a dialog project between young researchers, farmers and consumers in the context of biodiversity and climate change in agriculture. It promotes a reflection on consumer behavior and production, in line with SDG 12 Responsible Consumption and Production.

Abstract: How many earthworms live in this soil? How often does this cow chew? Is the insect on this apple tree a pest or a beneficial insect? During the last three years, the Agora project PubliFarm invited the public to do their own research. During eight interactive PubliFarm Research Days, the public could carry out hands-on experiments in the field on farms in the German speaking part of Switzerland. Young scientists coached visitors and put their findings in the context of sustainable agricultural production. The hosting farmers presented their farm and production methods during farm tours and could answer many questions of visitors. PubliFarm is a natural science education project of the science didactics group of the education department of the University of Applied Sciences of Northwestern Switzerland (PH FHNW) and the Grassland Sciences Group of ETH Zurich, funded by the Swiss National Science Foundation (SNSF).

39-O The Relationship between Food Disgust Sensitivity and Sustainability

Authors: J. Ammann, M. Siegrist, C. Hartmann

Affiliations: Consumer Behaviour, ETH Zurich

Contribution to Sustainable Food Systems: One third of the food produced is wasted. To tackle this issue, it is of crucial importance to understand its drivers. In the present study, we found a relationship between an individual's food disgust sensitivity and their edibility assessment for various foods.

Abstract: The present study aimed to investigate the relationship between people's food disgust sensitivity and their food hygiene behaviour. We asked 1066 participants in Switzerland to complete an online survey. They provided information on how often they performed certain hygiene behaviours, how likely they would be to eat different food items after they had passed their expiration dates, and, using a specific scenario, how they would decide whether milk was safe to drink after they forgot to put it in the refrigerator overnight. We found that food disgust sensitivity was a significant predictor of participants' edibility assessments and their reported frequencies of hygiene behaviour after controlling for age and sex. Our data suggested that food disgust was a strong predictor of food safety behaviour and food wastage behaviour in the domestic kitchen. Learning more about people's behaviour is crucial for the successful design of interventions to prevent food waste.

40-O Consumer's knowledge gain through a cross-categorical environmental food label

Authors: M. Dihr, M. Siegrist, B. Sütterlin

Affiliations: Consumer Behaviour, ETH Zurich

Contribution to Sustainable Food Systems: Informing consumers about the environmental impact of different food choices could lead to consumption pattern change and ultimately to a reduced global agricultural demand.

Abstract: In order to provide consumers with a neutral, easy-accessible and effective source of information about the environmental impact of food items, a label based on Life Cycle Assessment was created. Through an online survey, the consumer's knowledge, the label's usefulness and its demand were assessed. We conclude that consumers lack the ability to correctly rank the environmental impacts of crosscategorical food comparisons. The misjudgment can be corrected by using a color-coded, crosscategorical label, present on every product. Together with the findings of other studies the obtained results indicate that the characteristics of the label are crucial for its efficiency. Furthermore, the majority of participants stated that they would appreciate the introduction of the proposed label and consider it for their shopping choices.

World Food System Center Research Symposium 2019

41-O Can consumers contribute to the resilience of the food systems?

Authors: E. Monastyrnaya, J. Six

Affiliations: Sustainable Agroecosystems, ETH Zurich

Contribution to Sustainable Food Systems: In the world of changing climate building resilience of farmers is essential. In this study, we have conducted an online survey among 1200 Swiss consumers to investigate whether farmers could count on consumers support in case of a climatic shock.

Abstract: People of 21st century pay more and more attention to matters that are beyond their immediate consumption practices. Subsequently, the new demand patterns for food products emerge: consumers are willing to pay more for food produced locally, organically or in socially-fair way. However, in the discussions about food system resilience, consumers are mostly addressed as passive stakeholders whose nutritional needs are expected to be satisfied throughout times of supply disruptions. Others see consumers' role even more pessimistically: as a potential source for risk, as changes in demand can negatively affect upstream activities of value chains. In this study, we explore whether and to what extent consumers could play a positive role in resilience of farmers in times of shocks. The results of an online survey among 1200 Swiss consumers showed that consumers 1) show a high willingness to support Swiss farmers in case if a summer drought affects their activities and 2) are willing to pay extra for milk, beef, wheat, potato and wine products to compensate the losses caused by the summer drought.

42-O Rheology of Swiss Cheese Fondue

Authors: P. Bertsch, L. Savorani, P. Fischer

Affiliations: Institute of Food, Nutrition and Health, ETH Zurich

Contribution to Sustainable Food Systems: This work strives to raise public awareness for the complexity of food products and related research at ETH Zurich using a traditional Swiss food: fondue. The results demonstrate the interactions in dairy multiphase systems and provide an adequate tool for their assessment.

Abstract: Cheese fondue is a traditional Swiss dish prepared by melting cheese under the addition of wine, starch, and seasoning. The viscosity and flow behavior of fondue is of particular importance for mouthfeel, flavor perception, and making the cheese cling to the bread for consumption. We tackled the complex multi-phase system fondue from a material science perspective, providing a scientific framework for the influence of fondue ingredients and their interactions on the rheology of cheese fondue. Fondue can be considered a water continuous system whose viscosity is influenced by the interactions of its main colloidal ingredients: dispersed casein micelles, emulsified fat droplets, and swollen starch granules. A model moitié-moitié fondue was prepared with water and the influence of starch concentration and wine constituents (ethanol, acid) on fondue rheology were assessed.

43-O Iron requirements in women and children

Authors: C. Speich, M. Zimmermann

Affiliations: Laboratory of Human Nutrition, ETH Zurich

Contribution to Sustainable Food Systems: Reliable data on iron requirements are crucial for reaching the goal of a 50% reduction in anemia prevalence among women of reproductive age implemented in target 2.2: end all forms of malnutrition of the UN Sustainable Development Goals for 2030.

Abstract: Iron deficiency (ID) is the most common nutritional disorder worldwide and thus an important actor within the Zero Hunger Goal of the UN Sustainable Development Goals. Nutritional ID occurs when physiological iron requirements cannot be covered by iron absorption. However, as physiological iron requirements are difficult to predict, dietary iron intake recommendations by WHO still base on one early publication from the 1960s. With the novel dilution of labelled body iron methodology we measured iron absorption, iron loss and iron balance in women of reproductive age in Benin and Switzerland, in toddlers in The Gambia as well as in school-aged children in Malawi and precisely confirmed the indirect, theoretical WHO iron requirement estimations. Reliable data on iron requirements as well as the proportions of iron absorbed and lost are crucial for design and implementation of iron intervention programs. Our findings are invaluable for further programs to improve iron nutrition.

44-O Iodine absorption and thyroidal uptake: A novel ^{129}I tracer method for their assessment in humans

Authors: V. Galetti, O. Van der Reijden, A. Mannhart, L. Stierli, A. Krzystek, C. Zeder, M. Andersson, I. Herter-Aeberli, N. Casacuberta, C. Vockenhuber, M. Zimmermann

Affiliations: Laboratory of Human Nutrition, ETH Zurich

Contribution to Sustainable Food Systems: Optimal maternal iodine stores are critical to cognitive development of their fetuses, but iodine requirements of women of reproductive age have never been directly quantified. This safe tracer-based method contributes to SDGs no poverty and good health and well-being.

Abstract: Radioiodine species were previously used to trace iodine metabolism, but these cannot be used safely in women or children, for whom iodine requirements have never been directly measured. Our objective was to assess ^{129}I, a semi-stable isotope, as a novel tracer for the measurement of iodine fractional absorption (^{129}IFA) and iodine thyroidal uptake (^{129}ITU). We administered an oral dose of ^{129}I (12.42±0.05 µg) to eight euthyroid adults with adequate iodine intake and we measured ^{129}I recovery in urines (^{129}IU), feces (^{129}IF) and plasma (^{129}IP) using mass spectrometry. ^{129}IU was 63.3±9.2% of dose and ^{129}IF was 4.7±3.2%. ^{129}IFA (calculated as ^{129}I Dose minus ^{129}IF) was 95.3±3.2% and ^{129}ITU (^{129}IFA minus ^{129}IU) was 32.0±7.3%. Preliminary analysis of ^{129}IP kinetics indicated that iodine metabolism is based on three compartments. This novel method, that safely traces iodine metabolism from a single oral dose, could be used to assess iodine bioavailability from foods and determine iodine requirements.

World Food System Center Posters

Sustainable food systems World Food System Center

We act as a platform to bring together our members' multidisciplinary expertise with strategically relevant external partners and to provide the leadership and foresight needed to create innovative solutions.

Future Food Initiative - Promoting talents and new ideas for food systems of the future World Food System Center

Future Food provides opportunities to educate and train new talent around the food value chain by leveraging the complementary strengths of the Swiss academic and industrial research communities.

World Food System Center Mercator Program World Food System Center

The Mercator Program, in partnership with the Mercator Foundation Switzerland, supports activities in research, education, and outreach to explore the role and potential of organic production systems to contribute to global food security.

The World Food System Center Alumni Network (WFSCAN)- organized by alumni for alumni N. Bartolomé, V. Loaiza, M. Wiget, on behalf of WFSC alumni

WFSC Alumni Network (WFSCAN) allows alumni to share knowledge, learn, discuss and create solutions on food system challenges. A new digital platform allows alumni from around the world to engage, organize events, look for support/ expertise in cohort, and share job opportunities. We believe that this unique international community of food system experts can potentially lead to innovative co-creation of knowledge processes.

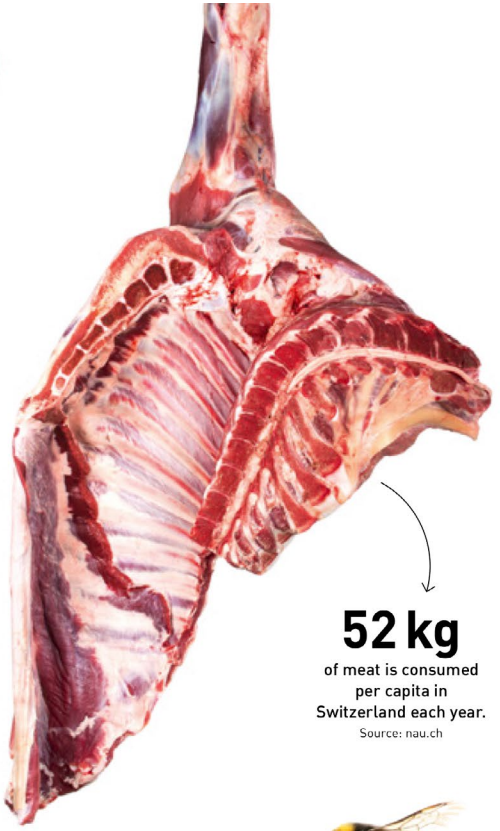
Creating sustainable change in food systems: The WFSC Summer School 2019 M. Grant, M. Piessens

The World Food System Summer School is an innovative approach to education that teaches participants to navigate complexity and build sustainable food systems. The course has taken place 8 times in 4 different countries, training 188 participants from 54 different nationalities. Built around 12 key design criteria, it is rigorous, meaningful and impactful for participants.

ArtScience: Creativity, curiosity, and courage World Food System Center

Is it Art? Is it Science? Knowledge transfer between artists and scientists does not have to be all about knowledge itself, but about sharing the process- the scientific process and the creative process. Visit the ArtScience exhibit in the Clock Hall!

1/3
of all the food produced in Switzerland ends up as food waste.
Source: foodwaste.ch



52 kg
of meat is consumed per capita in Switzerland each year.
Source: nau.ch

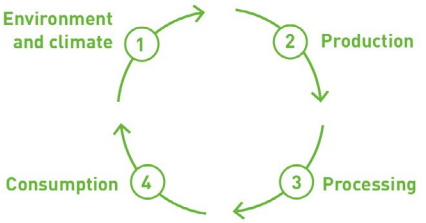
60%
of the 1,143 recorded insect species in Switzerland are endangered or threatened.
Source: naturwissenschaften.ch

9.7 bn
people will inhabit Earth by 2050
Source: UN

Our food: climate change, global population growth and biodiversity loss are a threat to our food system.

45%
of the planet's land surface is used for livestock farming.
Source: planted.ch

We need to take a more sustainable approach to what we eat and how we produce it. In its search for solutions, the ETH World Food System Center deploys cutting-edge technology to investigate the entire food value chain.



Graphic from *ETH GLOBE* 3/2019

25%
less precipitation will fall in Switzerland by the middle of this century.
Source: CH2018

Layout & Content: Nadine Stähli and
Jeanne Tomaszewski

Contact

ETH Zürich
World Food System Center
Stampfenbachstrasse 52
8092 Zurich

www.worldfoodsystem.ethz.ch